

Project No.: GXHBS- 2006-01-001

**The 900,000 Ton Pulp and 900,000 Ton Paper and  
Cardboard Project of Stora Enso (Guangxi) Pulp & Paper  
Co., Ltd**

# **Environmental Impact Report**

## **Volume I**

Compiler: Research Institute of Environmental Protection of Guangxi  
Zhuang Autonomous Region

Certificate No.: GHPZJZ NO. 2902

Time of Compilation: October 2008

Note; The document is a translation of the Chinese EIA report submitted for application for the environmental approval for the project according to Chinese regulations. The approval process took place in 2008.

The translated report has been edited by Stora Enso for the purpose of public disclosure. Certain financial information and technical details of the planned investment have been removed from the text.

Project Name: The 900,000 Ton Pulp and 900,000 Ton Paper and Cardboard Project of Stora Enso (Guangxi) Pulp & Paper Co., Ltd.

Industry Type: Light industry

Document Type: Environment Impact Report

Entrusting Unit: Stora Enso (Guangxi) Pulp & Paper Co., Ltd.

Evaluation Unit: Research Institute of Environmental Protection of Guangxi Zhuang Autonomous Region

Legal Representative: Li Min

Approved by:

Audited by:

Checked by:

|                  |                  |                                                                           |
|------------------|------------------|---------------------------------------------------------------------------|
| Project leaders: | (Senior engineer | Certificate No. of Environmental Impact Assessment Engineer A29020020300) |
|                  | (Senior engineer | Certificate No. of Environmental Impact Assessment Engineer A29020041000) |
|                  | (Senior engineer | Certificate No. of Environmental Impact Assessment Engineer A29020030300) |

Cooperation Unit: Environmental Protection Research Institute of Light Industry

Legal Representative: Cheng Yanjun (Director)

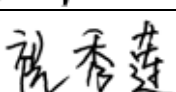
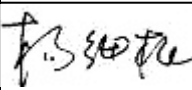
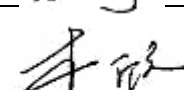
Cooperative Unit: Tianjin Research Institute for Water Transport Engineering of Ministry of Communications

Legal Representative: Zhao Chongjiu (Director)

Cooperative Unit: Guangxi Beihai Environment Monitoring Station

Legal Representative: Wang Rongli (Head)

## Assignment of compilers of the report

| Name          | Professional title | No. of qualification certificate | Contents of chapters                                                                                                                                                    | Signature                                                                             |
|---------------|--------------------|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Yu Wanli      | Senior engineer    | A29020014                        | General rules and evaluation conclusion                                                                                                                                 |                                                                                       |
| Wang Jie      | Senior engineer    | A10280006                        | Project overview and analysis, pollution prevention measures, cleaner production & control assessment                                                                   |    |
| Yue Bing      | Engineer           | A10280034                        |                                                                                                                                                                         |    |
| Zhu Xiulian   | Engineer           | A10280040                        |                                                                                                                                                                         |    |
| Pang Shaojing | Senior engineer    | A29020002                        | Project overview and analysis, pollution prevention & control measures,                                                                                                 |                                                                                       |
| Gu Zhanqi     | Senior engineer    | A29020005                        | Investigation and evaluation on land area water environment, impact analysis of solid wastes, cleaner production assessment and industrial policy review                |                                                                                       |
| Zhang Guangyu | Researcher         | A11030002                        | Prediction and evaluation of impact on sea water environmental quality                                                                                                  |  |
| Yang Xigen    | Senior engineer    | A11030020                        |                                                                                                                                                                         |  |
| Dong Shipai   | Engineer           | A11030043                        |                                                                                                                                                                         |  |
| Mao Tianyu    | Engineer           | A11030021                        |                                                                                                                                                                         |  |
| Li Xin        | Engineer           | A11030019                        |                                                                                                                                                                         |  |
| Gan Zhengqi   | Senior engineer    | A29020003                        | Status assessment and impact prediction on quality of atmosphere environment                                                                                            |                                                                                       |
| Zeng Hui      | Senior engineer    | A29020042                        | Status investigation and impact analysis on marine ecological environment                                                                                               |                                                                                       |
| Huang Shiyong | Engineer           | A29020009                        | Status investigation and impact analysis on sea water environment quality, water resources demonstration and impact analysis, rationality analysis on address selection |                                                                                       |

| Name          | Professional title | No. of qualification certificate | Contents of chapters                                                                                                                                                                                       | Signature |
|---------------|--------------------|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Zhong Shanjin | Senior engineer    | A29020020                        | Environmental protection management and monitoring system                                                                                                                                                  |           |
| Lin Weidong   | Senior engineer    | A29020012                        | Status investigation and impact analysis on land ecological environment quality, summary of environmental impact report on forest bases                                                                    |           |
| Luo Yaxue     | Senior engineer    | A29020006                        | Environmental impact assessment during construction, impact analysis on logistics transportation, water and soil conservation measures, total pollutant emission control index and regional reduction plan |           |
| Chen Qiuying  | Senior engineer    | A29020008                        | Impact analysis on regional social & economic development, economic cost-benefit analysis environmental impact                                                                                             |           |
| Wen Fengyu    | Assistant engineer | A29020028                        | Environmental risk analysis                                                                                                                                                                                |           |
| Liang Xiaohua |                    | A29020031                        | Regional environment overview, prediction of impact and assessment on acoustic environment quality, assessment on the quality status of marine organisms quality                                           |           |
| Zheng Xin     |                    | A29020032                        | Public participation, drawing                                                                                                                                                                              |           |

# Table of Contents

## Volume I

|                                                                                                    |            |
|----------------------------------------------------------------------------------------------------|------------|
| <b>1 General Rules</b>                                                                             | <b>1</b>   |
| 1.1 Project Background                                                                             | 1          |
| 1.2 Goal of Evaluation                                                                             | 2          |
| 1.3 Basis of Compilation                                                                           | 3          |
| 1.4 Term and Scope of Evaluation                                                                   | 7          |
| 1.5 Division of Environmental Compliance Function Zones and Evaluation<br>Implementation Standards | 8          |
| 1.6 Key Points for Evaluation                                                                      | 13         |
| 1.7 Pollution Control & Environmental Protection Target                                            | 13         |
| 1.8 Evaluation Level                                                                               | 20         |
| 1.9 Evaluation Procedure                                                                           | 22         |
| <b>2 Environment Overview of the Surrounding Area of the Project</b>                               | <b>23</b>  |
| 2.1 Geographical Location                                                                          | 23         |
| 2.2 Overview of Natural Environment                                                                | 23         |
| 2.3 Overview of Zoning Planning in Tieshan Port District                                           | 28         |
| 2.4 Overview of Social Environment                                                                 | 33         |
| 2.5 Overview of Pollution Source                                                                   | 34         |
| <b>3 Project Overview and Analysis</b>                                                             | <b>39</b>  |
| 3.1 Project Overview                                                                               | 39         |
| 3.2 Project Analysis                                                                               | 63         |
| 3.3 Pulp, Water and alkali Balance for the Whole Plant in the Proposed Project                     | 83         |
| 3.4 Analysis on Pollutants Emission in the Proposed Project                                        | 88         |
| 3.5 Check of Main Pollutants after the Completion of Proposed Project                              | 104        |
| <b>4 Investigation and Evaluation on Current Environmental Quality</b>                             | <b>105</b> |
| 4.1 Investigation and Evaluation on Current Environmental Air Quality                              | 105        |
| 4.2 Investigation and Evaluation on Current Water Environmental Quality                            | 120        |
| 4.3 Investigation and Evaluation on Current Coastal Sediments Quality                              | 138        |
| 4.4 Investigation and Evaluation on Current Marine Organisms Quality                               | 143        |
| 4.5 Investigation on Current Situation of Marine Ecology                                           | 147        |
| 4.6 Major Objectives for Marine Environmental Protection                                           | 190        |
| 4.7 Investigation and Evaluation on Current Land Ecological Environment                            | 194        |
| 4.8 Investigation and Evaluation on Territorial Water Environment                                  | 201        |
| 4.9 Investigation and Evaluation on Current Sound Environment                                      | 217        |
| <b>Appendices</b>                                                                                  | <b>220</b> |

## Volume II

### 5 Summary of Environmental Impact Report on the Project of Forest Bases

- 5.1 Brief Introduction of construction of raw material forest bases
- 5.2 Analysis of forest bases Project
- 5.3 Analysis on present ecological environment
- 5.4 Impact analysis on biodiversity and ecology sensitive target
- 5.5 Impact analysis on soil fertility
- 5.6 Impact analysis on soil corrosion
- 5.7 Impact analysis on water resource conservation areas
- 5.8 Impact analysis on ecological landscapes
- 5.9 Environmental Impact analysis on using pesticides and fertilizers
- 5.10 Environmental Impact on other Silvicultural activities
- 5.11 Preventive measures of ecological environmental impacts
- 5.12 Conclusions and Suggestions

### 6 Analysis on Environmental Effect during Construction ..... 2

- 6.1 Brief Introduction of Construction ..... 2
- 6.2 Analysis on the Effect of Air Environment during Construction ..... 3
- 6.3 Analysis on Sound Environment Impact during Construction ..... 4
- 6.4 Analysis on Water Environment during Construction ..... 7
- 6.5 Analysis on Water and Soil Loss Effect during Construction ..... 7
- 6.6 Analysis on Environmental Influence of Solid Waste during Construction ..... 7
- 6.7 Analysis on Health Effect of Population in Construction ..... 9
- 6.8 Analysis on Influence of Offshore Swage Pipe Construction ..... 9
- 6.9 Water and Soil Loss Control Measures.....10

### 7 Prediction and Evaluation of Impact on Aquatic Environment in Sea Area ·11

- 7.1 Hydrological Survey.....11
- 7.2 Numerical Simulation of Tidal Current and Analysis on Hydrodynamic  
Conditions.....11
- 7.3 Overview of Discharge Outlet .....28
- 7.4 Prediction on environmental impacts of discharge outlet in the case of port  
coastline plan implementation .....28
- 7.5 Environmental Impacts of discharge outlet in the case of port coastline plan  
unimplemented .....56

### 8 Prediction and Evaluation of Atmospheric Environmental Effects .....79

- 8.1 Analysis of Meteorological Conditions for Pollution .....79
- 8.2 Prediction and Evaluation of Effect on Air Environment.....100

|                                                                      |            |
|----------------------------------------------------------------------|------------|
| 8.3 Summary.....                                                     | 120        |
| <b>9 Ecological and Environmental Impact Analysis .....</b>          | <b>122</b> |
| 9.1 Marine ecological and environmental Impact .....                 | 122        |
| 9.2 Analysis of Ecological environmental Impact in Land Area .....   | 127        |
| <b>10 Analysis on Regional Social &amp; Economic Impact .....</b>    | <b>130</b> |
| 10.1 Direct Social Impact of the Project .....                       | 130        |
| 10.2 Analysis on Regional Social & Economic Impact .....             | 138        |
| 10.3 Summary .....                                                   | 140        |
| <b>11 Other Environmental Impact Prediction and Evaluation .....</b> | <b>141</b> |
| 11.1 Sound Environment Impact Prediction and Evaluation .....        | 141        |
| 11.2 Disposal and Impact Analysis of Solid Wastes .....              | 151        |
| 11.3 Impact Analysis of Transportation and Logistics .....           | 162        |
| <b>12. Analysis on Environmental Risk .....</b>                      | <b>167</b> |
| 12.1 Outline of Environmental Risk Evaluation .....                  | 167        |
| 12.2 Risk Identification .....                                       | 170        |
| 12.3 Sources Term Analysis .....                                     | 176        |
| 12.4 Consequence Calculation .....                                   | 180        |
| 12.5 Accident Risk Evaluation .....                                  | 185        |
| 12.6 Risk Precautions .....                                          | 188        |
| 12.7 Summary .....                                                   | 194        |
| 12.8 Emergency Rescue Plan .....                                     | 194        |

### Volume III

|                                                                                                                             |
|-----------------------------------------------------------------------------------------------------------------------------|
| <b>13. Demonstration and Impact Analysis of Water Resources</b>                                                             |
| 13.1 Water Intake Sources <b>Error! Bookmark not defined.</b>                                                               |
| 13.2 Overview of the Development and Utilization of Water Resources                                                         |
| 13.3 Analysis on the Rationality of Water Utilization in Construction Projects                                              |
| 13.4 Analysis on Impact of Water Intake                                                                                     |
| <b>14 Cleaner Production and Review on Industrial Policies</b>                                                              |
| 14.1 Cleaner Production                                                                                                     |
| 14.2 Review of industrial policy                                                                                            |
| <b>15 Countermeasure for Pollution Prevention and Treatment with Analysis on Its Technological and Economic Feasibility</b> |
| 15.1 Environmental protection measures during construction and feasibility analysis                                         |
| 15.2 Countermeasures and measures for pollution prevention and treatment during operation                                   |

15.3 Investment for environmental protection

## **16 Water and Soil Conservation Scheme**

16.1 Current conditions of soil and water loss

16.2 Prediction on soil and water loss

16.3 Prevention and treatment scheme of soil and water loss

16.4 Additional measures for water and soil conservation

16.5 Quantity and investment of water and soil conservation

## **17 Total Emission Control Indices and Regional Reduction Plan of Pollutants**

17.1 Recommendations on the total emission control indices of pollutants in the project

17.2 Total emission control indices during 11th Five-year in Beihai

17.3 Solution for total emission indices of pollutants in the project

17.4 Summary

## **18 Analysis on the Rationalization of Planning and Layout, Plant Site Selection and General Plan Layout**

18.1 Analysis on the consistency with related planning

18.2 Analysis on the rationalization of address selection of the project

18.3 General plan layout

## **19 Analysis on Economic Profit & Loss of Environmental Impact**

19.1 Project Economic and Social Benefits

19.2 Environmental Protection Investment and Environmental Benefits Analysis

## **20 Public Participation**

20.1 Objective

20.2 Working Procedures

20.3 Identification of Core Public Group

20.4 Time and Major Forms

20.5 Investigation Results

20.6 Solutions to Feedback Opinions

20.7 Conclusion

## **21 Environmental Protection Management and Monitoring System**

21.1 Environmental management

21.2 Monitoring of Examination & Acceptance of “Three Simultaneousness” of the Project Environmental Protection

21.3 Environmental Monitoring Plan

21.4 Environmental Monitoring Instrument & Technical Document Management

21.5 Management of Waste Discharge Outlet



## 21.6 Quality Assurance Measures to Investigation and Monitoring of Current Situation of Environmental Quality

## 22 Evaluation Conclusions

### 22.1 Industrial Policies & Planning Compliance Analysis

### 22.2 Conclusion of Analysis on the Construction Project

### 22.3 Investigation and Evaluation of Current Environmental Quality

### 22.4 Conclusions of Environmental Impact Prediction and Evaluation

### 22.5 Water Resources Appraisal and Water Intake Impact Analysis

### 22.6 Conclusion of Clean Production Evaluation

### 22.7 Pollution Prevention and Control Measures and Economic Feasibility Analysis

### 22.8 Pollutants Total Quantity Control Index

### 22.9 Rationality of Project Location, Discharge Outlet and General Layout

### 22.10 Project Environmental Economic Profit & Loss Analysis

### 22.11 Public Participation

### 22.12 Comprehensive Evaluation Conclusions

## Attached Drawings in Volume 1: [removed]

### 1. Drawing for Geological Location of the Project

### 2. Functional Division Drawing of Guangxi Inshore Area (2008 Adjusted Version)

### 3. Distribution Drawing of Terrestrial Environmental Protection Targets

### 4. Distribution Drawing of Marine Environmental Protection Targets

### 5. Beihai Overall Urban Planning Drawing

### 6. Overall Urban Planning Drawing of Tieshan Port District of Beihai City

### 7. Coastline Use Planning Drawing of Tieshan Port District

### 8. Distribution of Salt Fields in Tieshan Port District

### 9. Distribution of Pollution Source Locations in Tieshan Port District

### 10. General Layout of the Proposed Project

### 11. Layout of Land Evaluation Scope and Monitoring Points for Current Terrestrial Environmental Quality

### 12. Layout of Marine Evaluation Scope and Monitoring Points for Current Marine Environmental Quality

**13. Mariculture Planning in Beihai City****14. Map of Current Land Use in Tieshan Port District****15. Map of Groundwater Flow Direction in Tieshan Port District of Beihai City****Attached Drawings in Volume 2:** [not included]

16. Slag Stockpile Site Selection Scheme (I) Geological Hazard Comprehensive Evaluation Drawing
17. Slag Stockpile Site Selection Scheme (II) Geological Hazard Comprehensive Evaluation Drawing
18. Distribution Map of Regional Groundwater Type

**Appendices (see Volume 3):** [not included]

1. Letter of Attorney Concerning Evaluation of Project Environment Impact by Stora Enso (Guangxi) Pulp & Paper Co., Ltd.
2. GHPGG [2001] No. 81, *Advisory Opinions on the Evaluation Outline of Environment Impact of the 900,000 Ton Pulp and 900,000 Ton Paper and Cardboard Project of Stora Enso (Guangxi) Pulp & Paper Co., Ltd.*
3. Environment Protection Bureau of Guangxi Zhuang Autonomous Region: GHGH [2006] No. 203, *Preliminary Suggestions on the Environment Protection of the 900,000 Ton Pulp and 900,000 Ton Paper and Cardboard Integrated Project of Stora Enso Pulp & Paper Co., Ltd. (Chinese-Foreign Joint Venture), Beihai, Guangxi*
4. Environmental Protection Bureau of Guangxi Zhuang Autonomous Region: GHGH [2007] No. 387 and GHGH [2008] No 325, *Reply Letter Regarding the Instructions on the Evaluation Standards with Regard to the Environment Impact Report on the 900,000 Ton Pulp and 900,000 Ton Paper and Cardboard Project of Stora Enso (Guangxi) Pulp & Paper Co., Ltd.*
5. Environment Protection Bureau of Guangxi Zhuang Autonomous Region: GHGH [2007] No. 449, *Reply Letter to the Application for Total Quantity Index on the Emission of Sulfur Dioxide Concerning the 900,000 Ton Pulp and 900,000 Ton Paper and Cardboard Project of Stora Enso (Guangxi) Pulp & Paper Co., Ltd.*

6. BHHZ [2007] No. 172, *Reply Letter from Beihai Environment Protection Bureau on the Total Quantity Index of COD Concerning the 900,000 Ton Pulp and 900,000 Ton Paper and Cardboard Project of Stora Enso (Guangxi) Pulp & Paper Co., Ltd.*
7. People's Government of Guangxi Zhuang Autonomous Region :GZBF[2008] No.1 Notice of the General Office of People's Government of Guangxi Zhuang Autonomous Region on the Printing and Distributing *The Partial Adjustment Scheme of the Planning of the Offshore Sea Water Environment Functional Area in Guangxi*
8. Beihai Municipal People's Government: BZF [2004] No. 60, *Notice on Printing and Issuing the District Planning of Tieshan Port of Beihai*
9. Environment Protection Bureau of Guangxi Zhuang Autonomous Region: GHKGZ [2005] No. 275, *Official Reply to Regional Environment Impact Report Concerning the Large-size Port and Industrial Base of Tieshan Port, Beihai*
10. Environment Protection Bureau of Guangxi Zhuang Autonomous Region: GZBF [2008] No. 73 *Official Reply to the Technical Report on Demonstrating the Revising Scheme for Adjusting the Layout of the Discharge Outlets in Teishan Port Industrial Base*
11. People's Government of Guangxi Zhuang Autonomous Region: GZF [2004] No. 66, *Opinions of the People's Government of Guangxi Zhuang Autonomous Region on Accelerating the Construction of the Forestry Base for Forest-Pulp-Paper Materials along the Coastal Areas*
12. Environmental Protection Bureau of Guangxi Zhuang Autonomous Region: GHGH [2008 ] No. 75 Review on *The environmental impact of Overall Planning for the Integrated Development of Forest-Pulp-Paper Industry in Guangxi from 2005 to 2015*
13. The Land and Resources Department of Guangxi Zhuang Autonomous Region: GGTZH [2005] No. 530, *Opinions on the Preliminary Site Selection of the Land for the Jointly Funded Integration Forest-Pulp-Paper Project of Beihai, Guangxi*
14. The Construction Department of Guangxi Zhuang Autonomous Region: *Site Selection Report for Proposed Projects*
15. Beihai Municipal Bureau of Land and Resources: *Reply Letter to the Preliminary Proposals on the Site Selection for Slag Stockpile of the Pulp and Paper Project of*

*Stora Enso*

16. Beihai City Planning Bureau: BGH [2007] No. 229, *Reply Letter to the Preliminary Opinion Letter of Proposal on the Site Selection for Slag Stockpile of the Pulp and Paper Project of Stora Enso*
17. GSSZ [2007] No. 40, Review Opinions on Water Resource Feasibility Report of Beihai Tieshangang Water Supply Engineering of Guangxi Costal Industrial Park Water-supply Source Engineering Project
18. Water Resources Department of Guangxi Autonomous Region: *Reply Letter to Issues In Connection with Water Intake of the Pulp and Paper Project of Stora Enso (Guangxi)*
19. BTZF [2007] No. 19, *The People's Government of Tieshan Port District, Beihai, Transmits the Notice of State Development and Reform Commission for Printing and Issuing the Guiding Opinions on Adjusting the Structure of the Salt-making Industry Nationwide*
20. People's Government of Beihai City: BZH [2007] No. 37, *Official Reply of Beihai Municipal People's Government on Approving the Detailed Implementing Rules Concerning the Land Requisition and Relocation for the Forest-Pulp-Paper Integration Project of Beihai*
21. Beihai Xinli Import & Export Trading Co., Ltd.: *Commitment Letter for the Coal Supply to the Forest-Pulp-Paper Integration Project of Beihai, Guangxi*
22. Analysis Report on Coal Quality (design coal)
23. Analysis Report on Coal Quality (check coal)
24. Nanning Chemical Industry Co., Ltd.: *Letter on Supply of Liquid Alkali*
25. Letter of Intent on the Purchase and Sale of Slag
26. Agreement on the Purchase and Sale of Wood Residues
27. Information Announcement of Public Participation
28. Questionnaire of Public Participation
29. Registration Form for Examination and Approval on Environment Protection of Construction Projects

## 1 General Rules

### 1.1 Project Background

Guangxi Zhuang Autonomous Region is rich in forests with a 74.8% coverage of mountainous regions and 13,662,000 hm<sup>2</sup> land used for forestry accounting for 57.5% of the total area of the Region, holding 9,819,100 hm<sup>2</sup> forests and 403 million m<sup>3</sup> standing timber ranking the 8th in China, and 41.33% forest coverage ranking the 5th in China. Guangxi is one of the key provinces and regions planned by the state to develop fast growing forest projects. In order to develop forest & paper industry and boost local economy, Guangxi government acts actively in investment attraction seeking manufacturers both at home and abroad to invest in construction of forestry bases and pulp and paper making enterprises.

With its strength in resources technologies and human resources and through research on and deep analysis of demands for paper pulp, high class writing and press paper and liquid packing paper in domestic and overseas pulp & paper markets, especially in coastal and Southeastern Asian regions, Stora Enso makes the decision to construct a pulp & paper integration base in Guangxi by investing in 160,000 hm<sup>2</sup> fast growing and high-yield forests and a sustainable pulp & paper integration industrial project of 900,000 ton pulp, 450,000 ton high-class stationery paper and 450,000 ton high-class coated box board, as the response to the promising market with growing demand combined with the company's real conditions and existing strength and in accordance with its global strategic development plan, adjustments in consumption structure of China's papermaking industry in recent years, industrial requirements by the State and the trend of economical, large-scale production and group operation. The project will be undertaken by Stora Enso Asia and Gaofeng (Guangxi) Pulp & Paper (Group) Co, Ltd, the joint venture of which is Stora Enso (Guangxi) Pulp & Paper Co., Ltd.

The planned project will use eucalypt wood to make pulp and paper, which meets requirements of FGGY [2004] No. 9, On Issuance of Special Plan on Material-and-Paper Integration Project Construction during the 10<sup>th</sup> Five-Year Plan and 2010 issued by the National Development and Reform Commission and belongs to the encouraged projects listed in No. 57, Foreign Investment Industries Direction Catalogue (Revised, 2007) issued by the National Development and Reform Commission and Ministry of Commerce. In order to ensure smooth implementation of large pulp & paper integration projects in coastal areas and speed up construction of raw material forests bases, the People's Government of Guangxi Zhuang Autonomous Region issued GZF [2004] No. 66, Some Opinions by the People's Government of Guangxi Zhuang Autonomous Region on Accelerating Construction of Raw Material Forest Bases for Pulp Paper in Coastal Areas which emphasized the significance of advancing the process of pulp&paper integration in coastal areas. According to the Overall Development Plan of Guangxi's Pulp and Paper Integration Industry, 2005-2015, there will be 2,000,000 hm<sup>2</sup> forests by the end of the 11<sup>th</sup> Five-Year Plan, when the whole Region will have a production capacity of 4,200,000 tons of pulp, of which 3,000,000 tons are wood pulp and 1,200,000 tons bamboo pulp. In order to better develop the pulp & paper integration industry, the People's Government of Guangxi Zhuang Autonomous Region lays the emphasis of pulp & paper integration on South, Middle and West Guangxi with better forest resources, large rainfalls, conditions suitable for planting high-yield forests, being on the seaside or riverside therefore having convenient transportation, good supporting facilities and therefore being suitable for locating large pulp and paper enterprises.

In accordance with Law on Environmental Effects Evaluation of the People's Republic of China and

Regulations on the Administration of Construction Project Environmental Protection, Stora Enso (Guangxi) Pulp & Paper Co., Ltd. entrusts Environmental Protection Research Institute of Guangxi Zhuang Autonomous Region to evaluate the environmental effects of the 900,000 Ton Pulp and 900,000 Ton Paper and Cardboard Project of the pulp and paper integration project of the company. The supporting projects, such as terminal, transportation road works project will be set up and built by Beihai city government, and has been entrusted to relevant units with special evaluation, which does not belong to this EIA work. The environmental effects of raw material forest base will be evaluated independently by China Research Academy of Environmental Sciences as entrusted by the owner, and the evaluation result will be applied in this EIA.

Entrusted by Stora Enso (Guangxi) Pulp & Paper Co., Ltd in December, 2005, Environmental Protection Research Institute of Guangxi Zhuang Autonomous Region has undertaken evaluation of environmental effects of the project, and organized scientific researchers to carry out field inspection and basic information collection with the aid of relevant institutions in Beihai City. At the end of 2005, Stora Enso submitted the Report on Application for APC 1,200,000 Ton Pulp, 900,000 Ton Paper and Cardboard Project of Stora Enso (Guangxi) Pulp & Paper Co., Ltd. to the National Development and Reform Commission. In 2006, Stora Enso Group decided to shrink the production scale of pulp and reduce it to 900,000 tons/per year while keep that of paper and cardboard unchanged, considering forestry resources in project area and the global strategic deployment of the Group. In line with applicable laws and rules of the State, technical guidelines and the Report on Application for APC 900,000 Ton Pulp, 900,000 Ton Paper and Cardboard Project of Stora Enso (Guangxi) Pulp & Paper Co., Ltd. by Shandong Light Industry Design Institute. Environmental Protection Research Institute of Guangxi Zhuang Autonomous Region compiled the Outline of Evaluation of Project's Effects on Environment. On November 9 and 10, 2006, the Environmental Project Evaluation Center of State Environmental Protection Administration held a technical consulting meeting in Nanning, evaluating the Outline from technical perspective and bringing forth technical consulting opinions (Annex 2) based on GHPGG [2006] No. 59 File.

According to the opinions given by State Environmental Protection Administration, the Outline is compiled in accordance with standards with relatively complete contents and can be used as the basis for environment evaluation after being completed and supplemented, as it clearly describes the general situation of project and environment, chooses right evaluation factors, sets basically reasonable subjects and adopts feasible evaluation method in general. And this report is compiled based on the Outline and related technical consulting opinions.

## 1.2 Goal of Evaluation

Through research and inspection on natural environment, social environment and air, water on earth surface, noise, current quality of ecological environment and soil, the evaluation will predict and analyze the degree and scope of effects of the planned project on its surroundings during the periods of construction and operation, analyze and prove economic feasibility and rationality of environmental protection measures and related techniques to be adopted during the project, and expound the rationality of the location of the planned project from environmental protection perspective. Meanwhile, the evaluation will, following principles of "saving energy and reducing emission", "controlling total volume", "clean production" and "recycling economy", propose feasible and practical environmental protection measures and measures for pollution control as scientific basis for project decisions, engineering design and environmental management by relevant departments, minimizing negative effects on environment and ensuring sustainable development of the regional economy.

## 1.3 Basis of Compilation

### 1.3.1 Laws, Rules and Policies

- (1) Environmental Protection Law of the People's Republic of China (1989) ;
- (2) Law of the People's Republic of China on the Prevention and Control of Water Pollution (1996);
- (3) Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution (2000);
- (4) Law of the People's Republic of China on the Prevention and Control of Noise Pollution (1996);
- (5) Marine Environment Protection Law of the People's Republic of China (1999);
- (6) Law on the Prevention and Control of Environmental Pollution by Solid Wastes of the People's Republic of China (2005);
- (7) City Planning Law of the People's Republic of China (1989);
- (8) Law of People's Republic of China on Water and Soil Conservation (1991);
- (9) Law of Land Administration of the People's Republic of China (1998);
- (10) Law of the Peoples Republic of China on Evaluation of Environmental Effects (2003);
- (11) Law of the People's Republic of China on Promotion of Cleaner Production (2002);
- (12) Energy Conservation Law of the People's Republic of China (2007);
- (13) No. 8 Order: Regulations on Environmental Compliance Function Zone of Offshore Area issued by State Environmental Protection Administration of China (1999)
- (14) Administrative Regulation on the Prevention of Pollution Damage to the Marine Environment by Land-sourced Pollutants (1990);
- (15) Administrative Regulation of the People's Republic of China on the Prevention of Pollution to the Marine Environment by Coastal Engineering Construction Projects (1990);
- (16) Circular for a Plan of Energy Efficiency and Pollutant Discharge Reduction of the State Council (GF [2007] No. 15);
- (17) No. 253 Order: Regulations on the Administration of Construction Project Environmental Protection issued by the State Council (1998));
- (18) No. 14 Order: Classified Directory of Environmental Management of Construction Project issued by the State Environmental Protection Administration of China (2002);
- (19) HF [2002] No. 26 Technical Policy for Prevention and Control of the Sulfur Dioxide Pollution Caused by Fire Coal issued by State Environmental Protection Administration of China
- (20) GJMJ [1994] No. 14 Circular on Issuance of Regulation on Management of Comprehensive Utilization of Coal Ash issued by State Economic and Trade Committee, Ministry of Power Industry, etc.;

- (21) [2000] No. 1268 Circular on the Regulation on Thermal-power Co-generation issued by State Planning Commission, State Economic and Trade Commission, the Ministry of Construction, State Administration of Environmental Protection;
- (22) FGNY [2004] No. 864 Circular of the State Development and Reform Commission concerning Requirements on Planning and Construction of Coal Power Plant;
- (23) No. 57 Order: Foreign Investment Direction issued by the National Development and Reform Commission and Ministry of Commerce (2007 revision);
- (24) No. 40 (2005) Guiding Catalogue of Industrial Structure Regulation by the National Development and Reform Commission;
- (25) No. 71 Policy of Development of Paper Making Industry (2007) published by the National Development and Reform Commission;
- (26) No. 23 order Method of Prevention and Control over Environmental Pollution Caused by Waste Hazardous Chemicals by the State Administration of Environmental Protection (2005)
- (27) HF [2005] No. 152 the Circular on Strengthening the Management of Environmental Effects Evaluation and Prevention of Environmental Risks issued by State Administration of Environmental Protection
- (28) Approval by the Government of Guangxi Autonomous Region for the Plan on Controlling Total Emission of Main Pollutants in the Region During the 11th Five-Year Plan (GZH [2006] No. 183);
- (29) Regulation of Guangxi Zhuang Autonomous Region on Environmental Protection (2006)
- (30) GZ [2001] No. 13 the Circular on Strengthening the Management of Environmental Protection of Construction Projects in Development of China's Western Regions issued by Guangxi Environmental Protection Administration
- (31) Plan on Controlling Total Emission of Main Pollutants in Beihai City during the 11th Five-Year Plan (BZB [2007] No. 21).

### 1.3.2 Technical Guidelines and Specifications

- (1) HJ/T2.1-93 Technical Guidelines on Environmental Effects Evaluation General Principles;
- (2) HJ/T2.2-93 Technical Guidelines on Environmental Effects Evaluation Atmospheric Environment;
- (3) HJ/T2.3-93 Technical Guidelines on Environmental Effects Evaluation Water Environment on Surface of the Earth;
- (4) HJ/T2.4-95 Technical Guidelines on Environmental Effects Evaluation Sound Environment;
- (5) HJ/T19-97 Technical Guidelines on Environmental Effects Evaluation Non-polluting Ecological Effects;
- (6) GB/T19485-2004 Technical Guidelines on Environmental Effects Evaluation for Marine Projects;
- (7) HJ/T169-2004 Technical Guidelines for Environmental Risk Evaluation on Projects
- (8) HJ/T13-1996 Compiling Standards of Report on Environmental Effects of Thermal Power Plant Construction Projects;



- (9) HF 2006[No. 28] Temporary Measures of the Public Participation in Environmental Effects Evaluation by the State Administration of Environmental Protection;
- (10) GB/T13021-91 Technical Methods for Making Local Emission Standards of Air Pollutants;
- (11) HJ/T91-2002 Technical Specifications Requirements for Monitoring of Surface Water and Waste Water;
- (12) HJ/T92-2002 Technical Requirements for Monitoring of. Total Amount of Pollutants in Waste Water
- (13) HJ/T164-2004 Technical Specifications for Environmental Monitoring of Groundwater;
- (14) GB17378.4-1998 Specifications for Marine Monitoring (Part 4: Monitoring Water Quality in Sea Areas;
- (15) GB17378.7-1998 Specifications for Marine Monitoring (Part 7: Inspection of Polluted Ecology and Monitoring Biology in the Offing);
- (16) HJ/T55-2000 Technical Guidelines for Monitoring Fugitive Emission of Air Pollutants;
- (17) HJ/T 194-2005 Technical Guidelines for Manually Monitoring Air Quality;
- (18) HJ/T75-2001 Technical Specifications for Continuous Emission Monitoring of Flue Gas;
- (19) DL/T414-2004 Technical Specifications of Environmental Monitoring of Thermal Power Plants.
- (20) State Environmental Protection Administration Circular [2007] No. 17 Circular on Issuance of Guideline on Reinforcing the Revision of National Pollutant Emission Standards issued by State Environmental Protection Administration

### 1.3.3 Project Basis

- (1) Proxy of the project Proxy of Stora Enso (Guangxi) Pulp & paper Co., Ltd. on Evaluation of Project Environmental Effects (Annex 1).
- (2) Relevant official remarks, documents and research and design data of the project
  - 1) GHPGG [2006] No. 81 Opinions on the Outline of Environmental Effects Evaluation of the 900,000 Ton Pulp, 900,000 Ton Paper and Cardboard Project of Stora Enso (Guangxi) Pulp & paper Co., Ltd. 90 (12/2006) (Annex 2)
  - 2) GGTZH [2005] No. 530 Opinions on Initial Selection of Lands Used for Sino-foreign Joint Venture Forest-Pulp-Paper Integration Projects in Beihai, Guangxi (2005.11) issued by the Department of Land and Resources of Guangxi; (Annex 13)
  - 3) Opinions on Site Selection of Construction Projects (08/2006) issued by the Department of Construction of Guangxi (Annex 14)
  - 4) Report on Evaluation of Geologic Disaster Hazard of Residue Yard Construction Project for the 900,000 Ton Pulp, 900,000 Ton Paper and Cardboard Project of Stora Enso (Guangxi) Pulp & paper Co., Ltd. by Guangxi Investigation and Design Institute of Geologic Disaster and Environmental Protection (06/2007)
  - 5) Research Report on Hydrography of the Residue Yard of the 900,000 Ton Pulp, 900,000

Ton Paper and Cardboard Project of Stora Enso (Guangxi) Pulp & paper Co., Ltd. by Guangxi Investigation and Design Institute of Geologic Disaster and Environmental Protection (06/2007);

- 6) GHGH [2006]No. 203 Initial Opinions on the 900,000 Ton Pulp, 900,000 Ton Paper and Cardboard Integration Project of Guangxi Beihai Stora Enso Pulp & paper Co., Ltd. (Joint Venture ) issued by Guangxi Environmental Protection Administration (09/2006); (Annex 3)
  - 7) GZF [2004] No. 66 Several Opinions of the People's Government of Guangxi Zhuang Autonomous Region on Accelerating Construction of Raw Material Forests for Woods Pulp Paper in Coastal Areas (12/2004) (Annex 11)
  - 8) Reply by Bureau of Land and Resources of Beihai to the Initial Opinions on Site Selection of Residue Yard of Stora Enso Pulp-paper Project (04/2007) (Annex 15)
  - 9) BGH [2007] No. 229 Reply of Urban Planning Bureau of Beihai to the Initial Opinions on Site Selection of Residue Yard of Stora Enso Pulp&paper Project (04/2007) (Annex 16)
  - 10) Reply by Guangxi Environmental Protection Administration to Evaluation Report on Environmental Effects of Beihai Tieshan Port Large Harbors and Industrial Zones (11/2005) (Annex 9)
  - 11) Reply by Guangxi Environmental Protection Administration [2008] No. 73 to Evaluation Report on Environmental Effects of Beihai Tieshan Port Large Harbors and Industrial Zones (Annex 10)
  - 12) Report on Application for the APC 900,000 Ton Pulp, 900,000 Ton Paper and Cardboard Project of Stora Enso (Guangxi) Pulp & paper Co., Ltd. by Shandong Light Industry Design Institute;
  - 13) Report on Application for Raw Material Forestry Site of the APC 900,000 Ton Pulp, 900,000 Ton Paper and Cardboard Project of Stora Enso (Guangxi) Pulp & paper Co., Ltd. by Guangxi Forestry Inspection and Design Institute;
  - 14) Undertaking of Beihai Xinlin Import & Export Trade Co., Ltd. concerning Coal Supply for Guangxi Beihai Pulp & paper Integration Project (12/2005) (Annex 20)
  - 15) Analysis Report on Quality of Coals (Annex 21)
  - 16) Letter of Nanning Chemical Industry Co., Ltd. on Liquid Alkali (12/2005);
  - 17) Report on Environmental Effects of Raw Material Forestry Site of the 900,000 Ton Pulp, 900,000 Ton Paper and Cardboard Project of Stora Enso (Guangxi) Pulp & paper Co., Ltd. issued by Chinese Research Academy of Environmental Sciences
- (3) Division of Environmental Functional Zones
- 1) Division of Environmental Functional Zones on Tieshan Port Sea Area in Shore, Division of Environmental Function Zones of Sea Area in Shore of China (1998) ;
  - 2) Division of Sea Functional Zones of Guangxi Zhuang Autonomous Region by Guangxi

government (04/2005);

- 3) Reply to the Division of Sea Functional Zones in Sea Areas in Shore of Guangxi Zhuang Autonomous Region by the government of Guangxi Zhuang Autonomous Region (2007) (Annex 7)

#### (4) Planning

- 1) The FGGY [2004] No. 9 Circular about Issuance of the 10th Five-Year Plan and 2010 Special Plan of Pulp-and-Paper Integration Project Construction issued by the National Development and Reform Commission;
- 2) National Eleventh Five-Year Planning of Preventing Acid Rain and Sulfur Dioxide Pollution Issued by State Environmental Protection Administration and National Development and Reform Committee;
- 3) Guidelines of the Eleventh Five-Year Plan of Guangxi National Economic and Social Development;
- 4) Guangxi Beibu Gulf Economic Zone Development Plan;
- 5) The Eleventh Five-Year Plan of Industrial Development of Guangxi Zhuang Autonomous Region;
- 6) Review opinions of Guangxi Development and Reform Committee on the Overall Plan of Guangxi Pulp & Paper Integration Industry 2005-2015 ( 02/ 2008 ) (Annex 12)
- 7) Overall Urban Planning of Beihai City by Urban Planning Bureau of Beihai, etc.(08/2003)
- 8) Overall Plan of Land Use in Beihai City (1997-2010) the People's Government of Beihai City, (1999.10);
- 9) Plan of Ecological Construction of Beihai City (2002-2015);
- 10) Plan of Use of Water Front Areas of Harbors in Beihai by Guangxi Traffic Inspection, Planning and Design Institution (01/2005);
- 11) *Zoning Plan of Tieshan Port District of Beihai City* of People's Government of Beihai City (11/2004) (Annex 8)

### 1.4 Term and Scope of Evaluation

**1.4.1** Evaluation Term is divided into two phases: construction and operation.

12) Construction phase: when the project construction is ongoing.

13) Operation phase: when the project is constructed and being operated.

**1.4.2** Evaluation Scope

(1) Ambient Air

The ambient air scope is a 156 km<sup>2</sup> rectangle centered in the plant site extending 10km to the north, 3km to the south (there is the sea area beyond 2km away to the south), and 6km to the west along the main axis of north wind, the dominant wind of the year.

(2) Water Environment in Sea Area

The sea area nearby the planned effluent outlet is calculated as approx. 1580km<sup>2</sup> (including three protection zones).

(3) Noise Environment

The plant boundary and within 200m away from the plant boundary

(4) Ecological Environment

The ecological environment on land shares the same evaluation scope with ambient air. The ecological environment in sea area shares the same evaluation scope with marine water environment.

The evaluation scope of current environment quality is described in Figure 11 and 12.

## 1.5 Division of Environmental Compliance Function Zones and Evaluation Implementation Standards

### 1.5.1 Division of Environmental Compliance Function Zones

#### 1.5.1.1 Division of Environmental Compliance Function Zones of Offshore Area

As shown in Table 1.5-1 and Figure 2, the environmental compliance function zones of offshore area are divided in accordance with the Division Solution of Environmental Compliance Function Zones of Offshore Area of Guangxi approved by the government of Guangxi Zhuang Autonomous Region through GZB [1998] No.142 document and the scheme of partial adjustments approved by Guangxi government through GZB [2008] No.1 document.

**Table 1.5-1 Division of Environmental Compliance Function Zones of Offshore Area within the Evaluation Scopes**

| SN | Environmental Compliance Function Zones |      | Name of Environmental Compliance Function Zones   | Jurisdiction | Location of Environmental Compliance Function Zones                                                                             | Area (km <sup>2</sup> ) | Main Function                          | Current Type of Water Quality | Goal of Water Quality |
|----|-----------------------------------------|------|---------------------------------------------------|--------------|---------------------------------------------------------------------------------------------------------------------------------|-------------------------|----------------------------------------|-------------------------------|-----------------------|
|    | Code                                    | Type |                                                   |              |                                                                                                                                 |                         |                                        |                               |                       |
| 1  | A01 I                                   | 1    | Hepu Shatian Dugong State Nature Reserve          | Beihai       | Sea area from Shatian to south of Yingluo Harbor                                                                                | 350                     | Dugong Nature Reserve                  | —                             | —                     |
| 2  | A02 I                                   | 1    | Shankou Mangrove Nature Reserve                   | Beihai       | Shatian Dandou Harbor and Yingluo Harbor                                                                                        | 40                      | Mangrove Ecology Reserve               | 1                             | 1                     |
| 3  | A07 I                                   | 1    | Fishing zone                                      | Guangxi      | Sea area within -10~ -80m of Beibu Bay                                                                                          | 120,000                 | Fishery                                | 1                             | 1                     |
| 4  | GX001B II                               | 2    | Aquacultural area of YingLuo port                 | Beihai       | Shatian to Yingluo Harbor                                                                                                       | 45                      | Proliferation of sandworms             | 1                             | 2                     |
| 5  | B03 II                                  | 2    | Seawater aquaculture zone                         | Beihai       | Shatian, Baisha, Shankou                                                                                                        |                         | Prawn breeding                         | 1                             | 2                     |
| 6  | B07 II                                  | 2    | Sea products proliferation zone                   | Beihai       | Sea area on the south of Yingpan                                                                                                | 600                     | Pearl culture                          | 2                             | 2                     |
| 7  | GX002D I                                | 2    | Work area of Tieshan Port Harbor of Beihai Harbor | Beihai       | Harbor areas on the west shore of Tieshan Port Harbor from Baishatou Harbor to Beimu within the zoning boundary of Tieshan Port | 30                      | Port Navigation waste effluent harbors | 2                             | 3                     |
| 8  | GX003C III                              | 3    | Effluent zone 1 of Tieshan Port                   | Beihai       | Sea area of Tieshan gang                                                                                                        | 15                      | Waste effluent                         | 1                             | 3                     |
| 9  | GX004C III                              | 3    | Effluent zone 2 of Tieshan Port                   | Beihai       | Sea area of Tieshan Port                                                                                                        | 4                       | Waste effluent                         | 1                             | 3                     |
| 10 | GX030C III                              | 3    | Sea routes of Teishan Port                        | Beihai       | Southeast sea area of Tieshan Port<br>Now nearby the natural sea route<br>Length 20km, width 500m (two)                         | 20                      | Open to navigation                     | 1                             | 3                     |

## 1.5.1.2 Division of Air and Sound Environmental Functional Areas

According to the division solution of environmental functional areas in Tieshan Port, Beihai, the air

environment in the area being evaluated is Type 2 functional area; and the sound environmental functional area is divided into industrial, living, mixed business zones, zones on both sides of the traffic trunk road, etc.

### 1.5.2 Evaluation Implementation Standards

According to GHGH [2007] No. 387 and GHGH [2008] No. 325 document about confirmation letter to evaluation criterion of the project (Annex 4), the evaluation applies the following standards apply to this evaluation. For detailed standard, refer to table 1.5-2 and table 1.5-3.

#### 1.5.2.1 Standards of Environment Quality

- (1) GB3095-1996 Ambient Air Quality Standard Level II;
- (2) GB3097-97 Sea Water Quality Standard. Applicable standards listed in Table 1.5-1 shall be implemented in the environmental function region 1.5-1;
- (3) GB/T 14848-1993 Quality Standard for Ground Water Type III;
- (4) GB3096-93 Standard for Environmental Noise of Urban Area Type 3; Standard of type 4 shall be implemented for areas on two sides of traffic roads;
- (5) GB9137-88 Maximum Allowable Concentration of Pollutants in Atmosphere for Protecting Crops;
- (6) TJ36-79 Hygienic Standards for the Design of Industrial Enterprises
- (7) GB18668-2002 Quality of Marine Sediments; applicable standards to sediments in the environmental function area shall be implemented;
- (8) GB18421-2001 Marine Life Quality; applicable standards to marine lives in the environmental function area shall be implemented.

#### 1.5.2.2 Standards of Pollutant Emission

- (1) GB13223-2003 The standards for the 3rd period of time as stipulated in the Emission Standard of Air Pollutants for Thermal Power Plants;
- (2) GB16297-1996 Integrated Emission Standard of Air Pollutants (disorganized emission sources);
- (3) GB3544-2008 standards for bleaching pulp stipulated in the Discharge Standard of Water Pollutants for Paper Industry (where the standard of 100mg/L confirmed by Guangxi Environmental Protection Administration shall be adopted for COD);
- (4) GB8978-1996 Integrated Wastewater Discharge Standard Level 1 (for thermal power plants);
- (5) GB14554-93 Emission Standard for Odor Pollutants Level 2;
- (6) GB12523-90 Noise Limits for Construction Site;
- (7) GB12348-90 Standard of Noise at Boundary of Industrial Enterprises Type II;
- (8) GB18599-2001 Standards for Pollution Control on the Storage and Disposal Site for General Industrial Solid Wastes;

(9) GB18597-2001 Standard for Pollution Control on Hazardous Waste Storage

1.5.2.3 Other Standards

(1) GB/T18916.5-2002 Norm of Water Intake Part 5: Papermaking Products

(2) HJ/T340-2007 Cleaner Production Standard Papermaking Industry (Production process of sulfate chemical wood pulp);

(3) Index System for Cleaner Production of Pulp & Papermaking Industry (Provisional) by the National Development and Reform Commission (2006);

(4) [2007] No. 71 *Development Policy of Paper Industry* issued by National Development and Reform Committee: water demand per ton is controlled below  $45\text{m}^3/\text{t}\cdot\text{product}$  and comprehensive energy consumption (standard coal) below  $500\text{kg}/\text{t}\cdot\text{product}$ .

,

**Table 1.5-2 Proposed Standard Limits of Environmental Quality**

| Name of standard                                                                           |       | Name of pollutant |                                               | Concentration limits (mg/m³)                                                                                 |                      |                    |                                            |                        |                       |                        |                                 |       |
|--------------------------------------------------------------------------------------------|-------|-------------------|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------|----------------------|--------------------|--------------------------------------------|------------------------|-----------------------|------------------------|---------------------------------|-------|
|                                                                                            |       |                   |                                               | 1 hour                                                                                                       |                      | Daily average      |                                            |                        | Annual average        |                        |                                 |       |
| Ambient Air Quality Standard, GB3095-1996(Class II)                                        |       | TSP               |                                               | —                                                                                                            |                      | 0.30               |                                            |                        | 0.20                  |                        |                                 |       |
|                                                                                            |       | PM <sub>10</sub>  |                                               | —                                                                                                            |                      | 0.15               |                                            |                        | 0.10                  |                        |                                 |       |
|                                                                                            |       | SO <sub>2</sub>   |                                               | 0.5                                                                                                          |                      | 0.15               |                                            |                        | 0.06                  |                        |                                 |       |
|                                                                                            |       | NO <sub>2</sub>   |                                               | 0.24                                                                                                         |                      | 0.12               |                                            |                        | 0.08                  |                        |                                 |       |
| Sea Water Quality Standard, GB3097-1997 (mg/L, excluding pH Value)                         | Class | pH Value          | DO ≥                                          | COD <sub>Mn</sub> ≤                                                                                          | Inorganic nitrogen ≤ | labile phosphates≤ |                                            | Petroleum ≤            |                       | Cyanide ≤              | Volatile hydroxybenzene ≤       |       |
|                                                                                            |       | I                 | 7.8~8.5                                       | 6                                                                                                            | 2                    | 0.20               | 0.015                                      |                        | 0.05                  |                        | 0.005                           | 0.005 |
|                                                                                            |       | II                | 7.8~8.5                                       | 5                                                                                                            | 3                    | 0.30               | 0.030                                      |                        | 0.05                  |                        | 0.005                           | 0.005 |
|                                                                                            |       | III               | 6.8~8.8                                       | 4                                                                                                            | 4                    | 0.40               | 0.030                                      |                        | 0.30                  |                        | 0.10                            | 0.01  |
|                                                                                            |       | IV                | 6.8~8.8                                       | 3                                                                                                            | 5                    | 0.50               | 0.045                                      |                        | 0.50                  |                        | 0.020                           | 0.050 |
| Quality Standard for Ground Water, GB/T14848-93(Class III) (mg/L, excluding pH value)      |       | pH value          | Total hardness (Based on CaCO <sub>3</sub> )≤ | Ammonia nitrogen ≤                                                                                           | COD <sub>Mn</sub> ≤  | Cyanide ≤          | volatile hydroxybenzenes (based on phenol) | Nitrite ( based on N ) | Nitrate (based on N)≤ | Total soluble solid ≤  | Total coliform bacteria flora ≤ |       |
|                                                                                            |       | 6.5~8.5           | 450                                           | 0.2                                                                                                          | 3.0                  | 0.05               | 0.002                                      | 0.02                   | 20                    | 1000                   | 3 pcs/ L                        |       |
| Standard of environmental noise of urban area GB3096-1993                                  |       | Class             |                                               | Daytime [dB(A)]                                                                                              |                      |                    |                                            | Nighttime [dB(A)]      |                       |                        |                                 |       |
|                                                                                            |       | Class 3           |                                               | 65                                                                                                           |                      |                    |                                            | 55                     |                       |                        |                                 |       |
|                                                                                            |       | Class 4           |                                               | 70                                                                                                           |                      |                    |                                            | 55                     |                       |                        |                                 |       |
| Maximum allowable concentration of pollutants in atmosphere for protection crops GB9137-88 |       | Name of pollutant |                                               | Daily average concentration limits (mg/m³)                                                                   |                      |                    |                                            |                        |                       |                        |                                 |       |
|                                                                                            |       | Sulfur dioxide    |                                               | 0.15 (sensitive crops)                                                                                       |                      |                    | 0.25 (medium sensitive crops)              |                        |                       | 0.3 (resistant crops)  |                                 |       |
| Hygienic standards for the Design of Industrial Enterprises TJ36-79                        |       | methanol          |                                               | 3.0mg/m³ (Maximum allowable concentration of harmful substances in the atmosphere of residential district)   |                      |                    |                                            |                        |                       |                        |                                 |       |
|                                                                                            |       | Hydrogen sulfide  |                                               | 0.01 mg/m³ (Maximum allowable concentration of harmful substances in the atmosphere of residential district) |                      |                    |                                            |                        |                       |                        |                                 |       |
| Marine sediment quality GB18668-2002                                                       | Class | organic carbons≤  | Sulfides≤                                     | petroleum≤                                                                                                   | Inorganic nitrogens≤ | arsenic ≤          | coppers≤                                   | Lead≤                  | Total mercury≤        | cadmium≤               | Total chrome ≤                  |       |
|                                                                                            |       | ×10 <sup>-2</sup> | ×10 <sup>-6</sup>                             |                                                                                                              |                      |                    |                                            |                        |                       |                        |                                 |       |
|                                                                                            | I     | 2.0               | 300.0                                         | 500.0                                                                                                        | 0.20                 | 20.0               | 35.0                                       | 60.0                   | 0.2                   | 0.50                   | 80.0                            |       |
|                                                                                            | II    | 3.0               | 500.0                                         | 1000.0                                                                                                       | 0.30                 | 65.0               | 100.0                                      | 130.0                  | 0.5                   | 1.50                   | 150.0                           |       |
|                                                                                            | III   | 4.0               | 600.0                                         | 1500.0                                                                                                       | 0.40                 | 93.0               | 200.0                                      | 250.0                  | 1.0                   | 5.0                    | 270.0                           |       |
| Marine life quality BG18421-2001                                                           | Class | Total mercury≤    | cadmium≤                                      | leads≤                                                                                                       | chromes≤             | arsenics≤          | coppers≤                                   | zinc≤                  |                       | petroleum hydrocarbons |                                 |       |
|                                                                                            |       | mg/kg             |                                               |                                                                                                              |                      |                    |                                            |                        |                       |                        |                                 |       |
|                                                                                            | I     | 0.05              | 0.2                                           | 0.1                                                                                                          | 0.5                  | 1.0                | 10                                         | 20                     |                       | 15                     |                                 |       |
|                                                                                            | II    | 0.10              | 2.0                                           | 2.0                                                                                                          | 2.0                  | 5.0                | 25                                         | 50 ( oyster 100 )      |                       | 50                     |                                 |       |
|                                                                                            | III   | 0.30              | 5.0                                           | 6.0                                                                                                          | 6.0                  | 8.0                | 50                                         | 100 ( oyster 500 )     |                       | 80                     |                                 |       |



**Table 1.5-3 Proposed Standard Limits of Pollutant Emission**

|                                                                                                               |                                                                             |                                     |                   |                                     |        |
|---------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-------------------------------------|-------------------|-------------------------------------|--------|
| Emission Standard of Air Pollutants for Thermal Power Plants, (GB13223-2003), the 3 <sup>rd</sup> time bucket | Smoke and dust (mg/m <sup>3</sup> )                                         | Sulfur dioxide (mg/m <sup>3</sup> ) |                   | Nitrogen oxide (mg/m <sup>3</sup> ) |        |
|                                                                                                               | 50                                                                          | 400                                 |                   | 450                                 |        |
| Emission standard of air pollutants for industrial kiln and furnace, (GB9078-1996) Class II                   | 200                                                                         | 850                                 |                   | /                                   |        |
| Integrated emission standard of air pollutants, (GB16297-1996) (without organized emission source)            | Particulate matter (maximum concentration point outside of the unit border) |                                     |                   | 1.0 mg/m <sup>3</sup>               |        |
| Emission standard for odor pollutants, (GB14554-93) Class II                                                  | Odor concentration (dimensionless)                                          | 20                                  |                   |                                     |        |
|                                                                                                               | Hydrogen sulfide (plant boundary)                                           | 0.06 mg/m <sup>3</sup>              |                   |                                     |        |
| Discharge standard of water pollutants for Pulp and paper industry, (GB3544-2008)<br>Table 2                  | SS                                                                          | COD <sub>Cr</sub>                   | BOD <sub>5</sub>  | AOX                                 | Chroma |
|                                                                                                               | 30                                                                          | 90                                  | 20                | 12 (workshop discharge outlet)      | 50     |
| Standard of noise at boundary of industrial enterprises, (GB12348-90), Class III                              | Daytime [dB(A)]                                                             |                                     | Nighttime [dB(A)] |                                     |        |
|                                                                                                               | 65                                                                          |                                     | 55                |                                     |        |

Note: The numbers in the brackets is the standard value confirmed by Environmental Protection Bureau of Guangxi Zhuang Autonomous Region.

## 1.6 Key Points for Evaluation

- (1) According to the marine environment and effluent of the project, estimate and evaluate the impact extent and scope of production wastewater in the evaluation area, so as to propose reasonable suggestions on treatment measures through technical and economic demonstration.
- (2) Analyze the extent and scope of effluent impact on marine ecological environment so as to propose relief measures.
- (3) Estimate and evaluate the impact of smoke & dust, SO<sub>2</sub>, nitrogen oxide and orodor on the ambient air, ecological environment and residential area, so as to propose reasonable suggestions on waste gas treatment measures through technical and economic demonstration.
- (4) Analyze the disposal of solid wastes and its environmental impact, so as to propose comprehensive utilization plans and safety disposal measures.
- (5) Implement principle of clean production through analyzing and evaluating the clean production level.
- (6) According to the effluent of main pollutants, "eleventh five-year plan" control target and the program of energy-saving and emission-reduction, it proposes total controlling system target and reduction of pollutant effluent.

## 1.7 Pollution Control & Environmental Protection Target

### 1.7.1 Pollution Control

- (1) Control the mechanical noise and flyash from transportation and construction, which impact the living environment, during construction period; control random discharge of domestic garbage and sewage; control random piling of unplanned excavation soil and ballast, so as to reduce the damage for ecological environment and landscape.
- (3) Control emission of such atmospheric pollutants as SO<sub>2</sub>, smoke & dust and diffusion of orodor, so as

to protect ecological environment of the surrounding area and ensure the air quality meet the requirements of functional areas and the normal growth of crops.

(4) The wastewater from the project shall be discharged into the marine area of Tieshan Port to ensure that the water quality meet the requirement of corresponding water environment functional area.

(5) Protect the resources of mangrove, marine biology and mariculture in Tieshan marine area. Make sure that there is no impact on Shankou mangrove state-level natural protection zone, Dugong natural protection zone and Yingpan Mashi pearl oyster protection zone (in planning).

(6) Dispose of solid wastes in a reasonable way and control noise in an efficient way.

### 1.7.2 Environmental Protection Target

#### 1.7.2.1 Environmental Protection Target for Land

Through investigation and analysis on environment sensitive targets within the project evaluation area, environmental protection on targets of the project in planning are determined as follows:

(1) Air environment: evaluate sensitive point within the scope (see Table 1.7-1) for the air quality in accordance with the evaluation standard.

(2) Water environment: the water quality of marine area at discharge outlets complies with the requirement for functional division.

(3) Sound environment: sound environment at the plant boundary and its surrounding area within 200m.

(4) Social environment: surrounding residential area.

Currently, there are 4 residential areas within the range of the proposed plant side, including entire migration of Tianliao Village and partial migration in other villages. Besides the residential areas of planned migration, there are 5 areas within 200 m of the project boundary, 15 areas within 1 km, 10 within 1~2km, 14 within 2~3 km, 10 within 3~4 km, 16 within 4~5km and 5 within 2 km away from the slag stockpile. There is no special protection for scenic resorts and natural protection zones and no discovery of historical relics and other sensitive areas within the evaluation area. Besides, according to Beihai Urban Drinking Water Sources Environmental Protection Plan, Tieshan Port District where the plant and ash yard are located has no groundwater and drinking water conservation district, only has wells dug by peasants.

See Table 1.7-1 and Attached Drawing 3 for details of main land environmental protection target.

**Table 1.7-1 Main Environmental Protection Target for Land**

| SN | Name          | Relation with the plant site |              | Relation with Beimu spoil yard |             | Popul-ation | Basic information                                                      |
|----|---------------|------------------------------|--------------|--------------------------------|-------------|-------------|------------------------------------------------------------------------|
|    |               | Relative location            | Distance (m) | Relative location              | Distance(m) |             |                                                                        |
| 1  | Tianliao      | Inside                       | /            | NW                             | 1710        | 600         | Migration caused by acquisition of project construction                |
| 2  | Beimu Village | North                        | 20           | West                           | 850         | 957         | Migration of 96 families caused by acquisition of project construction |
| 3  | Xinwopo       | West                         | 40           | NW                             | 2400        | 160         | Natural village; plant potatoes and have fresh water from wells        |
| 4  | Haishan Dam   | North                        | 80           | NW                             | 2250        | 262         | Migration of 1 family caused by                                        |

| SN | Name                 | Relation with the plant site |              | Relation with Beimu spoil yard |             | Population                     | Basic information                                                     |
|----|----------------------|------------------------------|--------------|--------------------------------|-------------|--------------------------------|-----------------------------------------------------------------------|
|    |                      | Relative location            | Distance (m) | Relative location              | Distance(m) |                                |                                                                       |
|    |                      |                              |              |                                |             |                                | acquisition of project construction                                   |
| 5  | Yasi Village         | North                        | 100          | NW                             | 2420        | 203                            | Natural village; plant potatoes and have fresh water from wells       |
| 6  | Pokoutang            | West                         | 200          | West                           | 1940        | 132                            | Migration of 6 families caused by acquisition of project construction |
| 7  | Nanle Village        | West                         | 300          | West                           | 2090        | 431                            | Natural village; plant potatoes and have fresh water from wells       |
| 8  | Nanle Primary School | West                         | 340          | West                           | 1980        | Teacher : 23;<br>Student : 380 | Primary school                                                        |
| 9  | Dengwu Village       | SW                           | 410          | SW                             | 2820        | 360                            | Flat and wide; have fresh water from wells                            |
| 10 | Xinpu                | East                         | 450          | NW                             | 500         | 459                            | Flat and wide; have fresh water from wells                            |
| 11 | Anze                 | SE                           | 570          | SW                             | 1300        | 161                            | Flat and wide; have fresh water from wells                            |
| 12 | Nagetang             | NW                           | 820          | West                           | 3100        | 423                            | Flat and wide; have fresh water from wells                            |
| 13 | Shanxin Village      | West                         | 830          | West                           | 2870        | 558                            | Flat and wide; have fresh water from wells                            |
| 14 | Dengjiutong          | NE                           | 860          | NW                             | 2120        | 368                            | Flat and wide; have fresh water from wells                            |
| 15 | Guiyutan             | North                        | 940          | NW                             | 3020        | 336                            | Flat and wide; have fresh water from wells                            |
| 16 | Xiejia               | NE                           | 1120         | North                          | 830         | 351                            | Flat and wide; have fresh water from wells                            |
| 17 | Zhuergen             | SW                           | 1210         | SW                             | 2750        | 390                            | Flat and wide; fresh water from wells                                 |
| 18 | Honghuagen           | North                        | 1260         | NW                             | 3670        | 522                            | Flat and wide; have fresh water from wells                            |
| 19 | Laolingtong          | SE                           | 1390         | SW                             | 2980        | 551                            | Flat and wide; have fresh water from wells                            |
| 20 | Youma Mountain       | NE                           | 1520         | North                          | 2580        | 94                             | Flat and wide; have fresh water from wells                            |

| SN | Name             | Relation with the plant site |              | Relation with Beimu spoil yard |             | Population | Basic information                          |
|----|------------------|------------------------------|--------------|--------------------------------|-------------|------------|--------------------------------------------|
|    |                  | Relative location            | Distance (m) | Relative location              | Distance(m) |            |                                            |
| 21 | Podiwei          | SE                           | 1570         | South                          | 1870        | 61         | Flat and wide; have fresh water from wells |
| 22 | Chuanjiang River | SE                           | 1590         | South                          | 2440        | 336        | Flat and wide; have fresh water from wells |
| 23 | Bingao Village   | West                         | 1672         | West                           | 3520        | 291        | Flat and wide; have fresh water from wells |
| 24 | Binchi           | North                        | 1860         | NW                             | 3910        | 1826       | Flat and wide; have fresh water from wells |
| 25 | Baiban           | SW                           | 1810         | SW                             | 2740        | 234        | Flat and wide; have fresh water from wells |
| 26 | Xiaditong        | West                         | 2220         | West                           | 4610        | 318        | Flat and wide; have fresh water from wells |
| 27 | Hengchong        | NW                           | 2410         | NW                             | 4530        | 158        | Flat and wide; have fresh water from wells |
| 28 | Datian           | West                         | 2520         | West                           | 4480        | 212        | Flat and wide; fresh water from wells      |
| 29 | Binding          | SW                           | 2630         | SW                             | 3850        | 413        | Flat and wide; have fresh water from wells |
| 30 | Xincunpo         | SW                           | 2640         | SW                             | 4110        | 144        | Flat and wide; have fresh water from wells |
| 31 | Dong'anchang     | NW                           | 2670         | North                          | 2000        | 254        | Flat and wide; have fresh water from wells |
| 32 | Shanggaotong     | West                         | 2680         | West                           | 5230        | 183        | Flat and wide; have fresh water from wells |
| 33 | Xinwudi          | North                        | 2710         | NW                             | 5200        | 209        | Flat and wide; have fresh water from wells |
| 34 | Botou            | West                         | 2760         | West                           | 5010        | 166        | Flat and wide; have fresh water from wells |
| 35 | Dapaoling        | NE                           | 2800         | North                          | 3520        | 151        | Flat and wide; have fresh water from wells |
| 36 | Dachunyuan       | SW                           | 2830         | SW                             | 4120        | 515        | Flat and wide; have fresh water from wells |
| 37 | Niulutang        | West                         | 2870         | SW                             | 5330        | 413        | Flat and wide; have fresh water from wells |
| 38 | Bangang          | North                        | 2930         | NW                             | 4670        | 553        | Flat and wide; have fresh water from wells |

| SN | Name           | Relation with the plant site |              | Relation with Beimu spoil yard |             | Population | Basic information                          |
|----|----------------|------------------------------|--------------|--------------------------------|-------------|------------|--------------------------------------------|
|    |                | Relative location            | Distance (m) | Relative location              | Distance(m) |            |                                            |
| 39 | Jingutang      | NW                           | 2940         | NW                             | 5560        | 149        | Flat and wide; have fresh water from wells |
| 40 | Jiangdi        | SW                           | 3040         | NW                             | 4440        | 399        | Flat and wide; have fresh water from wells |
| 41 | Shanlu Village | NE                           | 3220         | North                          | 3320        | 211        | Flat and wide; have fresh water from wells |
| 42 | Binglanggen    | SW                           | 3280         | SW                             | 4330        | 408        | Flat and wide; have fresh water from wells |
| 43 | Fuwu           | NE                           | 3370         | NE                             | 4450        | 2151       | Flat and wide; have fresh water from wells |
| 44 | Dashan Village | SW                           | 3480         | SW                             | 4780        | 225        | Flat and wide; have fresh water from wells |
| 45 | Shayongtang    | NE                           | 3550         | North                          | 4650        | 526        | Flat and wide; have fresh water from wells |
| 46 | Chongtou       | SW                           | 3580         | SW                             | 5210        | 218        | Flat and wide; have fresh water from wells |
| 47 | Wubei Mountain | SW                           | 3700         | SW                             | 5130        | 257        | Flat and wide; have fresh water from wells |
| 48 | Tangxi         | SW                           | 3740         | SW                             | 5020        | 218        | Flat and wide; have fresh water from wells |
| 49 | Chongzi        | North                        | 4000         | NW                             | 6850        | 333        | Flat and wide; have fresh water from wells |
| 50 | Beitang        | SW                           | 4110         | SW                             | 5230        | 167        | Flat and wide; have fresh water from wells |
| 51 | Huangshao      | SW                           | 4150         | SW                             | 5250        | 119        | Flat and wide; have fresh water from wells |
| 52 | Potang         | North                        | 4160         | NW                             | 6840        | 239        | Flat and wide; have fresh water from wells |
| 53 | Tan Village    | NE                           | 4170         | North                          | 5580        | 167        | Flat and wide; have fresh water from wells |
| 54 | Shangkantou    | West                         | 4290         | NW                             | 6720        | 537        | Flat and wide; have fresh water from wells |
| 55 | Duoyan Village | North                        | 4310         | NW                             | 5870        | 497        | Flat and wide; have fresh water from wells |
| 56 | Nanchong       | West                         | 4500         | West                           | 6700        | 178        | Flat and wide; have fresh water from       |

| SN | Name                     | Relation with the plant site |              | Relation with Beimu spoil yard |             | Population   | Basic information                          |
|----|--------------------------|------------------------------|--------------|--------------------------------|-------------|--------------|--------------------------------------------|
|    |                          | Relative location            | Distance (m) | Relative location              | Distance(m) |              |                                            |
|    |                          |                              |              |                                |             |              | wells                                      |
| 57 | Shanzi                   | West                         | 4510         | West                           | 7230        | 558          | Flat and wide; have fresh water from wells |
| 58 | Chelujiang River         | NW                           | 4570         | NW                             | 6960        | 164          | Flat and wide; have fresh water from wells |
| 59 | Miaoshandi               | NE                           | 4570         | North                          | 5570        | 121          | Flat and wide; have fresh water from wells |
| 60 | Danshuikou               | SW                           | 4590         | SW                             | 6320        | 179          | Flat and wide; have fresh water from wells |
| 61 | Xin Village              | SW                           | 4650         | SW                             | 6130        | 308          | Flat and wide; have fresh water from wells |
| 62 | Mutoutian                | NW                           | 4790         | NW                             | 6610        | 253          | Flat and wide; have fresh water from wells |
| 63 | Longdanshui              | NW                           | 4810         | NW                             | 6650        | 133          | Flat and wide; have fresh water from wells |
| 64 | Yangwu                   | North                        | 4850         | NW                             | 6720        | 2550         | Flat and wide; have fresh water from wells |
| 65 | Xiakantou                | West                         | 4890         | west                           | 6810        | 447          | Flat and wide; have fresh water from wells |
| 66 | Xiaomatou                | NW                           | 5270         | NW                             | 6600        | 354          | Flat and wide; fresh water from wells      |
| 67 | Banjiuchong              | West                         | 5610         | West                           | 7560        | 2739         | Flat and wide; have fresh water from wells |
| 68 | Shitoubu                 | NE                           | 6240         | NW                             | 6350        | 566          | Flat and wide; have fresh water from wells |
| 69 | Xinjuying Primary School | NE                           | 6410         | NW                             | 8530        | Faculty: 260 | Flat and wide; have fresh water from wells |
| 70 | Shanzhujiang River       | NW                           | 6490         | NW                             | 8380        | 419          | Flat and wide; have fresh water from wells |
| 71 | Nankang Town             | NW                           | 9780         | NW                             | 12620       | 48749        | Flat and wide; have fresh water from wells |

### 1.7.2.2 Environmental Protection Target for Offshore Area

Main environmental protection targets in the offshore area (including mudflat) are as follows:

- (1) State-level Shankou mangrove protection zone: located between Dandou Port and Yingluo Port in Hepu Town with an area of 80 km<sup>2</sup>, 40 km<sup>2</sup> for marine area and 40 km<sup>2</sup> for land.
- (2) Hepu Dugong state-level protection zone: located in southeast marine area of Shatian Town within zero depth contour of 21°30'00"N, 109°38'00"E, 21°30'00"N, 109°46'30"E, 21°18'00"N, 109°34'30"E and 21°18'00"N, 109°44'00"E.
- (3) Yingpan costal marine aquaculture zone: In the Yingpan and Fucheng costal mudflat from east coast of Xicungang to Beihai Harbor Tieshan Port operating area, the 146km<sup>2</sup> maritime space within the -5m depth contour of the west of the buffer area at the west side of the sea is used as marine aquaculture zone, mainly used for marine products culturing, including Sipunculus nudus and pearl, and the water quality goal is Grade II.
- (4) Yingpan pearl oyster culture zone: located in Yingpan, Tieshan Port, Beihai City to the north of 21°18'N, 109°10'E and 21°20'N, 109°30'E. The area is a natural offshore area for Mashi pearl oyster growth and mariculture as well as small shell culturing.
- (5) Yingpan Mashi natural protection zone (to be applied): located in the middle of the Yingpan pearl oyster mariculture area within the line of connecting the five points of 21°24'18"N, 109°24'00"E, 21°21'30"N, 109°24'00"E, 21°18'00"N, 109°16'00"E, 21°20'58"N, 109°16'00"E and 21°24'18"N, 109°21'18"E,
- (6) Shatian northwest mudflat mariculture area: located at the north mudflat area of Shatian as the key shell (mainly clams) mudflat culture area by Beihai mariculture planning.
- (7) Fangge sipunculid culture area: located in the south beach of Shatian which is the natural growth place for its culture as a protection zone by Beihai mariculture planning.

See Table 1.7-2 and Attached Drawing 4 for main offshore marine environmental protection targets.

**Table 1.7-2 Main Offshore Marine Environmental Protection Targets**

| Name of sensitive point                                    | Category                                                          | Area (km <sup>2</sup> )            | Protection target for water quality | Relative location against discharge outlet B3 and distance (km) |
|------------------------------------------------------------|-------------------------------------------------------------------|------------------------------------|-------------------------------------|-----------------------------------------------------------------|
| Shankou Mangrove Protection Zone                           | State-level natural ecological protection zone                    | 80 (40 for marine and 40 for land) | Class I                             | E, 4.7                                                          |
| Hepu Dugong Protection Zone                                | State-level natural protection zone                               | 350                                | Class I                             | ES, 5.0                                                         |
| Yingpan Pearl Oyster Culture Zone                          | Natural culture zone; mariculture zone                            | 600                                | Class II                            | WS, 11.9                                                        |
| Yingpan Mashi Pearl Oyster Protection Zone (to be applied) | Autonomous regional level natural protection zone (to be applied) | 92                                 | Class I                             | WS, 23.6                                                        |
| Shatian Northwest Mudflat Culture Zone                     | Key shell mudflat culture zone in Beihai City                     | 12.5                               | Class II                            | ENE, 3.7                                                        |
| Fangge Sipunculid Culture Zone                             | Resources protection zone by Beihai mariculture planning          | 7.2                                | Class II                            | E, 6.2                                                          |

### 1.8 Evaluation Level

According to the construction scale, features, environmental characteristics of the proposed project, as well as the impact extent and scope during construction and operation periods, the environmental impact evaluation level shall be determined in accordance with the division method stipulated in *Technical Guidance of Environmental Impact Assessment*. See details in Table 1.8.1

**Table 1.8-1 Level Division for Evaluation Work**

| Evaluation contents                           | Work level           | Basis                                                                                                                                                                                                                    | Status of project                                                                                                                                                                                                                                                                                               |
|-----------------------------------------------|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Water environment                             | Class I              | According to HJ/T2.3-93, wastewater effluent volume > 50,000 m <sup>3</sup> /d; Category II pollutant; The number of parameters for water quality required to be tested < 7; the complexity of sewage quality is simple. | The main pollutants in sewage include COD <sub>cr</sub> , SS, AOX as Category II pollutant. The number of parameters for water quality required to be tested is 3 (less than 7); the effluent volume of sewage is 133,848 m <sup>3</sup> /d. The receiving gulf of sewage is not closed.                        |
| Air environment                               | Class II             | According to HJ/T2.3-93, the discharge volume of main pollutants is $2.5 \times 10^9 > P_i \geq 2.5 \times 10^8$ ; complicated topography                                                                                | Low hill; main pollutants are SO <sub>2</sub> , NO <sub>2</sub> , dust and smoke<br>Q <sub>SO<sub>2</sub></sub> =0.24t/h; P <sub>i</sub> =0.48×10 <sup>9</sup><br>Q <sub>NO<sub>x</sub></sub> =0.28t/h; P <sub>i</sub> =1.17×10 <sup>9</sup><br>Q <sub>TSP</sub> =0.032t/h; P <sub>i</sub> =3.1×10 <sup>8</sup> |
| Sound environment                             | Class I              | According to J/T2.4-1995, the noise increases by 5-10 dB(A) before and after construction of large and medium project as Class III standard in GB3096-93                                                                 | Large-scaled project; plant boundary adopts Class III standard; the noise increases by 5-10 dB(A) before and after construction; the boundary is 2-10 dB(A)                                                                                                                                                     |
| Ecological environment (pulp & paper project) | Land: Class III      | According to HJ/T19-1997, project impact scope < 20 km <sup>2</sup> ; the biomass decreases sharply by < 50%.                                                                                                            | Hilly area; artificial vegetation; 198 hm <sup>2</sup> ; a little impact on biology; wastewater treatment meets the standard; certain impact on marine biology                                                                                                                                                  |
|                                               | Marine area: Class I | According to HJ/T19-1997, project impact area is sensitive area.                                                                                                                                                         | The marine area of the project pollutant discharge belongs to sensitive area.                                                                                                                                                                                                                                   |
| Risk evaluation                               | Class I              | HJ/T169-2004 Table1; great hazard source with flammable dangerous materials                                                                                                                                              | Storage volume for alcohol and petroleum is 20t and 158.3t (200 m <sup>3</sup> ). If over critical point, it will create great hazard with flammable material.                                                                                                                                                  |



## 1.9 Evaluation Procedure

See Diagram 1.9-1 for the procedure of evaluation work.

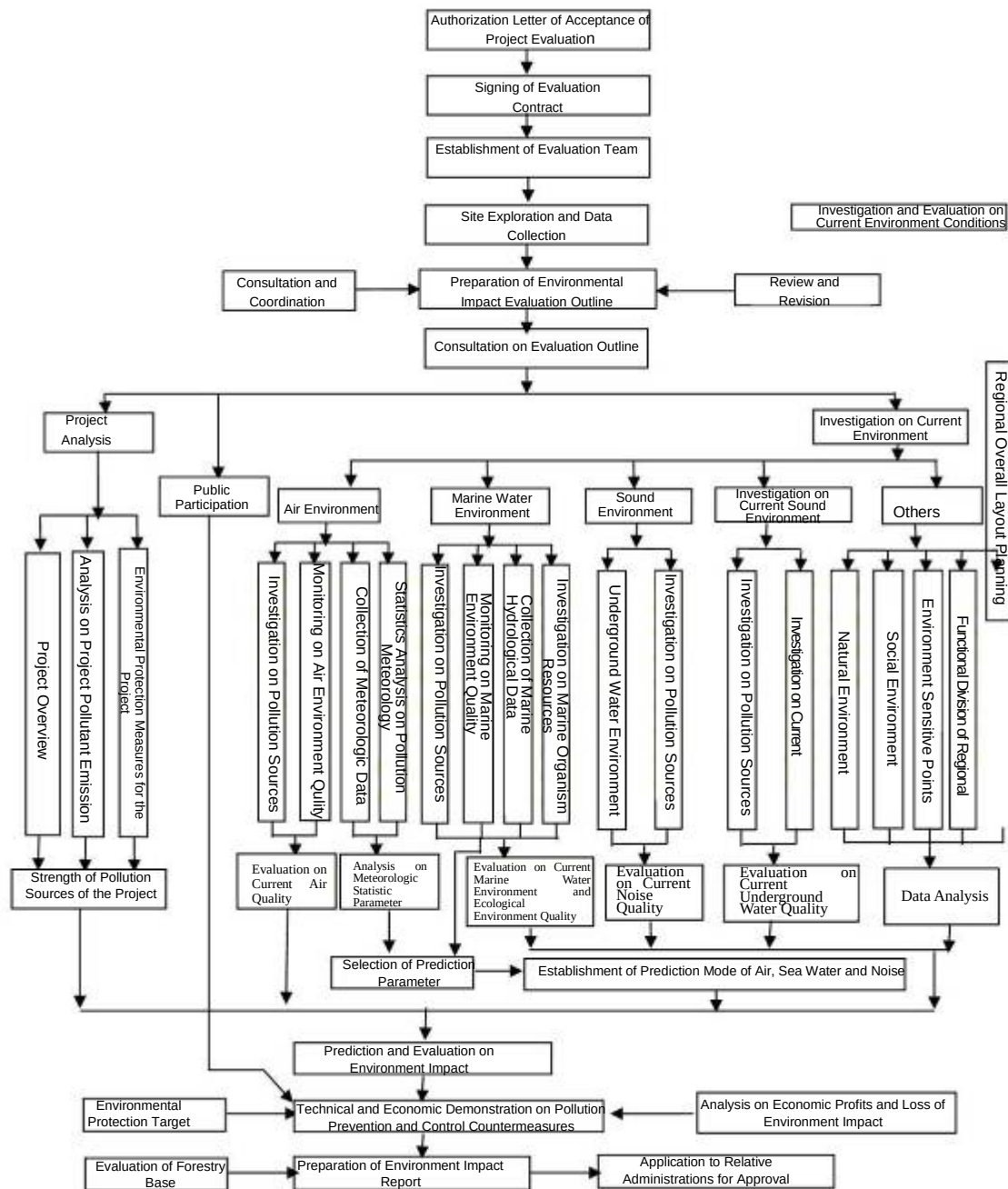


**Figure 1.9-1 Diagram of Environment Impact Evaluation Procedure of the Project**

## 2 Environment Overview of the Surrounding Area of the Project

### 2.1 Geographical Location

Tieshan Port is located in the southern end of Guangxi Zhuang Autonomous Region and in the east of Beihai City with the latitude of 21°26'~21°40' N and the longitude of 109°15'~109°45' E. It adjoins Zhanjiang City of Guangdong Province to the east, Beibu Gulf to the south, Beihai City to the west and the Counties of Lingshan, Pubei and Bobai to the north. The port is about 50km away from Beihai City, 250km from Nanning City, about 150km from Zhanjiang City of Guangdong Province and about 120 nautical miles away from Haikou City, the capital city of Hainan Province.

The planned project lies in Tieshan Port of Beihai City of Guangxi Province, close to Beimu Salt Works to the southeast, adjacent to Dapaoling Village to the west and is about 6.5km away from Beihai Power Plant in the northeast.

See Attached Drawing 1 for the geographical location of the planned project.

### 2.2 Overview of Natural Environment

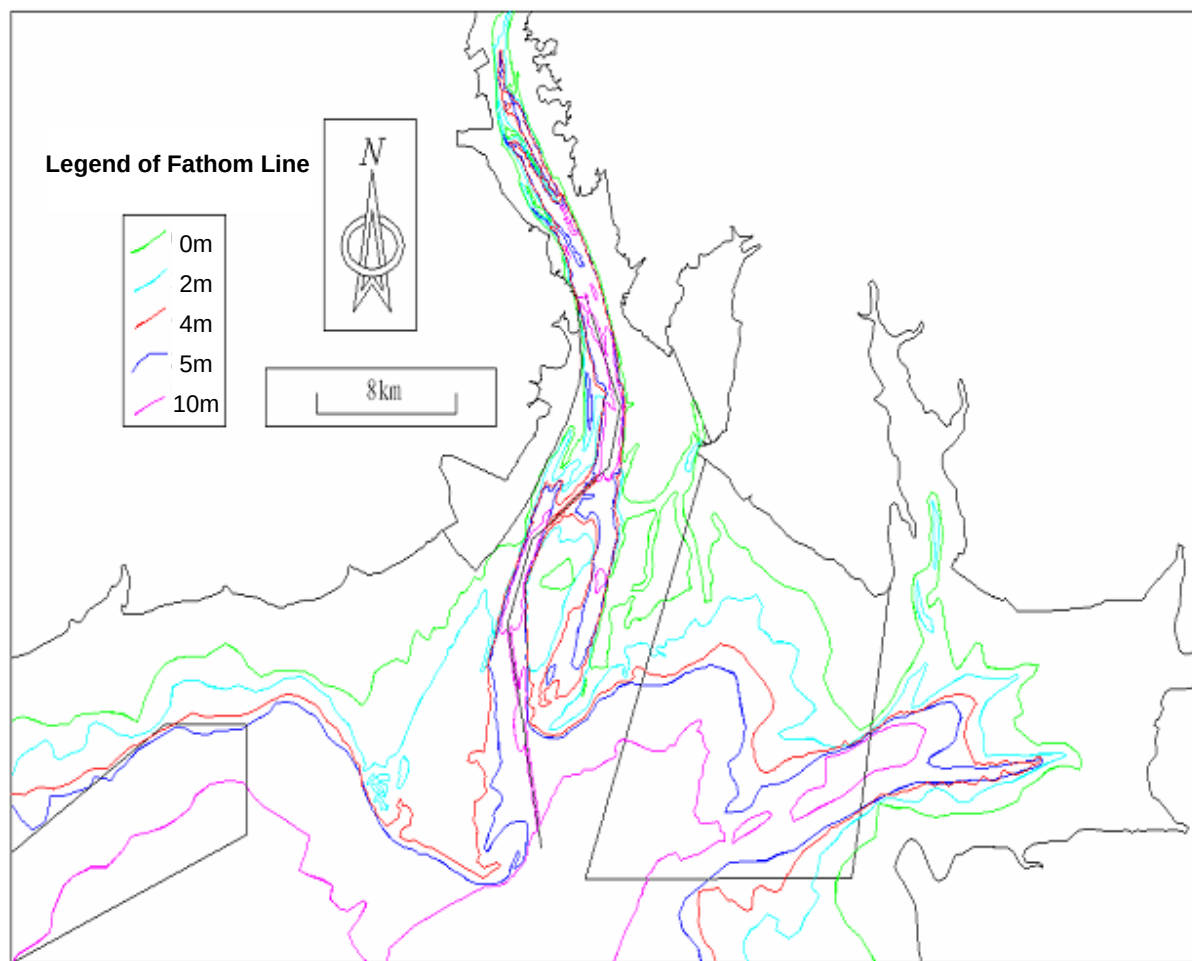
#### 2.2.1 Topographical and Geological Features

Beihai City is surrounded by hills in the north and sea in the south, with the topography tilting from the north to south interpenetrated with low hill, plain land and bench terrace. It is plain in downtown, which is erosion terrace formed by coast elevation of North Gulf and belongs to littoral deposit. Its geology is simple, whose top layer belongs to the Quaternary lower Pleistocene Beihai Group mainly with clay, sand clay and gravel clay and whose bottom layer belongs to the Quaternary lower Pleistocene Zhanjiang Group with clay, sand clay and gravel clay. The area for mudflat is large with an area of 46,800 hectares, among which sand beach, semi-beach and clay beach covers 30,400, 9,600 and 6,800 hectares, accounting for 65%, 20.5% and 14.5% respectively. Various rivers, meandering coastlines and water channels create the natural port in the area with over 150 berths for holding thousands of tons and over 20 berths for holding more than 100,000 tons to 200,000 tons.

Tieshan Port area belongs to littoral plain topography with 0-30m elevation (generally 10-20m), tilting from the north to south. The main topographical types includes running water, offshore (mixed deposit from marine and fluvio-marine) and artificial type, etc. According to the drilling information on special coal port sailing course for Beihai Power Plant, the geology for Xicao wharf at the mouth of Tieshan Port is divided into: the top surface is middle coarse sand and partially grit sand; top layer for the middle coarse sand is -9.4m and the height mark of the bottom layer is -18.4m. It is medium density.  $N=16\sim21$ ; the next layer is clay and there is no bedrock within -30m.

Tieshan Port is categorized as a platform drowned valley bay, which is a narrow and long tidal channel drowned with the rise of sea level during the late frozen age on the basis of a depression structure, with 40km in length (from the bay roof to the entrance mudflat) and 3~4km in width. Channels in the bay (the deep trench) are mainly derived out of the tidal effects, that is to say, born out of the scouring and erosion of ebb and flow of the tides. As reflected from the topographical features and sediments distribution, there has been a notable development of ebb delta, with an obvious tidal scour channel from the bay mouth toward the inner bay, which is actually the main channel of the bay at Tieshan Port. The tidal scour channel in waters around and outside the entrance area is diversified into 2 deep trenches in the east as the result of ebb of tides and in the west as the result of flow of tides respectively. The eastern trench is interconnected with the main trench, with sediment storage dams and mudflats

between the eastern and western trenches. See Picture 2.2-1 for underground water landform in Tiesha Port.



**Picture 2.2-1 Constant Value Line for Underground Water landform in Tiesha Port**

As revealed by the drilling data from the project of channels in coal harbor for exclusive use of Beihai Power Plant, the lithology around the wharf area of western trench at Tiesha bay mouth consists of: medium coarse sand at the surface (partially gravel sand, with the top sand layer about -9.4m, and -18.4m for elevation height at the bottom; generally in medium dense state, with  $N=16\sim21$ ) and mainly clay layer underneath. No signs of bed rocks have been found within -30 meters.

## 2.2.2 Climate

### (1) Meteorology

The Beihai City features the semitropical marine climate with its low latitude geographical location, showing the main characteristics of high temperature and plentiful rainfall through the year. As shown in the metrological statistics of Beihai over the past 30 years, the annual mean temperature in Tiesha Port District is  $22.6^{\circ}\text{C}$ , with the extremely high temperature at  $36.1^{\circ}\text{C}$  and the extremely low temperature at  $2.0^{\circ}\text{C}$ ; the average annual precipitation is 1548mm, with a maximum of 1774.6mm. The rainy season is mainly from June to September, accounting for up to 83% of the rainfall of the entire year; the mean annual days of thunderstorm reach 8.2 days and the annual evaporation is 1869.6mm; the average relative humidity is 81% and annual sunshine hour is 2088.7h. A north wind traverses the City of Beihai through the year with the frequency of 22%, where the prevailing wind is northerly wind in winter and southerly wind in summer. The frequency of calm wind is 5% while the average wind speed is 3.6m/s.

Fog mainly appears during late winter through to early spring (from January to March), while March claims the most foggy days of the year and the average annual foggy days over the years reach 13.2 days.

## (2) Weather Disasters

Severe weather disasters in the area can be drought, rainstorm and flood, typhoon, etc.

a. Drought: Drought occurs most frequently during spring with droughty weather and rare rainfall in the City of Beihai under the influence of seasonal wind changes. In some cases, rare rainfall even occurs in summer and winter, which may even so severe to cause the short of water supply for industrial and agricultural production in some years.

b. Rainstorm and flood: The mean annual days of thunderstorm reach 8.2 days in the City of Beihai, mainly from April to October, while the period from June to August claims to be the flood season with the highest frequency and intensity of rainstorms. As the statistics of precipitation shows, daily maximum precipitation in Beihai City during June, July and August reaches above 260mm.

c. Typhoon: Heavy typhoon normally happens during summer and autumn with an annual occurrence of 0-6 times on average. The wind force is normally 5-6 scales as it is blocked by Hainan Island and Leizhou Peninsula and can last for about 24 hours with historical maximum wind speed recorded at 40m/s, while wind over 10 scale seldom occurs in the area. Typhoon is always accompanied by heavy rains and may form storm tide when large tide occurs.

d. Thunderstorm: Annual days of thunderstorm reach up to 10 days.

## 2.2.3 Hydrology

### 2.2.3.1 Oceans

#### (1) Tide

Sea tide in Tieshan Port District is of mixed tide primarily with irregular diurnal tide which features firstly with wide tidal range, with the maximum tidal range of 7.03m and yearly average tidal range of 2.45m, and a longer duration of rising tide (approx. 15h) than that of the ebb tide (approx 10h) (Quoted from data of tide from Shitoubu tide station in Shitoubu Village at the west bank of Tieshan Port, about 11km from the Port District). The area is characterized with a strong tidal effect, with an average tide level of 2.55m, average high tide of 3.90m and average low tide of 1.38m. The highest tide is 5.40m and the lowest of 0.19m.

#### (2) Wave

Waves at Tieshan Port District are weakened under the shield of Leizhou Peninsula. Based on the wave observation data in Weizhou Island over the years, annual average wave height is said to be 0.67m. In addition, the direction of the strong waves appears in SSW with a frequency of 8.9% and the regular wave directions in the area are NNE, NE and E, with the wave frequency of 10.67%, 10.39% and 10.07% respectively. Frequency for waves under the height of 0.5m is recorded to be 38.85%, while the figure for waves above 1.5m in height is up to 4.6%.

#### (3) Ocean Currents

##### a. Tidal current

Tieshan Port is a platform drowned valley bay in its geographical landform, while tide current is a simple to-and-fro flow in the water area near the bay mouth under the influence and restraint of its landform, which gradually takes the form of rotating flow alongside the area outside the bay to Weizhou Island, with the major axis still located along the direction of NE-SW. Generally speaking, the duration of rising tide is longer than that of the ebb tide. Additionally, velocity curves of rising flows appear to be the bimodal type, which in some cases show a steady time history record when reaching the medium tidal

flow level, while, in other cases, may fall back a bit, leading to a short period of ebb flows. The rotating flow, in general, moves in a clockwise direction from the ebb to rising tide and the opposite while turning conversely.

#### b. Residual current

Residual current on the surface layer of Tieshan Port District is mainly composed of the wind-driven current that diversifies with changes in different wind directions; while on the medium and bottom layer, tide-induced residual current is predominant, moving close in the direction of the rising tide. Velocity of residual current on the surface layer is quick with the maximum of 0.22m/s at the bay roof, while velocity of residual current at the bottom layer is about 0.17m/s. Residual current is mainly directed towards the inner bay near the bay mouth, while moves in an outbound direction in the area outside the bay.

#### (4) Silt

Silts of Tieshan Port are mainly classified into continental and marine silt in terms of the sources.

Continental silt mainly comes from creeks and rivers near the bay, in which the bigger ones keep flowing into the Baisha River of Dandou' gang, with an annual silt discharge amount of around 16~18t. In addition, the rest of the small creeks and rivers (i.e. Gongguan River, Zhali River, Bainijiang River, etc.) also contribute to the silt of the bay. Besides, gullies on the platform and wave erosion scarps near the mean high water line also provide with a small proportion of silt for the harbor. The entire continental silt is estimated to be around 300,000t per year, primarily with fine grains deposited inside or in the southeast of Dandou' gang and in the vicinity of Laoyazhou at the bay roof of Tieshan Port.

Marine silt is mainly composed of coarse grained minerals. Tidal scour channels in the east, west and north of the bay are distributed with sediments such as gravel sands, medium sands, medium-fine sands and sand, while sea mudflats alongside the various channels are mainly composed of fine grained sands. Deeper waters in the southeast of the ebb delta area and the open sea area to the south of Dandou' gang are characterized with lithology of fine grained sediments, such as powder fine sands, medium-fine sands, sands and sandy clays, while also serve as the major source of marine silt in Tieshan Port. Water bodies as the result of joint effects by ocean waves and tidal currents keep pushing the silt towards the sea shore and the maximum silt concentration inside the bay is  $0.068\text{kg/m}^3$ . North and NE winds prevail in winter, in an opposite direction with that of rising tide due to the narrow range of wind fetch, therefore silt concentration inside the bay throughout the entire winter is lower than that in summer.

### 2.2.3.2 Surface Water

Major surface water bodies in the evaluation area are the Nankangjiang River, with the Hepu Reservoir as the water resource.

#### (1) Nankangjiang River

Nankangjiang River is an independent hydrological unit which flows into the sea separately, originated from the mountainous region to the east of Baishuitang at the ShiziluTown of Hepu County. The river, with the catchment area of  $193.8\text{km}^2$  and a length of 31km along the effluent area, streams from north to south across the towns of Nankang, Xinggang and Yingpan in Tieshan Port District of Beihai City and enters into Tieshan Port in Shajiaozui of Qingshantou in Yingpan town. 3km adjacent to the entrance area are open river mudflats, 1-1.2km in width with large and coarse grains. There are 12 tributary gullies along Nankangjiang River, 6 of which are large in scale, all with dendritic injection into the effluent area. The belt of 0.5 to 2 km alongside the platform on both sides of the river bank is for cultivation use. Tidal current in the mouth area of Nankangjiang River is of the mixed type. Maximum

and average tide range at the Shitoubu tide station nearby reaches 6.25m and 2.45m respectively. The general rule for tidal changes features on a longer duration of rising tides (8 h 50 min on average) than that of the ebb tides (6 h 52 min on average). Part of the river is diagnosed of sedimentation, especially with that of the tide lock near the entrance area, where the river bed gets wider while velocity of water flows is weakened, taking on the look of alluvial fan.

The planned plant site is located 6km west to the Nankang River. There is not a hydrological connection between water effluent (water waste and rainfalls included) of the project and the Nankangjiang River.

## (2) Hepu Reservoir

Hepu Reservoir is a large-scaled construction project of hydrological facilities, with irrigation as the major purpose, and water supply, floods prevention, power generation, cultivation and tourism as means for its comprehensive utilization. The facility has been in operation since its completion in March 1960 and has 89 main and auxiliary dams, 13 spillways and 1 large aqueduct. Hepu Reservoir is connected with the Wangshengjiang-Liuhu reservoir through the large aqueduct of Nanliu River and with the 4 medium sized reservoirs of Zhakou, Qingshuijiang, Shikang and Niuweiling through the Huhai Canal, all of which is collectively named as Hepu Multi-reservoir System. Rain collection area under the regulation of reservoir is 1052.8km<sup>2</sup>, with 1.2502 billion m<sup>3</sup> of total storage volume, 0.532 billion m<sup>3</sup> of effective storage volume, 0.2203 billion m<sup>3</sup> of inactive storage volume and a designed irrigation area of 701,000 mu.

Rivers within the irrigation area of Hepu Reservoir belongs to coastal water system of southern Guangxi, with a flow direction from north to south in general. Main rivers include the Nanliu River, together with its tributaries (also called Majiang River), Changle River, Baisha River, Shikang River, Qili River, Qingshui River, etc. The irrigation area covers the Bobai County of Yulin City, Pubei County of Qin Zhou City and one county and three districts in Beihai City, with 450,000 mu of effective irrigation area so far. The main canals, branch canals, lateral canals and farm ditches add up to a total length of 1783.56km, while the main canal of Nankang River being drained to the Tieshan Port District directly.

The Water Supply Project of Tieshan Port under construction presently shall be the major water source for Tieshan Port Offshore Industrial Zone and the planned project.

## 2.2.3.3 Underground Water

### (1) Types, supply and discharge patterns of the underground water

The site of planned project falls into the category of Nankang basin with its geographical landform. Regionally, the basin is an independent hydrological unit with a coverage area of about 1200km<sup>2</sup>, whose major underground water types are bedrock fissured water, and carbonate rock karst fissured water and loose rock pore water. The underground water in Nankang basin water source is mainly recharged by atmospheric precipitation and ditch water, with a lateral recharge of mountainous bedrock fissured water in the north side. The effluent pattern of underground runoff waters is primarily under the control of its geographical features, with the overall flow direction from north to south into the sea area, in the form of spring or dispersive flow.

### (2) Dynamic characteristics of groundwater level

Dynamic changes of groundwater level are mainly affected by atmospheric precipitation, tides, evaporation from topsoil and field activities. In those dry seasons with low precipitation, water discharge is ceased in canals and the groundwater level decreases; while in spring and the high flow period with

high precipitation, the water discharge is resumed and the groundwater level goes up. Annual amplitude of phreatic water level in void space reaches as much as 2~5m, while the confined water within 2km near the sea shore areas is under the influence of tides, and the amplitude of groundwater level reaches 2~3m.

### (3) Chemical characteristics of underground water

Chemical characteristics of the pore phreatic water and pore confined water in Nankang Basin are primarily  $H_2O_3Cl-CaNa$  and  $Cl-Na$ , which present to be weakly acidic to neutral, with the pH value between 5.5~7.0 in general, the degree of mineralization under 0.05g/L and the total hardness of 0.2~0.39mmol/L. While the fissured water is commonly  $HCO_3-Ca$ , which presents to be neutral and slightly hard in its composition, with the degree of mineralization around 0.15~0.30g/L. It may turn to hard water of  $Cl-Na$  type or even very hard water under the influence of sea water alongside the sea shore areas.

## 2.2.4 Channels

Tieshan Port enjoys the advantage of water depth. The 60km-long outer channel from near the Weizhou Island to the Tieshan Port boasts its natural water depth of over 16m, which constitutes a natural deep water channel for 100-thousand-ton channel with no need of excavation, while the excavation depth only goes for 1~2m for 150-thousand-ton and 200-thousand-ton channels, with 7.7~18m of natural water depth in the part of the entrance channel. The port is characterized with a wide tide range, while the maximum tide range reaches 5.37m. The usable tide-bound water level is above 3m, therefore the overall excavation amount in the channel shall be quite few. Tieshan Port is also known for its large tidal discharge volume (with the figure for spring tides as much as  $3 \times 10^8 \sim 4 \times 10^8 m^3$ ) and the strong effect of tides, which serves the best for maintaining the water depth upon excavation in the channel. As shown by the results of comparative study of underground topography, the water depth in Tieshan Port District is stable, with very small variation of scouring-sedimentation and small back silting volume, while water depth in the channel can be controlled by means of dredging.

## 2.2.5 Seismic Intensity

According to the Seismic Intensity Zonation Map of China (1990), the seismic intensity in Beihai City is VI degree (with design basic acceleration of ground motion of 0.05g and the design characteristic cycle of 0.35s), which proves to be a regional stable block.

## 2.3 Overview of Zoning Planning in Tieshan Port District

Tieshan Port District is a newly-established administrative district under the governance of Beihai City reviewed and approved by the State Council on Dec. 17th, 1994, which now governed the three towns of Nankang, Yingpan and Xinggang, with a total area of  $94 km^2$ , a 50 km-long coastline and  $80 km^2$  mudflat area. According to Beihai Overall Plan (Amended) 2001-2010, Tieshan Port shall be listed as one of the urban subcenters, centered upon the harbor to develop the entrepot trade, the coastal heavy chemical industry, energy industries, etc. And in the layout pattern of coastlines in Beihai City, the area of Tieshan Port is categorized as the industrial coastline. See the Attached Drawing for the overall plan of Beihai City.

Based on the *Beihai Overall Plan (Amended) 2001-2010* (already completed), the *Zoning Planning of Tieshan Port, Beihai City* (hereinafter referred as the Zoning Planning) is specially compiled and has

been printed and distributed to all interested parties from Nov. 2004. (See the Annex 8 for details.) According to the Zoning Planning, Tieshan Port will be built into a large-scaled harbor and a key industrial plant base in the area.

### 2.3.1 Nature, Scope and Population in the Planned Area

(1) Nature of the planned area: Tieshan Port is one of the urban subcenters of Beihai City, where the priority shall be given to the development of harbor, in building up urban functional areas of entrepot (trade, the coastal heavy chemical industry, energy industries, etc.

(2) Scope of the planned area: Major planned area starts from the administrative center of Tieshan Port, alongside the Beitie First Grade Highway to the coastlines from the west to the east, and from Shitoubu to the entrance of Nankangjiang River from the north to the south, with a total area of around 50.54km<sup>2</sup>. See the Attached Drawing for the overall plan of Beihai City.

(3) Population size in the planned area: Population in the planned area shall be 80,000 by 2010 in the short-term plan and 200,000 by 2020 in a long-term plan.

(4) Industrial development size: according to planning forecast, the total industrial output value shall be 25 billion Yuan by 2010 in the short-term plan. Calculated on the basis of 10% growth rate from 2010 to 2020, the total industrial output value shall be 65 billion Yuan by 2020 in the long-term plan.

### 2.3.2 Developing orientation and focus

(1) Taking full advantage of local, surrounding and inland resource advantage, vigorously developing resource-based industries including food, building materials and papermaking industries, etc.

(2) Taking full advantage of the ports advantage, taking ports as the core to develop coastal heavy industries, energy industry and transit trade.

(3) Taking full advantage of the geographic advantages of coast and border to vigorously develop knowledge-intensive and intellectual-intensive new high-tech industries focusing on electronic information technology, biological engineering and environmental protection.

### 2.3.3 Land Use Planning

(1) Functional zone layout

1) According to the current urban development and development rules of harbor district in recent period, planned area will be divided into administration section and living area, Xinggang living and service area, industrial zone, port and dock zone.

2) Administration and living area is the development area taking the original administrative center of the harbor area, north of Beitie First Grade Highway, as its core.

3) The Xinggang living and service area locates at the southeast corner of the crossing of Beitie First Grade Highway and planned railway line.

4) The industrial zone locates at the south of the Beitie First Grade Highway and the north of transmeridional railway.

5) Port and dock zone shall be coastal area along the shore.

(2) Industrial zone layout

Industrial land mainly distributes in coastal region and is divided into the following three categories:

1) Chijiang-Shitoubu industrial zone: focusing on industrial and hazardous article warehouse, taking up



751.5 hm<sup>2</sup> land area.

2) Central industrial zone: the nature is second grade industrial land and warehouse land, mainly developing high-technology industry with less pollutant, and the planned area is 1497.8 hm<sup>2</sup>.

3) Beimu industrial zone: focusing on three categories of large industrial projects, developing large heavy industries, and the planned area is 1465.1 hm<sup>2</sup>.

(3) Priorities in the industrial development shall be given to petrochemical plants, thermal power plants and the building materials industry.

### 2.3.4 Harbor and Coastline Use Planning

#### 2.3.4.1 Harbor Layout Planning

(1) Plans for the establishment of a new harbor shall take into consideration the adequate land width (1.0~1.5km and 2.0km for some individual harbor area) so as to meet the need of operation for modern harbors. Efforts shall be made in the justified use of mudflats for building up the harbors to achieve the minimum occupation of farm lands.

(2) To make full use of the coastline resources of Tieshan Port as well as to meet the lines in the overall plans for the City in harbor development, the port areas of Tieshan Port will be divided in the four major parts of industrial harbor, commercial harbor, civil harbor and dangerous goods (DG) warehousing area on the whole, with the land width of 1~3km, of which the DG warehousing harbor area, civil harbor area (for passenger transportation), power plant in industrial harbor area and the special industrial wharfs on both sides are under construction plans within the scope of planned areas for future use, while the large-scale harbor area and commercial harbor area, with the need for sea filling in the mudflat area, have not been included within the plan yet still fall under the control of it.

It has been planned to build up large-scaled wharf for passenger transportation at Shitoubu of Tieshan Port District, which opens up with both domestic and international services.

The detailed layout for operation areas of productive harbors shall be specified in the overall plan of harbors in Tieshan Port District.

#### 2.3.4.2 Coastline Utilization Planning

(1) The planning is specified with the purpose to make full use of the coastlines in the planned area and build up a harbor industrial areas on its primary stage towards modernization.

(2) The scope of the planning covers the area from Poweidi to Xinlong Wharf, with the total coastline length of about 18.5km.

(3) Functional division of the land and marine comprehensive use shall be worked out in accordance with the current situation of construction projects and utilization of harbors, along with the existing problems as well as requirements in the recent plans of urban development in the harbor areas.

(4) See the attached drawing 7 for functional division of the land and marine comprehensive use alongside the coastlines within the planned area, which shall be carried out as follows:

- a. Coastlines for the use of large-scaled industries: from Poweidi to the Beimu Salt Works.
- b. Coastlines for the use of commercial harbor: from Beimu Salt Works to the wharf of the power plant.
- c. Port for the special use of industries: from the wharf of the power plant to Shitoubu.
- d. Coastlines for the wharf for passenger transportation: Shitoubu.
- e. DG wharf area: from Shitoubu to Xinlong Wharf.

## 2.3.5 Municipal Public Facilities Planning

### 2.3.5.1 Planning of Water Supply Project

Total urban consumption of water resources is said to be 760,000t/d in the planning by 2020. So far, water supply sources for urban use are made of the underground water bodies and those from the Hepu Reservoir and shall be shifted to Hepu Reservoir as the primary source in the long run. A system for water supply and distribution according to different location and with varied qualities, has been deployed in the water supply pipe network, arranging in ring, and shall be carried out through different stages to build up a network in ring for district water supply.

### 2.3.5.2 Effluent Project Planning

The planned urban effluent system is a separated one with the diversion of rain and sewage water. The planned volume of sewage effluent is estimated to reach 608,000m<sup>3</sup>/d. Effluent of sewage is done in two separated areas in the east and west side of the railway respectively, of which capacity for eastern sewage treatment plant shall be 568,000m<sup>3</sup>/d, specialized in the treatment of industrial sewage discharged into the sea after secondary treatment within the plant. Meanwhile, capacity for western sewage treatment plant shall be 40,000 m<sup>3</sup>/d, where the sewage goes all the way through the pump station to Yingpan for unified planning and regulation; while rain water shall be effluented into the nearest sea or rivers.

### 2.3.5.3 Electric Power Planning

Power load forecasting: Living and general industrial power consumption in the planned area shall be 300,000kW/a, power consumption volume shall be 1,200,000,000kW/a and that for large-scaled industries shall be 1,700,000,000kW/a.

Power supply: Power generation for the newly-built Beihai Power Plant is planned to be 4×300MW, with a capacity of 2×300MW for the short-term. Two transformer substation of 220kV and 4 more of 110kV shall be set up in the planned area.

In principle, power cables shall be laid in the east side of the road in a north-south direction and in the north side with east-west direction.

## 2.3.6 Environmental Protection Planning

(1) Water environment: The water quality in sea areas of Hepu Dugong State Nature Reserve, National Shankou Mangrove Nature Reserve, shall achieve Category I of sea water quality standard, while the rest offshore sea areas also meet the standards in correspondence with the functional divisions. (See GB3097—1997 *Marine Water Quality Standard*)

(2) Atmospheric environment: Atmospheric environmental quality in the planned area shall meet the requirements of quality and functionality for Class II and shall also achieve the standards for air quality of Category II as prescribed in GB3095—1996 of *Atmospheric Environment Quality Standard*.

(3) Sound environment: Functional areas for sound environment shall be divided into the industrial area, residential area, commercial mixed area and the roadsides of main trunks, which shall be carried out in accordance with the corresponding provisions in the GB3096—93 of *Standard of Environmental Noise of urban Area*.

(4) Ecological environment: Protection of marine ecological system in offshore waters, regional landscape pattern and the peripheral agricultural ecological system shall be all included in the planning.

### 2.3.7 Infrastructure Construction in Tieshan Port District

#### (1) Water supply

Capacity for water supply from Hepu Reservoir to Tieshan Port District is designed to be 226,000t/d. So far, the Phase I project of water supply facilities and pipe networks has been completed, which shall be fully capable of water supply for large-scaled projects.

#### (2) Power supply

Establishment of the Beihai Power Plant seated in the harbor area has been approved officially by the State Development Planning Commission in 1993, with a total investment of CNY 2,680,000,000, including the two 300,000 kW power generating units in Phase I, which have already been put into production for power supply as scheduled, and another two sets for Phase II, which have also been on the agenda for further progress. Power lines from Pingyang to the Power Plant (110kV), from the Power Plant to Chongkou (220kV) and Bobai (220kV) have all been completed. The 3,000 DWT heavy cargo wharf with an investment of CNY 13,000,000 has already been put into use (which will be able to hold vessels of 10,000 DWT at high tides). Besides the 35,000 DWT coal terminals (which shall be considered as 50,000 DWT of foundation) has also been put into use from November 2004.

#### (3) Roads

The Beihai-Tieshan Port first class highway has been built, leading all the way to the port. The highway from Yulin to Tieshan Port is also under construction, which shall be connected with the highways from Beihai to Nanjing and Guangdong Province upon its completion. The Hepu-Hechun railway and the railway branch connecting Yulin and Tieshan Port are under planning so far, with the purpose to build Tieshan Port into a convenient channel to the sea for the grand southwestern region of China.

Roads that have been constructed in Tieshan Port include the road entering the port, Beitie first class highway, No. 4 motor lane (the No.4 urban expressway) and YingZha Road (Yingpan-Zhakou Coast Highway), all of which have been open for traffic. The Xinggong Road and No. 7 Road are also under construction. See the Attached Drawing for sketch maps of the planned roads.

#### (4) Ports

Major wharfs in the planned areas, mainly including Shitoubu boundary trade port wharf, the 50,000 DWT coal terminal of Beihai Power Plant, the 3,000 DWT heavy cargo wharf, the specialized oil-and-gas terminal of Xinlong Gas Co., Ltd., with 10 berths at present have been open for traffic with the ports in Fangcheng, Hainan, Zhanjiang and Vietnam. Two other 50,000 DWT deep water wharfs for commercial use as well as the ones for oil-and-gas and petrochemical owners are also under construction now. So far, the existing 50,000 DWT entrance channel shall be used to enter the port.

### 2.3.8 Regional environment evaluation and main evaluative conclusions

Beihai Tieshangang government prepared the Regional Environment Impact Report Concerning the Large-size Port and Industrial Base of Tieshan Port, Beihai (hereinafter referred to as the report) in September 2005. Environment Protection Bureau of Guangxi Zhuang Autonomous Region agreed the site selection, development and construction of the port and industrial base in GHKZ [2005] No. 275, Official Reply to Regional Environment Impact Report Concerning the Large-size Port and Industrial Base of Tieshan Port, Beihai. And the report believes that:

The prevailing wind direction of the industrial base region is north wind, so pollutants could diffuse to the sea surface and industrial wastewater can be discharged to the deep sea. The air and water environmental capacity is relatively large, which could basically satisfy the development requirement of the industrial base. The site selection of the industrial base complies with the functional division requirement of the overall planning of Beihai city, district planning of Tieshan port, and marine environment functional division requirement of Guangxi Province. The result of environmental impact

assessment shows that the development scale is basically reasonable.

As the ecological environment in the region is relatively sensitive, we need to reinforce the protection for sensitive environmental protection targets including nature reserves, marine aquaculture zone concentration area, mangrove forest and intertidal belt. Industrial base shall take environmental protection measures, ecological protection and construction measures to strictly implement the gross contamination emission controlling system, prevent environmental pollution and ecological damage, lower the unfavorable impact brought by project construction and operation, and protect regional ecological environment to realize the unification of economic benefits and environmental benefits.

## **2.4 Overview of Social Environment**

### **2.4.1 Population and Land Area of Tieshan Port District**

Tieshan Port District is located in eastern Beihai City, governing the 3 towns, with an administrative area of 394km<sup>2</sup>. The population of the district was recorded to be 168,800 by the end of 2006, with a natural growth rate of 13.29‰. Area of the cultivated land amounts to 11128hm<sup>2</sup>, while the figure for effective irrigated area of farmland, sowing area and forestry area reaches 3973 hm<sup>2</sup>, 8358 hm<sup>2</sup> and 220 hm<sup>2</sup> respectively. See the Attached Drawing for current situation of land use.

### **2.4.2 Social Economic Status**

The year of 2006 has witnessed the achievement of a total output volume of CNY 1,926,000,000, of which the added value of primary industry, secondary industry and tertiary industry accounted for CNY 665,000,000, CNY 938,000,000 and CNY 323,000,000 respectively. The per capital gross regional product scored at CNY 11744. General fiscal budget revenue has reached CNY 80,000,000, while the expenditure went for 129,000 000 Yuan over the same period. And the rural per capita net income claimed to be 3468 through the year.

Thermal power, sugar refinery, porcelain, salt and spirulina are the pillar industries in the area. Scale-sized industries across the region had achieved CNY 1,489,500,000 of added value as a whole in the same year, showing a growth by 19.12% over the previous year. Meanwhile, tax and profit had amounted to CNY 268,930,000, in which the profits accounted for CNY 183,370,000, indicating an increase by 138.94% and 520.79% respectively.

### **2.4.3 Current Situation of Drinking Water in the Evaluation Area**

Well water of villages in the evaluation area is taken as the major source for drinking water. For residents in Nankang Town, the Nankang Water Treatment Plant shall be the primary supplier of drinking water (with the underground waters as the source of supply).

### **2.4.4 Distribution of Salt Field**

Salt fields in the evaluation region covers an area of around 578hm<sup>2</sup>, of which the Beimu Salt Works accounts for 535 hm<sup>2</sup> while the rest 43 hm<sup>2</sup> belongs to the Committee of Xiejia and Sushan Village respectively. For the distribution of salt fields, see the Attached Drawing 8.

The nearest salt field to the east of proposed plant site is called Beimu Salt Works (The project covers 16.66hm<sup>2</sup> of the salt field). It belongs to marine salt field with salt area of 560.91 hm<sup>2</sup> with the production capacity of 28,000t/a and single production about 50t/hm<sup>2</sup>. In 2006, the production volume is

about 28,000 tons and the total value is 12,000,000 RMB with the profit of 160,000 RMB. According to the Guiding Proposals about Structural Adjustment for National Salt-making Industry by State Development and Reform Commission ([2006] No. 605), the private-owned salt producers with lower economic scale should be gradually closed. Among them, the eliminated scale for marine salt is 300,000 t/a and Beimu is less than 100,000 t/a. therefore, it should be adjusted required by Tieshan Port Government, Beihai City according to the distributed documents. (Enclosure 18 BTZF [2007] No.19)

## 2.5 Overview of Pollution Source

### 2.5.1 Industrial Pollution Sources

Major pollution discharge and pollution sources in Beihai City are shown in Table 2.5-1, of which the pollution sources 1<sup>#</sup>-4<sup>#</sup> are located in Tieshan Port District. The distribution of pollution sources in Tieshan Port might be seen in Attached Drawing 9.

As shown in the Table, the total volume of SO<sub>2</sub> (as one of the major pollution sources in Beihai City) amounted to around 31398.4t in the year of 2006 and that in Tieshan Port District was 28763.3 t over the same period, taking up 91.6% of the total discharge (in which SO<sub>2</sub> discharged by SDIC Beibuwan Electric Power Co., Ltd accounted for 87.5% of the total discharge volume of SO<sub>2</sub>). Meanwhile, the total volume of COD (as one of the major pollution sources in the Beihai City) amounted to around 16351.5t and that in Tieshan Port District was 4735.1t over the same period, taking up 29.0% of the total discharge volume.

Until February 2008, key projects in planning and construction in Beihai city (subject to approval by environmental protection authority) include 200,000 tons per year fuel ethanol project of Guangxi COFCO Biomass Energy Co., Ltd (Phase I project) and 1,200,000 tons per year heavy oil chemical project of Beihai Taibang Energy Co., Ltd, For the specific pollutant emission situation, please refer to Table 2.5-2.

**Table 2.5-1 Discharge of Main Pollution Sources in Beihai City**

| SN | Company Name<br>excluded<br>Type of production | Waste gas (t)   |                  |                | Waste water (t)  |                  |                | Notes                                                            |
|----|------------------------------------------------|-----------------|------------------|----------------|------------------|------------------|----------------|------------------------------------------------------------------|
|    |                                                | Pollutant       | Discharge volume | Removal amount | Pollutant        | Discharge volume | Removal amount |                                                                  |
| 1  | Power plant (coal)                             | SO <sub>2</sub> | 27465.7          |                | COD              | 0                |                | Discharged into Tieshan Port                                     |
|    |                                                | Smoke & Dust    | 5392.4           |                | Ammonia Nitrogen | 0                |                |                                                                  |
| 2  | Paper industry/<br>Sugar production            | SO <sub>2</sub> | 792.0            |                | COD              | 4701.7           | 3558.8         | Discharged into Nankangjiang River                               |
|    |                                                | Smoke & Dust    | 1528.0           | 3168.0         | Ammonia Nitrogen | 62.5             | 1486.7         |                                                                  |
| 3  | Alcohol Factory                                | SO <sub>2</sub> | 16.6             |                | COD              | 32.4             | 291.6          | Discharged into Tieshan Port through farming irrigation channels |
|    |                                                | Smoke & Dust    | 4.7              | 312.8          | Ammonia Nitrogen | 2.7              | 13.5           |                                                                  |
| 4  | Pottery Factory                                | SO <sub>2</sub> | 489.0            | 0              | COD              | 1.0              |                | Discharged into Tieshan Port                                     |
|    |                                                | Smoke & Dust    | 458.4            | 2597.6         | Ammonia Nitrogen | 0.2              |                |                                                                  |
| 5  | Sugar production                               | SO <sub>2</sub> | 22.6             |                | COD              | 2701.0           | 917.3          | Discharged into the Lianzhou Bay ultimately                      |
|    |                                                | Smoke & Dust    | 134.8            | 3232.4         | Ammonia Nitrogen | 122.7            | 47.4           |                                                                  |
| 6  | Sugar production                               | SO <sub>2</sub> | 0                |                | COD              | 3281.6           |                | Discharged into Nanliu River                                     |
|    |                                                | Smoke & Dust    | 425.0            |                | Ammonia Nitrogen | 150.6            |                |                                                                  |
| 7  | Sugar production                               | SO <sub>2</sub> | 0                |                | COD              | 1620.0           |                | Discharged into Tieshan Port ultimately                          |
|    |                                                | Smoke & Dust    | 206.3            |                | Ammonia Nitrogen | 114.9            |                |                                                                  |
| 8  | Starch production                              | SO <sub>2</sub> | 240.0            |                | COD              | 1214.1           |                | Discharged into the Lianzhou Bay ultimately                      |
|    |                                                | Smoke & Dust    | 300.0            |                | Ammonia Nitrogen | 25.1             |                |                                                                  |
| 9  | Wine                                           | SO <sub>2</sub> | 80.0             |                | COD              | 2751.0           |                | Discharged into the Lianzhou Bay ultimately                      |
|    |                                                | Smoke & Dust    | 21.3             | 850.0          | Ammonia Nitrogen | 103.8            |                |                                                                  |
| 10 | Leather-making                                 | SO <sub>2</sub> | 0                |                | COD              | 48.7             |                | Discharged                                                       |

| SN    | Company Name<br>excluded<br>Type of production | Waste gas (t)   |                     |                   | Waste water (t)     |                      |                   |                                           |
|-------|------------------------------------------------|-----------------|---------------------|-------------------|---------------------|----------------------|-------------------|-------------------------------------------|
|       |                                                | Pollutant       | Discharge<br>volume | Removal<br>amount | Pollutant           | Discharg<br>e volume | Removal<br>amount | Notes                                     |
|       |                                                | Smoke &<br>Dust | 25.8                |                   | Ammonia<br>Nitrogen | 12.0                 |                   | into the<br>Lianzhou<br>Bay<br>ultimately |
| 11    | Cement Factory                                 | SO <sub>2</sub> | 588.0               |                   | COD                 |                      |                   | /                                         |
|       |                                                | Smoke &<br>Dust | 2100.0              |                   | Ammonia<br>Nitrogen |                      |                   |                                           |
| 12    | Cement Products                                | SO <sub>2</sub> | 580.0               |                   | COD                 |                      |                   | /                                         |
|       |                                                | Smoke &<br>Dust | 2100.0              |                   | Ammonia<br>Nitrogen |                      |                   |                                           |
| 13    | Cement Production                              | SO <sub>2</sub> | 324.5               |                   | COD                 |                      |                   | /                                         |
|       |                                                | Smoke &<br>Dust | 1200.0              |                   | Ammonia<br>Nitrogen |                      |                   |                                           |
| 14    | Cement Factory                                 | SO <sub>2</sub> | 410.0               |                   | COD                 |                      |                   | /                                         |
|       |                                                | Smoke &<br>Dust | 1500.0              |                   | Ammonia<br>Nitrogen |                      |                   |                                           |
| 15    | Cement Factory                                 | SO <sub>2</sub> | 390.0               |                   | COD                 |                      |                   | /                                         |
|       |                                                | Smoke &<br>Dust | 1350.0              |                   | Ammonia<br>Nitrogen |                      |                   |                                           |
| Total |                                                | SO <sub>2</sub> | 31398.4             |                   | COD                 | 16351.5              |                   |                                           |
|       |                                                | Smoke &<br>Dust | 16746.7             |                   | Ammonia<br>Nitrogen | 594.5                |                   |                                           |

**Table 2.5-2 Discharge of Main Pollution Sources under construction and planning in Beihai City**

| SN | Company Name<br>excluded                                               | Waste gas (t)   |                  |                | Waste water (t)  |                  |                |                                                                                                                  |
|----|------------------------------------------------------------------------|-----------------|------------------|----------------|------------------|------------------|----------------|------------------------------------------------------------------------------------------------------------------|
|    |                                                                        | Pollutant       | Discharge volume | Removal amount | Pollutant        | Discharge volume | Removal amount | Notes                                                                                                            |
| 1  | 1,200,000 tons per year heavy oil chemical project (Tieshan Port area) | SO <sub>2</sub> | 426.5            |                | COD              | 41.3             |                | Discharging into Tieshan Port (under planning)                                                                   |
|    |                                                                        | Smoke & Dust    | 76.7             |                | Ammonia Nitrogen | 17.2             |                |                                                                                                                  |
| 2  | 200,000 tons per year fuel ethanol project of Guangxi                  | SO <sub>2</sub> | 607.9            |                | COD              | 501.8            |                | Discharging into Beihai Hongkan sewage treatment plant, finally discharging into Lianzhou Bay (trial production) |
|    |                                                                        | Smoke & Dust    | 47.7             |                | Ammonia Nitrogen | 36.2             |                |                                                                                                                  |

Note: figures in the table are quoted from environmental evaluation report of the projects.

## 2.5.2 Living Pollution Sources

Population of Tieshan Port was recorded around 168,800 in 2006, from where living sewage and water waste are discharged into the nearest surface waters. Besides, it is also shown in relevant statistics that COD discharge is estimated to be around 4200t/a, while ammonia nitrogen is 300 t/a.

## 2.5.3 Ship Pollution Sources

According to the relevant statistics, there were about 7700 vessels of motor fishing boats and alike in the Tieshan Port District in 2006, hence the petrochemical pollutants discharged from the marine motor vessels can be estimated as around 1150t/a.

## 2.5.4 Mariculture Pollution Sources

The total area for mariculture in Beihai had reached 32,000 hm<sup>2</sup> by 2006, hence the discharge volume of COD can be calculated as 995 t/a and 200 t/a for that of ammonia nitrogen.

## 2.5.5 Investigation of environmental pollution events

According to the results verified by Beihai Environmental Protection Administration, in recent two years, there is no environmental pollution event such as plant pollution accident, marine carrying vessel leakage accident and red tide in Tieshan Port area.



### 3 Project Overview and Analysis

#### 3.1 Project Overview

##### 3.1.1 Basic Information

(1) Project Name

The 900,000 Ton Pulp and 900,000 Ton Paper and Cardboard Project of Stora Enso (Guangxi) Pulp & Paper Co., Ltd.

(2) Construction Unit

Stora Enso (Guangxi) Pulp & Paper Co., Ltd.

(3) Nature

Newly-established project

(4) Location

Tieshan Port Offshore Industrial Zone of Beihai City, Guangxi

(5) Total Investment

The total investment of the proposed project is 20,395,623,900 RMB.

---

(6) Site and Building Area

---

(7) Product Scheme and Scale

The proposed project is scheduled in three phases, including production lines for 900,000 tons of bleached eucalyptus chemical pulp, 450,000 tons of high quality card packing paper and 0.45million ton high quality fine paper (200,000 tons of dry static duplicating paper and offset printing paper, 250,000 tons of coated paper annually). See Table 3.1-1 for details.

**Table 3.1-1 Category and Yield of Products**

| Construction period           | Product                                                                        | t/a                           |
|-------------------------------|--------------------------------------------------------------------------------|-------------------------------|
| Phase I Project (2007-2009)   | Eucalyptus chemical pulp                                                       | 900,000                       |
| Phase II Project (2009-2010)  | High quality card packing paper                                                | 450,000                       |
| Phase III Project (2011-2012) | High quality fine paper<br>include: advanced writing paper<br>and coated paper | 450,000<br>200,000<br>250,000 |

##### 3.1.2 Project Composition

See Table 3.1-2 for the detailed composition of the proposed project. *edited, detailes excluded*

**Table 3.1-2 List of Project Composition in all Phases, *edited, details excluded***

| Phase                                                                                 | Category                     | Project Name                          | Content and Scale                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|---------------------------------------------------------------------------------------|------------------------------|---------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Phase I Project<br>(production of 0.9 million ton bleached eucalyptus pulp per annum) | Main production project      | Raw Material Yard                     | The storage period of rollway yard is considered to be 45 days with the capacity                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                                                                                       |                              | Raw Material Preparation Workshop     | The preparation workshop contains the working procedures of chipping and screening.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                                                                       |                              | Pulp-making Workshop                  | The pulp-making workshop contains working procedures of cooking, washing, screening, oxygen delignification and bleaching;<br>a. Cooking section: continuous cooking technology is applied<br>b. Washing and screening section: the extraction rate of black liquid is up to 99% by pressing washing.<br>c. Oxygen delignification section: with two phases ---.<br>d. Bleaching section: pulp material bleached via four stage belaching according to ECF procedure                                                                                                                                                               |
|                                                                                       |                              | Pulp Board Workshop                   | The pulp dryer includes steps of screening, drying, sheeting and baling. Equipped with a set of imported pulping machine.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|                                                                                       | Auxiliary production project | Alkali Recovery Workshop              | The alkali recovery workshop contains processes of evaporation, burning, caustic processing, lime recovery and odor treatment; the alkali recovery rate is 98%;<br>a. Evaporation station: b. Recovery boiler: daily handling capacity up to 4000 t DS; chimney 120mH×Φ4.6m; c. Caustic processing: designed capacity of white liquid is 9000m <sup>3</sup> /d; d. Limekiln: lime recovery production capacity is 750t/d; chimney is 120mH×Φ2.0m (double-flue chimney shared with the recovery boiler);<br>e. Steam turbine: equipped with the steam extracted turbine with back pressure 1×100MW for the power supply in Phase I. |
|                                                                                       |                              | Chlorinedioxide Preparation Workshop  | Production scale reaches 35 tClO <sub>2</sub> /d (100% counts), while the concentration of ClO <sub>2</sub> is 9g/l. Method R <sub>10</sub> is adopted for ClO <sub>2</sub> preparation: use the raw material of sodium chlorate to get ClO <sub>2</sub> through the reduction of sodium chlorate with methanol and vitriol.                                                                                                                                                                                                                                                                                                       |
|                                                                                       |                              | Warehouse Facilities                  | -----                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|                                                                                       | Public Works                 | Water Purification Station            | Design scale is 115000m <sup>3</sup> /d. The water resource originates from Hepu Reservoir, which meets the Class II quality standard of surface water.                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                                                                                       |                              | Station for Circulation Cooling Water | Design scale is 27000m <sup>3</sup> /h, with a GFRP cooling tower, a pond and a pump room for circulation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                                                                       |                              | Sewage Treatment Station              | Design scale is 100000m <sup>3</sup> /d, with the processes of physical chemistry, secondary biology and tertiary physical chemistry technology.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

| Phase                                                                    | Category                              | Project Name                          | Content and Scale                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------------------------------------------------------------------------|---------------------------------------|---------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Phase II Project<br>(0.45million ton high quality card board per annum)  | Main production and auxiliary project | Pulp Preparation Workshop             | Stock preparation for ; BSKP, BHKP, BCTMP, Broke waste processing line                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                                                                          |                                       | Board production Workshop             | After the process of pulping, self-made BHKP, BCTMP and BSKP                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|                                                                          |                                       | Finishing Workshop                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|                                                                          |                                       | Warehouse Facilities                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|                                                                          | Public Works                          | Thermal Power Station                 | Build a 2×220t/h multi-fuel circulation fluidized bed boiler (one for use and one for backup), equipped with a 50MW single exhaust condensing type turbo-generator unit. Adding limestone to boiler to desulfurize with the efficiency of 80%; treat the smoke with a double-chamber electrostatic precipitator with four electric fields with the efficiency of 99.7%; the boilers chimney is 120mH×Φ2.7m. The open air coal yard is 24000m <sup>2</sup> , while the construction area of dry coal shed is 12000 m <sup>2</sup> |
|                                                                          |                                       | Water Purification Station            | Based on the scale of 115000m <sup>3</sup> /d by water purification station in Phase I, the designed capacity increases 28000m <sup>3</sup> /d.                                                                                                                                                                                                                                                                                                                                                                                  |
|                                                                          |                                       | Station for Circulation Cooling Water | Based on the designed scale of 27000 m <sup>3</sup> /h in Phase I, the cooling water designed capacity increases 9000m <sup>3</sup> /h.                                                                                                                                                                                                                                                                                                                                                                                          |
|                                                                          |                                       | Sewage Treatment Station              | Based on the sewage treatment station scale of 100000m <sup>3</sup> /d in Phase I, the designed scale increases 25000m <sup>3</sup> /d.                                                                                                                                                                                                                                                                                                                                                                                          |
| Phase III Project<br>(0.45million ton high quality fine paper per annum) | Main production and auxiliary project | Pulp Preparation Workshop             | stock preparation; Raw material preparation includes BSKP, integrated BHKP, re-slushed and screened broke from uncoated and coated paper, white water and mixing of the raw material into defined ratio.                                                                                                                                                                                                                                                                                                                         |
|                                                                          |                                       | Copying Paper Workshop                | The prepared pulp materials are formed then pressed, coated, dried, press polished, coiled to make the finished paper.                                                                                                                                                                                                                                                                                                                                                                                                           |
|                                                                          |                                       | Completon Workshop                    | processing for the finished paper, including sheet cutting paper, paper packing and roll packing.                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                                                          | Public works                          | Thermal Power Station                 | New construction of a 220t/h multi-fuel circulation fluid bed boiler and equipped with a 50MW single exhaust condensing type turbo-generator unit. Adding limestone to the boiler to desulfurize and dedust by electrostatic precipitator. The boiler share chimney, 120mH×Φ2.7m of PB phase II                                                                                                                                                                                                                                  |
|                                                                          |                                       | Station for Circulation Cooling Water | Based on the designed scale of 36000 m <sup>3</sup> /h in Phase II, the cooling water designed capacity increases 7000m <sup>3</sup> /h.                                                                                                                                                                                                                                                                                                                                                                                         |
|                                                                          |                                       | Sewage Treatment Station              | Based on the sewage treatment station scale of 125000m <sup>3</sup> /d in Phase I and II, the designed scale increases 20000m <sup>3</sup> /d to reach 145000 m <sup>3</sup> /d.                                                                                                                                                                                                                                                                                                                                                 |
|                                                                          |                                       |                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

### 3.1.3 Main Technical and Economic Index

See Table 3.1-3 for the main technical and economic index of the proposed project.

**Table 3.1-3 Main Technical and Economic Index of the Proposed Project** *edited, details excluded*

| SN  | Index Name                                     | Unit      | Quantity   | Remarks |
|-----|------------------------------------------------|-----------|------------|---------|
| 1   | Production scale                               | t/a       |            |         |
| 1.1 | BHQP board                                     | t/a       | 900000     |         |
| 1.2 | High quality card packing paper                | t/a       | 450000     |         |
| 1.3 | High quality fine paper                        | t/a       | 200000     |         |
| 1.4 | Coated paper                                   | t/a       | 250000     |         |
| 2   | Total investment                               | 10,000RMB | 2039562.39 | -----   |
| 2.1 | Wherein: construction investment               | 10,000RMB | -----      |         |
| 2.2 | Current fund                                   | 10,000RMB | -----      |         |
| 3   | Investment index                               |           | -----      |         |
| 3.1 | 100 RMB sales revenue/total investment         | 1/100RMB  | -----      |         |
| 3.2 | 100 RMB sales revenue/construction investment  | 1/100RMB  | -----      |         |
| 3.3 | 100 RMB sales revenue/current fund             | 1/100RMB  | -----      |         |
| 4   | Employees, direct                              | person    | 1392       |         |
|     | Wherein: workers                               | person    |            |         |
|     | Project technical and administrative personnel | person    | -----      |         |
|     | Others                                         | person    | -----      |         |
| 5   | Annual working days                            | day       | 354        |         |
| 6   | Total annual cost (100 load)                   | 10,000RMB | -----      |         |
| 7   | Annual sales revenue                           | 10,000RMB | -----      |         |
| 8   | Total annual profit                            | 10,000RMB | -----      |         |
| 9   | Annual profit and tax                          | 10,000RMB | -----      |         |
| 10  | Loan payback period                            | a         | -----      |         |
| 11  | Investment payback period                      | a         | -----      |         |
| 12  | Investment profit-taxation rate                | %         | -----      |         |
| 13  | Investment profit-taxation rate                | %         | -----      |         |
| 14  | Financial internal rate of return              | %         | -----      |         |
| 15  | Breakeven point                                | %         | -----      |         |

### 3.1.4 General Plane Layout

#### 3.1.4.1 Principal of General Plane Layout

The proposed project strictly complies with the basic national policy of “Cherish and reasonably utilize lands and protect farmland pressingly” to improve the intensive utilization and optimized configuration of land.

#### 3.1.4.2 General Plane Division and Layout

##### (1) General Layout

Factors to be considered in the general layout are as follows:

- a. To meet the requirements of industrial processes and ensure the reasonable connection between public and production facilities.
- b. To shorten the traffic flow line and power supply pipelines to the minimum for land, resources and cost saving.
- c. To coordinate the transportation organization, functional division and landscape organization for the convenient and safe transportation and reasonable utilization of land.
- d. To meet the requirements on interval of industrial fireproofing, explosion-proofing, sunlight, etc.
- e. The orientation of main buildings shall make full use of the sunlight and avoid the dominant wind direction in winter and ensure the natural summer ventilation. Adapt to the local climate characteristics.
- f. All kinds of piling yards are located in the down wind area of dominant wind direction.

##### (2) Main Function Division

General plane layout is carried out around the production area. The production area, considered to be the core part, is located in the center of the plant and occupies an area of 737m×1520m. It mainly includes production lines for 0.9 million ton/year pulp making, 0.45million ton/year high quality card packing paper and 0.45million ton/year high quality fine paper. The constructions and buildings include the pulp-making workshop, pulp board drying workshop, evaporation workshop, causticization workshop, burning workshop, chemical finished pulp board warehouse, main workshop of thermal power station, melting workshop and control building, etc. Projects for 0.45million ton/year high quality card packing paper and 0.45million ton/year high quality fine paper are located in the south area, with a magnificent scale and complete space configuration. The main constructions and buildings are paper-making workshop, finishing workshop and finished products warehouse, etc.

Considering the local effluent condition and water frequency characteristics, the container piling yard and sewage treatment station shall be set in the farthest south part of the plant.

The site for raw material supply is located in the east of pulp-making core area, including raw material yard, wood chip piling yard, raw material preparation workshop, etc. The supply of raw materials is convenient with the transportation from 2 lines of highway and wharf. The wharf transportation is set for emergency.

Local water resource originates from Hepu Reservoir to the north of the plant, while the clean water supply and circulation water treatment are concentrated in the north of pulp-making core area. The industrial process and pipeline layout are reasonable and effective.

See the Attached Drawing 10 for the plant area plane layout of the proposed project.

### 3.1.5 Main Raw & Auxiliary Materials and Energy Consumption

See Table 3.1-4 for the main raw & auxiliary materials and energy consumption of the proposed project.

**Table 3.1-4 Main Raw & Auxiliary Materials and Energy Consumption of the Proposed Project**

| SN                                                       | Index Name                                    | Unit              | Quantity | Remarks          |
|----------------------------------------------------------|-----------------------------------------------|-------------------|----------|------------------|
| 1. Main raw & auxiliary materials and energy consumption |                                               |                   |          |                  |
| 1                                                        | Eucalyptus                                    | t/a               | 1842300  | Dry component    |
| 2                                                        | NaOH                                          | t/a               | ---      | purchased alkali |
| 3                                                        | O <sub>2</sub>                                | t/a               | ---      | purchased        |
| 4                                                        | Na <sub>2</sub> S <sub>2</sub> O <sub>5</sub> | t/a               | ---      | purchased        |
| 5                                                        | H <sub>2</sub> SO <sub>4</sub>                | t/a               | ---      | purchased        |
| 6                                                        | Limestone                                     | t/a               | ---      | purchased        |
| 7                                                        | Mirabilite                                    | t/a               | ---      | purchased        |
| 8                                                        | Heavy oil                                     | t/a               | ---      | purchased        |
| 9                                                        | H <sub>2</sub> O <sub>2</sub>                 | t/a               | ---      | purchased        |
| 10                                                       | Commercial softwood pulp                      | t/a               | ---      | purchased        |
| 11                                                       | Commercial bleached mechanical pulp           | t/a               | ---      | purchased        |
| 12                                                       | Sizing agent                                  | t/a               | ---      | purchased        |
| 13                                                       | Alum                                          | t/a               | ---      | purchased        |
| 14                                                       | Aid sulfuration agent                         | t/a               | ---      | purchased        |
| 15                                                       | PAM                                           | t/a               | ---      | purchased        |
| 16                                                       | Amylum                                        | t/a               | ---      | purchased        |
| 17                                                       | Latex                                         | t/a               | ---      | purchased        |
| 18                                                       | Covered film                                  | t/a               | ---      | purchased        |
| 19                                                       | Dry net                                       | m <sup>2</sup> /a | ---      | purchased        |
| 20                                                       | Felt                                          | t/a               | ---      | purchased        |
| 21                                                       | Wrappage                                      | t/a               | ---      | purchased        |
| 22                                                       | AKD                                           | t/a               | ---      | purchased        |
| 23                                                       | Polymer                                       | t/a               | ---      | purchased        |
| 24                                                       | Dye                                           | t/a               | ---      | purchased        |
| 25                                                       | Padding                                       | t/a               | ---      | purchased        |
| 26                                                       | Raw coal                                      | t/a               | 538000   | purchased        |
| 27                                                       | NaCl                                          | t/a               | ---      | purchased        |
| 28                                                       | Methanol                                      | t/a               | ---      | purchased        |

| 2. The ration of main raw materials power consumption |                                                 |                        |                                 |                              |
|-------------------------------------------------------|-------------------------------------------------|------------------------|---------------------------------|------------------------------|
| (1) Phase I Project                                   |                                                 |                        |                                 |                              |
| 1                                                     | Eucalyptus                                      | t/t pulp               | 2.047                           | Dry<br>(including<br>cortex) |
| 2                                                     | Water                                           | m <sup>3</sup> /t pulp | 33.3                            |                              |
| 3                                                     | Electricity                                     | kWh/t                  | 729                             |                              |
| 4                                                     | Vapor                                           | t/t pulp               | 2.35 (1.1MPa)<br>1.97 (0.5 MPa) |                              |
| (2) Phase II Project                                  |                                                 |                        |                                 |                              |
| 1                                                     | Bleached eucalyptus<br>chemical pulp board      | Kg/t                   | ---                             |                              |
| 2                                                     | Commercial bleached<br>mechanical pulp<br>board | Kg/t                   | ---                             |                              |
| 3                                                     | Commercial softwood<br>dried market pulp        | Kg/t                   | ---                             |                              |
| 4                                                     | Water                                           | m <sup>3</sup> /t pulp | 16.23                           |                              |
| 5                                                     | Electricity                                     | kWh/t                  | 987                             |                              |
| 6                                                     | Vapor                                           | t/t pulp               | 0.4 (1.1MPa)<br>2.2 (0.5 MPa)   |                              |
| (3) Phase III Project                                 |                                                 |                        |                                 |                              |
| 1                                                     | Commercial softwood<br>dried market pulp        | Kg/t                   | ---                             |                              |
| 2                                                     | Commercial bleached<br>mechanical pulp<br>board | Kg/t                   | ---                             |                              |
| 3                                                     | Water                                           | m <sup>3</sup> /t pulp | 15.25                           |                              |
| 4                                                     | Electricity                                     | kWh/t                  | 993                             |                              |
| 5                                                     | Vapor                                           | t/t pulp               | 0.13 (1.1MPa)<br>2.2 (0.5 MPa)  |                              |
| III                                                   | Transportation<br>volume                        | Ten<br>thousand<br>t/a | ---                             |                              |
|                                                       | Wherein: Import<br>volume                       | 10 <sup>5</sup> t/a    | ---                             |                              |
|                                                       | Export volume                                   | 10 <sup>5</sup> t/a    | ---                             |                              |

### 3.1.5.1 Main Raw Materials and Energy

#### (1) Main Raw Materials

##### a. The wood demand scheme of raw material in proposed project Phase I

The annual production capacity of chemical pulp in the proposed project Phase I is expected to be 0.9million ton from the end of 2009 and the beginning of 2010. The production load shall be 80% in 2009 and reach the designed capacity in 2010. According to the requirements of production process, the raw material of wood shall be eucalyptus (a few acacia wood may be used in the year of putting into production). Each ton of chemical pulp requires 4.01546 m<sup>3</sup> eucalyptus/acacia wood (with 60% bark and equal to 3.77453m<sup>3</sup> when peeling off bark by conversion). According to calculation, the pulp plant shall need 2717700 m<sup>3</sup> raw material of wood (peeling off bark) in 2009 and 3397100 m<sup>3</sup> (peeling off bark) each year from 2010.

##### b. The plan for base raw material wood supply

According to the raw material base construction and cutting plan, the annual volume of wood supply from raw material base is listed in Table 3.1-5.

**Table 3.1-5 Annual Volume of Wood Supply from Raw Material Base Unit: 10,000 m<sup>3</sup>**

--- See 3.1.5.1 for overall consumption at full production



### c. The balance analysis of wood supply and demand

See Table 3.1-6 for annual supply and demand balance of raw wood of assorted pulp plants.

It indicates that, in normal conditions, the annual wood production volume from the raw material base can meet the annual demand for wood raw material for the assorted pulp plants in the project from 2009 to 2015.

According to the previous preparation of the project, production in 2010 wins the biggest possibility. The production load of the first year shall be 80% and the designed capacity shall be reached in second year. Upon the requirements of production process in pulp plant, the raw material shall adopt eucalyptus and each ton of chemical pulp requires 4.02 m<sup>3</sup> eucalyptuses (with 60% cortex and equal to 3.77m<sup>3</sup> without bark by conversion). According to calculation, the pulp plant shall need 2717700 m<sup>3</sup> raw material of wood (without bark) in 2010 and 3397100 m<sup>3</sup> (without bark) each year from 2011. According to the construction and the cutting plan of raw material woods base, the raw material woods base shall supply 2147600 m<sup>3</sup> woods in 2009; the annual wood supply shall exceed 3450000 m<sup>3</sup> from 2010 to 2014 and over 3620000 m<sup>3</sup> after 2015. All of the annual wood production capacity of the raw material woods base exceeds the demand in the pulp plant; thus, the social supply is not required in the project. Therefore, the annual wood output of raw material woods base can meet the demands of 0.9 million ton annually of chemical pulp when the base reaches the designed growth and outturn rate.

Part of the chemical pulp in Phase I is adjusted from the group (such as Stora Enso Suzhou Zixing Paper Co., Ltd) and part is sold as commercial pulp. The main raw materials in Phase II and III are bleached eucalyptus chemical pulp, commercial softwood dried market pulp and bleached mechanical dried market pulp. The bleached eucalyptus chemical pulp is supplied by Phase I, while most of the commercial softwood pulp board and bleached chemi-Mechanical pulp board are allotted from Stora Enso group and few are purchased from international market.

**Table 3.1-6 Balance Sheet of Wood Supply and Demand in Prophase of Pulp & Paper Plant of Stora Enso (Guangxi) Pulp & Paper Co., Ltd.**

 --- see text 3.1.5.1 c) for overall demand and supply

## (2) Fuel

## a. Coal

The thermal power station of the proposed project Phase II shall consume 0.269million ton raw coal (designed coal quality, checking coal quality 0.293million ton). After the completion of Phase III, the raw coal consumption of the thermal power station shall reach 0.538 million ton annually (designed coal quality, checking coal quality 0.586million ton). See Table 3.1-7 for details.

According to the information offered by the construction unit, the raw coal for the proposed project is from Datong, Shanxi Province. See Table 3.1-8 for the coal quality parameters.

**Table 3.1-7 Coal Consumption of the Proposed Project**

| SN | Name                                          | Designed coal type    |                       |                                    |                       |
|----|-----------------------------------------------|-----------------------|-----------------------|------------------------------------|-----------------------|
|    |                                               | Phase II Project      |                       | Phase III Project<br>(newly-added) |                       |
|    |                                               | Designed coal quality | Checking coal quality | Designed coal quality              | Checking coal quality |
| 1  | Hourly coal consumption (t/h)                 | 31.7                  | 34.5                  | 31.7                               | 34.5                  |
| 2  | Daily coal consumption (t/d)                  | 760.8                 | 828                   | 760.8                              | 828                   |
| 3  | Yearly coal consumption (10 <sup>4</sup> t/a) | 26.9                  | 29.3                  | 26.9                               | 29.3                  |
| 4  | Annual running time (h)                       | 8496                  | 8496                  | 8496                               | 8496                  |

**Table 3.1-8 Parameter Index of Coal Quality in the Proposed Project**

| SN | Item                              | Symbol   | Unit  | Designed coal quality | Checking coal quality |
|----|-----------------------------------|----------|-------|-----------------------|-----------------------|
| 1  | Received base carbon              | Car      | %     | 53.95                 | 49.55                 |
| 2  | Received base hydrogen            | Har      | %     | 3.22                  | 2.84                  |
| 3  | Received base oxygen              | Oar      | %     | 8.64                  | 8.10                  |
| 4  | Received base nitrogen            | Nar      | %     | 0.64                  | 0.71                  |
| 5  | Received base total sulfur        | Sar      | %     | 0.74                  | 0.80                  |
| 6  | Total water                       | Mar      | %     | 13.6                  | 11.1                  |
| 7  | Received base ash content         | Aar      | %     | 19.21                 | 26.9                  |
| 8  | Air drying base volatile content  | Vad      | %     | 23.5                  | 24.5                  |
| 9  | Received base net calorific value | Qnet, ar | MJ/kg | 20.2                  | 18.5                  |

## b. Light Diesel Oil

Once the proposed project Phase I begins, set 2 spare 54t/h oil-burned boilers for the start-up and backup heat source of the power boiler. Once the alkali recovery boiler is put into normal operation, the oil-burned boiler shall stop running. The fuel for oil-burned boiler is 0# light diesel oil with the percentage of sulfur content less than 0.2%.

## c. Heavy Oil

According to the investigation to major suppliers including China National Petroleum , China Petrochemical Industry and Shanghai futures fuel oil trading market, the region in which the project is located lacks clean fuel resources. The project under planning uses heavy oil (with the percentage of sulfur content less than 3%) as its fuel to calcine white mud in limekiln, which could guarantee its economical efficiency and reliability. After the finishing of Phase III, the annual heavy oil consumption shall be 35000 ton. The characteristics of heavy oil are as shown in Table 3.1-9:

Table 3.1-9 Characteristics of heavy oil

| SN          | 1       | 2                   | 3              | 4              | 5             | 6              | 7             | 8           | 9           | 10    | 11  | 12 | 13 | 14 | 15                    |
|-------------|---------|---------------------|----------------|----------------|---------------|----------------|---------------|-------------|-------------|-------|-----|----|----|----|-----------------------|
| Item        | Density | Kinematic viscosity | Sulfur content | Carbon residue | Water content | water+ residue | Incline point | Flash-point | Ash content | Na    | V   | Al | Ni | Si | Gross calorific value |
| Unit        | kg/L    | mm                  | %              | %              | %             | %              | °C            | °C          | %           | mg/kg |     |    |    |    | MJ/kg                 |
| Value (MAX) | 0.991   | 180                 | 3              | 15             | 0.5           | 0.5            | 24            | 66          | 0.1         | 80    | 150 | 30 | 30 | 50 | 40                    |

#### d. Limestone

To control the emission of  $\text{SO}_2$  in the circulating fluidized bed boiler flue gas, the dry lime desulfurization system is applied to add limestone powder into boiler hearth directly by pneumatic transfer, in which the ratio of Ca to S equals 2.2:1. The annual consumption of limestone powder shall be 43000 tons/year after the completion of proposed project.

#### (3) Steam and Electricity

The steam and electricity required by Phase I project are all supplied by alkali recovery boiler and the auxiliary 100MW turbo-generator. The steam consumption of Phase I is 458 t/h and averages  $3.9 \times 10^6$  t each year; the annual consumption of electricity in Phase I shall be  $6.6 \times 10^8$  kWh. The additional consumption of steam and electricity of Phase II are supplied by 2 new 2×220t/h circulating fluidized bed boilers (one for use and one for backup) and the auxiliary turbo-generators (50MW). The additional steam consumption of Phase II shall be 139 t/h and averages  $1.2 \times 10^6$  t each year. The additional consumption of electricity in Phase II shall be about  $4.4 \times 10^8$  kWh. The additional consumption of steam and electricity in Phase III are supplied by 1 new 220t/h circulating fluidized bed boiler and the auxiliary turbo-generator (50MW). The additional steam consumption in Phase III shall be 125 t/h and  $1.1 \times 10^6$  t/a. The additional consumption of electricity in Phase III shall be about  $4.5 \times 10^8$  kWh.

#### (4) Water

The water consumption in the proposed project Phase I includes that for pulp-making workshop, copying paper workshop, alkali recovery workshop, chemicals preparation workshop and the circulating cooling water system, etc. The consumption of fresh water reaches 33.3 m<sup>3</sup>/t pulp, i.e. 29970000 m<sup>3</sup>/a

The additional water consumption of the proposed project Phase II includes that for cardboard workshop, thermal power station of circulating fluidized bed boiler and the circulation cooling water system, etc. The additional consumption of fresh water reaches 16.23 m<sup>3</sup>/t cardboard, i.e. 7304000 m<sup>3</sup>/a. The total fresh water consumption shall be 37274000 m<sup>3</sup>/a after Phase II project is completed.

The additional water consumption of the proposed project Phase III includes that for fine paper workshop, thermal power station of circulating fluidized bed boiler and the circulation cooling water system, etc. The additional consumption of fresh water reaches 15.25 m<sup>3</sup>/t

paper, i.e. 6862000 m<sup>3</sup>/a. The total fresh water consumption shall be 4.4136,000 m<sup>3</sup>/a after Phase III project is completed.

### 3.1.5.2 Transportation

#### (1) Transportation outside the Plant

The imported and exported materials of the proposed project are mainly the raw wood, pulp board, paper, coal, coal ash, sludge and chemical raw materials, etc. The project requires 1842300 ton eucalyptus (absolutely dry) annually. Raw woods are transported directly to the plant by railway and highway while the purchased pulp boards are transported by railway and highway. The transportation of finished products shall be more economical by waterage, firstly via container vehicles to the wharfs and then by ship. Coal for the thermal power station of the proposed project shall be transported by railway and highway to the plant. The solid wastes (such as coal ash and the sludge from sewage treatment station, etc.) are all shipped out for comprehensive utilization and landfill. The chemical raw materials are transported by local railway and highway.

Since there is abundant local social transportation equipment in Beihai City, lots of investment shall be saved for transportation outside plant in the project.

For the sake of convenient transportation of the large amount of raw materials and finished products, the proposed project shall utilize the 50000 DWT composite wharfs (in planning) close to the south end of Beihai plant. The wharf is proposed to be completed by 2008.

#### (2) Transportation inside the Plant

The transportation inside the plant includes material transportation between piling yards, warehouses and workshops. A few forklift trucks and battery tow tractors, etc. are planned to equip.

#### (3) Transport Volume

The total annual transport volume of the proposed project is 4699000t/a with 3043000t/a imported and 1656000t/a exported.

### 3.1.6 Main Equipment

See Table 3.1-10 for the main equipment in the proposed project. -excluded-

## 3.2 Project Analysis

The proposed project takes eucalyptus produced by company's self-operated forest farm and commercial eucalyptus as raw material. The annual production capacity of bleached eucalyptus chemical pulp reaches 900000 tons. After Phase III project is put into production, about ----- tons chemical pulp shall be used to produce high quality fine paper and high quality card packing paper in the project while the rest ----- tons pulp shall be sold as merchandise. At the same time, the alkali recovery workshop, thermal power station, pulp board drying workshop, chemicals preparation workshop shall be built synchronously for the auxiliary projects.

### 3.2.1 Phase I Project (900,000 million ton/year Bleached Eucalyptus Chemical Pulp)

#### (1) Raw Material Preparation Workshop

The main raw material in the project is eucalyptus, provided by the raw material wood base. The raw material workshop in Phase I shall peel off the bark of the wood already in the forest. Lumber shall be transported to the workshop by discharge rubber belt conveyor or directly carried to the workshop by vehicles. Chips are made from logs by chipping and transported in proportion according to the quantity required by the digester. Accept chips after screening shall be transported by belt conveyor to the chips warehouse of the cooking section via belt gallery. Oversize chips screened out shall be chipped again and sent for re-screening. ---  
The wood blocks and scrapings produced during the process shall be comprehensively utilized.

---

The raw material preparation workshop is equipped with log water wash system and the logs will be washed to remove the stone blocks, sandy soil and other impurities attached to the log before chipping procedure. The washing water will be sprayed, under certain pressure, to the log from the injecting nozzles on both sides of the log conveying roller, and the washing water will be sent to flow tank after removing impurities with effluent conveyor. The grains of sand will settle in the tank and be collected, and the clarified water will flow to pump pit to realize the recycling of water.

#### (2) Pulp-making Workshop

The production capacity of the pulp-making workshop is designed to be 2750ADt/d ---. The processes include cooking, washing and screening, oxygen delignification and bleaching sections.

##### a. Cooking section

The qualified chips from the raw material preparation workshop shall be transported to

pre-cooking warehouse for cooking. Steam shall be utilized to heat the chips and remove the air, thus promoting the impregnating effect and the uniformity of cooking. Afterwards, the processed chips shall enter the presoaking tower of the digester via feeder, presoak with chemical solution, digest again and then perform countercurrent washing under high temperature. After Kappa value of the pulp reaches 16-18, blow it out of the blow tank.

b. Washing and screening and oxygen delignification sections

The pulp pumped from the blow tank in the cooking section shall be sent to knotted screen. The qualified knags shall be washed for the fine fibers, which shall be sent back for cooking again. The fine pulp shall be processed with four stages pressure screen and one stage mud filter for the fiber recovery. ---. The screened pulp shall be condensed and washed by press pulp washing machine. The processed pulp shall be transported to oxygen delignification section. Pulp from the washing and screening section shall enter the oxidation reactor for oxygen delignification with oxidative white fluid and oxygen. After the Kappa value of pulp with lignin removal reaches around 10, the pulp shall be washed by pressing washer, flown into a medium concentration pulp tower for storage and sent to the bleaching section after washed by the second pressing washer.

c. Bleaching section

Pump-sending into the bleaching section after washed by the two pressing washers.

The bleaching section adopts the typical four-stage --- ECF bleaching.

In the four-stage bleaching section of bleaching kraft pulp plant, the last bleaching process could be either chlorinedioxide bleaching (D) or hydrogen peroxide bleaching (P), decided on specific production situation. When selecting hydrogen peroxide bleaching (P), the total chlorinedioxide consumption in the bleaching section will be lower than that taking chlorinedioxide (D) for bleaching as the last bleaching process. In view of the strict requirement for AOX in waste water discharged by pulping production line ( $AOX \leq 12\text{mg/L}$ ) in GB3544-2008 Discharge Standard of Water Pollutants for Pulp and Paper Industry (press release), this project plans to adopt hydrogen peroxide bleaching (P) as the last bleaching process of the bleaching section.

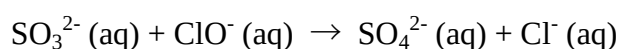
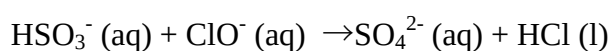
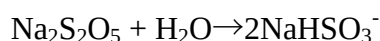
Another advantage of selecting hydrogen peroxide bleaching (P) as the last process in Eucalyptus bleaching section is to ensure lower yellowing ratio of pulp. Other parameter index of P stage as the last bleaching process: pH value 10--10.5, temperature between 75--85°C. The consumption of chemicals, depending on the condition of pulp of the previous stage and the requirement for final brightness of the pulp, is 2--6kg/Adt generally.

The technical processes of the bleaching section are as follows: Non-bleached pulp from oxygen delignification section shall enter the feed tank of the medium and high concentration pulp pump. Add vitriol to the feed tank and mix them in the pump, which shall be pumped to the mixer and well mixed with the added chlorine dioxide. Then, enter the  $D_0$  bleaching tower. The processed pulp shall be pumped to the  $D_0$  pressing washer, while the washed pulp shall flow into the feed tank of the medium concentration pump, accompanying sodium hydroxide and



hydrogen peroxide for the mixture. Then, pump into the mixer and enter the EOP bleaching tower. The pulp after reaction shall be pumped to the EOP pressing washer and flow into the feed tank after washing. Pump into the mixer to mix with chlorine dioxide and vitriol and enter the D<sub>1</sub> bleaching tower. The pulp after reaction shall be pumped to the D<sub>1</sub> pressing washer and flow into the feed tank after washing. Pump into the mixer to mix with chlorine dioxide and enter the D<sub>2</sub> bleaching tower. The bleached pulp shall be pumped to D<sub>2</sub> pressing washer for washing and the processed pulp shall then be pumped to the storage tower.

The project will replace sulfur dioxide with sodium metabisulfite to be used in the sulfur dioxide bleaching section in bleaching workshop and absorb the residual chlorine in bleaching exhausts. The reaction equation is as follows:



See Chart 3.2-1 for the process flow and sewage discharge joint of pulp-making workshop.

### (3) Pulp bodrying workshop

The pulp board workshop includes the pulp screening, pulp drying, cutting, baling and wrapping sections. See Chart 3.2-2 for the process flow and sewage discharge joint.

Pulp board machine white water in Phase I of the project was not fully recovered, mainly taking certain unfavorable impacts caused by long-term recycling of large quantity of white water into consideration: ① Increase of resin sticky substances in white water will cause the clog of headbox dilution pipes in the pulp board machine, uneven distribution of dilution water, thus causing paper breaking or uneven quantity. ② Resin sticky substances will also stick to the dewater blanket and web of the pulp board machine, affecting the dewater function of the dewater blanket and web and shortening the useful life of dewater blanket and web. ③ Accumulation of impurities in white water will cause the increase of pollutants and affect the cleanliness of the final pulp board .

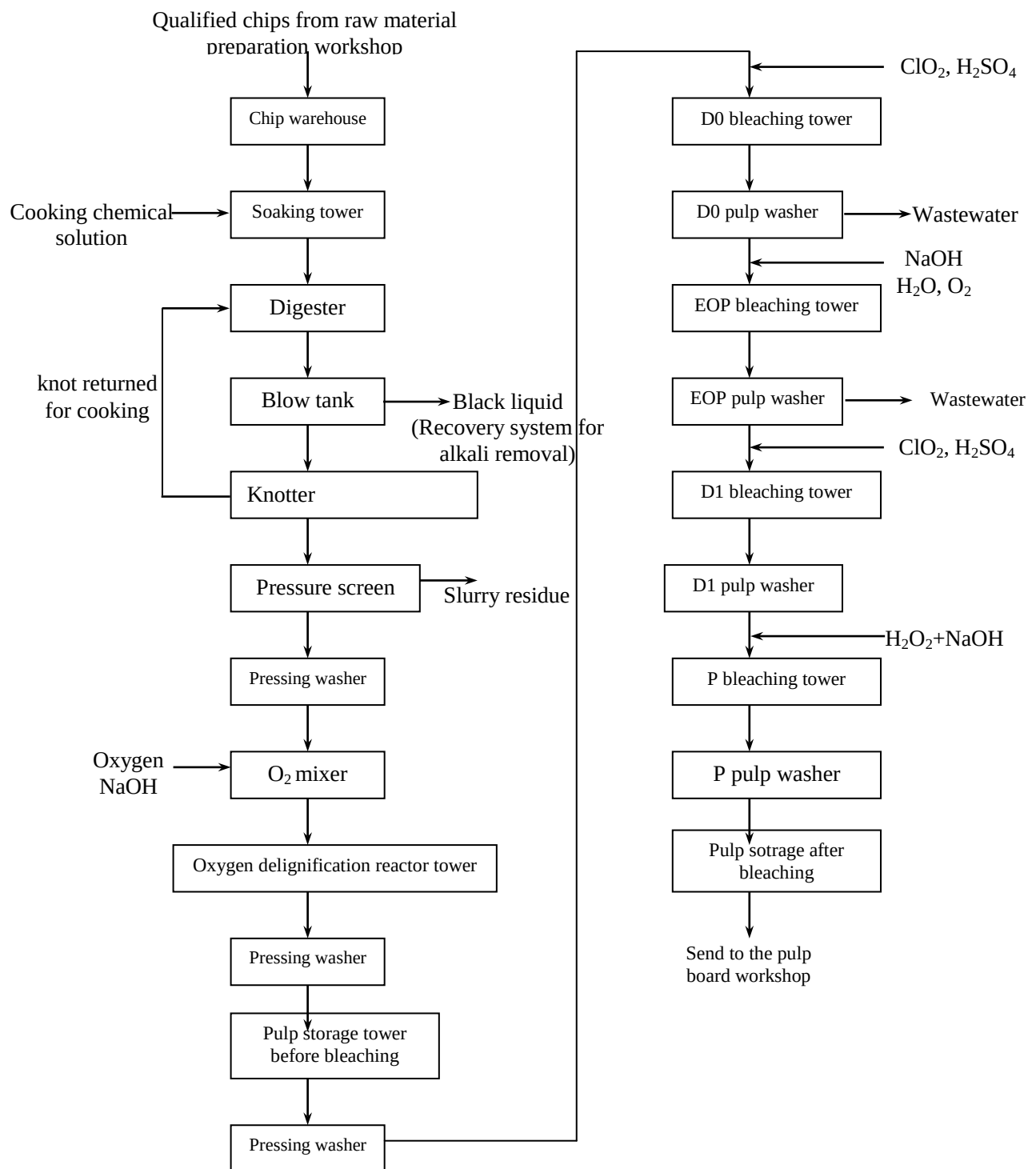


Chart 3.2-1 Process Flow Chart and Sewage Discharge Joint of Pulp-making Workshop

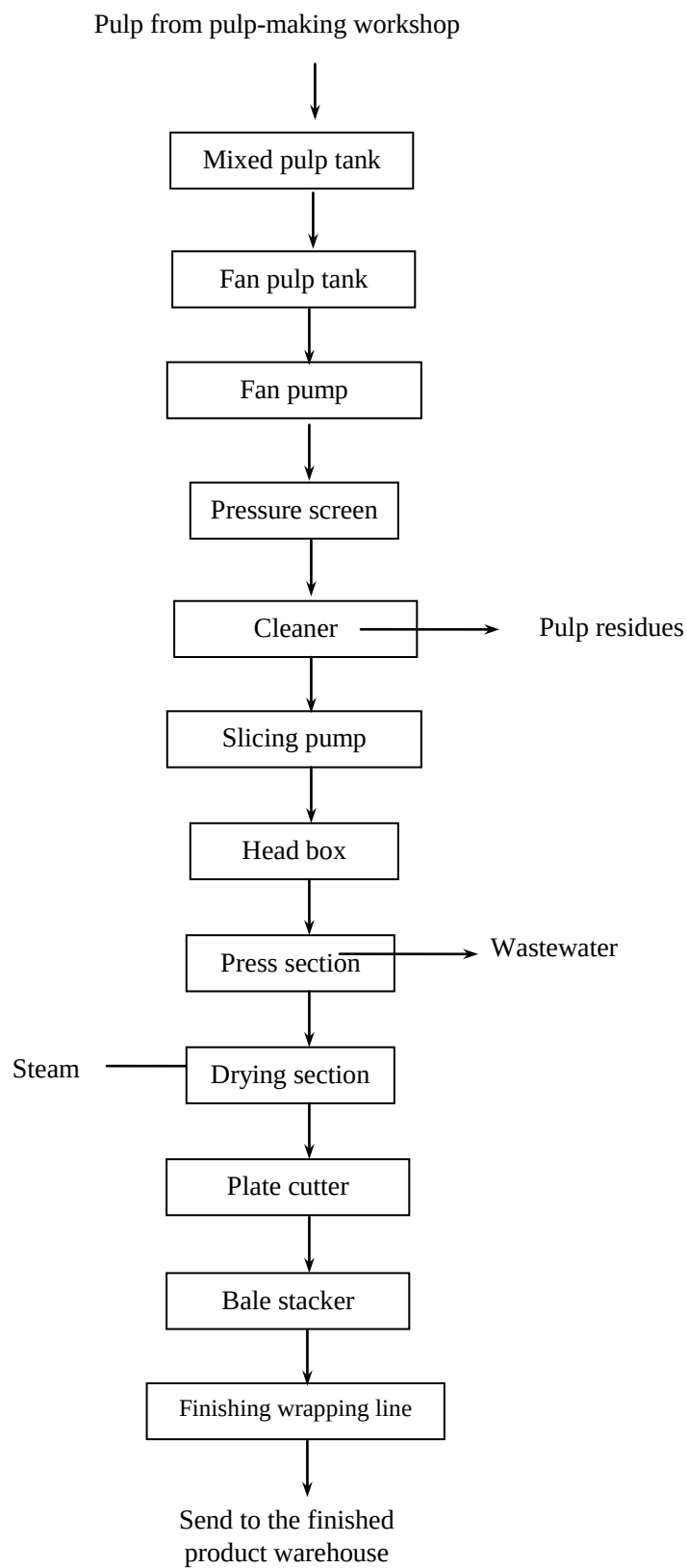
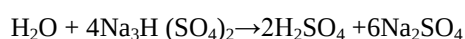
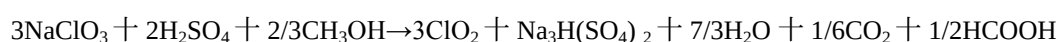


Chart 3.2-2 Process Flow Chart and Sewage Discharge of Pulp Dryer Workshop

R10 method is the process of deacidizing sodium chlorate with methyl alcohol to produce ClO<sub>2</sub> in acidic environment, i.e. SVP-SCW (SVP is only the trade name registered by the supplier; while SCW means Salt Cake Washing, which refers to separating the persulfate hydrogen trisodium crystal in the process into neutral sodium sulfate and sulphuric acid). The process takes sulphuric acid as acidulant and methyl alcohol as reducing agent to deacidize sodium chlorate, and the chlorine dioxide produced will enter the chlorine dioxide absorption tower along with the vapor. Chilled water at the temperature of 7~10°C will be sprayed to absorb chlorine dioxide to produce chlorine dioxide solution, which is stored in chlorine dioxide storage tank and shipped to the bleaching section of the pulping workshop. The whole system will be operated under subpressure and exhausts, containing the chlorine dioxide, produced in the reactor and storage tank shall be fully absorbed by soda solution (sodium hydroxide solution or white liquor) in exhausts absorption tower. Even in startup and shutdown or in emergency, the absorption tower shall also continue operation to ensure there is no residual chlorine gas emission. At the same time, advanced automatic interlock control system will be adopted to realize emergency safe stopping in case of abnormal production.

Sodium sulfate as the byproduct in ClO<sub>2</sub> production flow could be returned to the alkali recovery system as the supplement, recovering sulphuric acid for recycling at the same time. See Chart 3.2-4 for the process flow of ClO<sub>2</sub> preparation workshop. The reaction equation is as follows:



### 3.2.2 Phase II (450,000 ton High Quality Card Packing Paper Annually)

The high quality card packing paper production line mainly includes the pulp preparation workshop, paper-making workshop and finishing workshop. The pulp preparation workshop includes the processes of pulp board treatment, broke treatment and auxiliary material preparation; the paper-making workshop contains the sizing system, papermaking and coating, steam condensed water, vacuum system, white water recovery, coating preparation and compressed air preparation; the finishing workshop mainly includes the post-processing procedures like film covering.

The process produces a variety of high quality card packing paper with the total volume of 0.45 million ton by the raw materials of commercial bleached softwood pulp, self-made eucalyptus bleached chemical pulp and commercial bleached chemi-mechanical pulp. ---

#### (1) Pulp-stock preparation Workshop

The pulp stock preparation workshop sets several treatment lines for bleached softwood pulp, eucalyptus bleached chemical pulp and bleached chemi-mechanical pulp. The bleached sulfate softwood pulp from Phase I pulp-making workshop shall be stored in the pulp tank when reaches the certain beating degrees after pulp beating. Purchased bleached sulfate softwood pulp board and bleached chemi-mechanical pulp board shall be beaten by hydrapulper, high consistency cleaner, disc concentrator and twin-disc refiner and then sent to the storage tank. The wet or dry waste stuff and pulp materials recovered from disc filter in the workshop production shall be sent to the tank after treatment.

#### (2) Papermaking Workshop

The pulp mixed with bleached sulfate softwood pulp, bleached sulfate hardwood pulp and bleached chemimechanical pulp shall conduct sizing, formed on a wire, pressing, drying, press polishing, coating, winding, rewinding and the finished products shall be packed for storage. The whole production line is controlled by continuous automatization.

The residual white water of the workshop shall be sent to the multi-disc filter, while the reclaimed pulp material shall be sent to the broke storage chest and the reclaimed white water be reused.

---

The press section applies the combination of a large-diameter roll press, shoe press and light pressure to meet the quality standard of high quality coated cardboard. ---

---

After coating and calendaring, paper shall enter the horizontal paper winder to form paper rolls.

#### (3) Finishing Workshop

-----

See Chart 3.2-5 for the process flow and sewage discharge joint in the high quality packing paper production line.

### 3.2.3 Phase III Project (0.45million ton High Quality Fine Paper Annually)

The line produces 0.2million ton high quality writing paper like dry xerography and offset printing paper from commercial bleached softwood sulfate pulp and self-made eucalyptus chemical pulp, as well as 0.25million ton coated paper annually from the base coated paper via off-machine coating.

The products of the proposed project are high quality writing paper and coated paper with high quality requirement and large scale. Upon the development of domestic and international paper making technology and considering the demand, the variety, scale and the quality requirement of products, a vertical twin-wire papermaking machine is proposed to be used.

The fine paper production line includes the pulp preparation section, pulp storage tower, pulping machine and paper cutter with automatic shelf for paper.

### (1) Pulp Stock Preparation Process

The pulp board and fillers for papermaking shall be transported by shipment, unloaded in the wharf and stored in the pulp board and padding warehouses. The commercial pulp board shall be cracked by hydropulper and pumped to the papermaking workshop. The pulp preparation section includes the bleached sulfate softwood pulp board; the refining of self-made eucalyptus bleached chemical pulp, the condensation and screening of uncoated and coated waste stuff, the white water circulation system and the mixture ratio of pulp materials.

### (2) Pulping Section

The finished pulp pumped from blending pulp chest to the paper pulp tank shall be mixed with and diluted by white water in the washing gullet of paper machine after the processes of concentration adjustment and flow control (fix quantification) and wash. Afterwards, purified by the degassing purification system and screened by three stages pressure screen and sent to the head box of the paper machine. The fine pulp from the degassing purifier has removed the residual air from pulp material in the degasser, so as to prevent the negative influence of air to the high speed papermaking system.

When the pulp materials enter the paper machine, they shall be sprayed to the net shaper via new head box with the dilution of white water and molded by dehydration. The wet paper shall be further dewatered by the complex press of controllable medium and high speed roller, the shoe press with --- rollers and --- nips. ---

### (3) Off-machine Coating

---

See Chart 3.2-6 for the process flow and sewage discharge joint of high quality fine paper production line.

## 3.2.4 Public Works

### (1) Water Supply Project

The total consumption of fresh water for the proposed project is 124659 m<sup>3</sup>/d, provided by the water supply treatment station in the plant. The designed capacity of the station is 143000m<sup>3</sup>/d and the water source is from Hepu Reservoir. See Table 3.2-1 for the detailed consumption of the fresh water in the proposed project Phase III.

#### a. Water-supply source

The industrial water in Tieshan Port District is from Hepu Reservoir, which has abundant water source and the water quality exceeds the Class II quality standard of surface water. The total capacity of the reservoir is 1.175 billion m<sup>3</sup> and the average storage is 830 million m<sup>3</sup> over the years. Excluded the agricultural water of 400~500 million m<sup>3</sup>, the average supply of water to the towns reaches 300 to 400 million m<sup>3</sup> every year. After the completion of the whole project, the fresh water shall be 124659m<sup>3</sup>/d. Therefore, the water source can meet the requirement of

water supply in the project. Hepu Reservoir shall supply 226,000 m<sup>3</sup>/d water for Phase I project in Tieshan Port District, which has been authorized by the Guangxi Zhuang Autonomous Region and has been under construction. The project has been completed and put into production in 2006. The total water supply for Phase II project is 226,000 m<sup>3</sup>/d, scheduled to be completed and put into production in 2008. The supply in Phase I has fully met the demand of the proposed project.

The water quality in production of the proposed project is implemented according to the QBJ101-88 the *Design Code of Pulp-making Plant*, authorized by national former Ministry of Light Industry and living water refers to GB5749-85 the *Hygienic Standard for Daily Drinking Water*.

**Table 3.2-1 Conditions of Fresh Water Consumption in the Proposed Project***Detailed figures per department removed*

| SN                | Production Workshop | Unit Product Consumption (m <sup>3</sup> /Adt) | Consumption Volume (m <sup>3</sup> /d) |
|-------------------|---------------------|------------------------------------------------|----------------------------------------|
| Phase I project   | Subtotal            | 33.3                                           | 84648                                  |
| Phase II Project  | Subtotal            | 16.23                                          | 20628                                  |
| Phase III Project | Subtotal            | 15.25                                          | 19383                                  |
|                   | Total               | -                                              | 124659                                 |



### b. Water Supply Mode

A water supply treatment station is proposed to be built with the designed treatment volume of 143000m<sup>3</sup>/d. According to the actual situation of project technology implementation, the water supply treatment volume in Phase I is calculated as 115000 m<sup>3</sup>/d while 28000 m<sup>3</sup>/d shall be newly added in Phase II. The original water enters into fresh water tank after flocculation and sedimentation and then supplies for the production of the whole plant through fresh water pump room. The detail process flow of water supply treatment station is as follows.

Reservoir water→mixed reaction pond→slanting board sedimentation pool→fiber bundle filter bed→fresh water tank→fresh water pump room→water supply pipeline network→production and firefighting water site.

Filtered water→disinfection→ fresh water tank→fresh water pump room→water supply pipeline network→ fresh water site.

### (2) Effluent Project

The effluent of the proposed project complies with “the split-flow of clean water and sewage” and shall be divided into two parts based on the pollution degree of effluent water quality. One is rain water effluent which collects rain water of sites, roads and roofs by gutter effluent method and discharges into the recipient water nearby; the other is production wastewater and living sewage which discharges into sewage treatment station by independent pipeline system. The designed sewage treatment station of the proposed project reaches 145000 m<sup>3</sup>/d, which uses the treatment technology of physical chemistry + secondary biochemistry + physical chemistry to meet the index requirements in the evaluation standard confirmation letter offered by Environment Protection Bureau of Guangxi Zhuang Autonomous Region (after the sewage treatment), namely: COD<sub>Cr</sub>≤100mg/L (90 mg/L integrate production), BOD<sub>5</sub>≤70 20mg/L, SS≤100-30mg/L, deep sea effluent. The effluent volume shall be 109158m<sup>3</sup>/d after the whole proposed project is completed. See the details on wastewater effluent volume of Phase III in Table 3.2-2.

**Table 3.2-2 Effluent Condition of the Proposed Project**

*Detailed figures per department removed*

| SN                | Production Workshop | Unit Product Effluent (m <sup>3</sup> /Adt) | Effluent Volume (m <sup>3</sup> /d) |
|-------------------|---------------------|---------------------------------------------|-------------------------------------|
| Phase I project   | Subtotal            | 30.0                                        | 76260                               |
| Phase II Project  | Subtotal            | 13.9                                        | 17678                               |
| Phase III Project | Subtotal            | 12.0                                        | 15220                               |
|                   | Total               | -                                           | 109158                              |

### (3) Heat Supply and Power Supply

#### a. Heat supply

The proposed project is expected to build a self-owned thermal power station to meet the demands of heat and power. The proposed project is divided into 3 construction phases. The thermal power station shall be constructed synchronously with the production line.

The steam and power needed in Phase I of the proposed project are all provided by the alkali recovery boiler (with the steam volume of 518t/h) and the auxiliary 100MW turbo-generator. The steam and power needed in Phase II of the proposed project are all provided by the alkali recovery boiler, 2 newly-added 220t/h circulating fluidized bed boilers (one for use and one spare) and auxiliary turbo-generators (100MW +50MW single exhaust condensing type turbo-generator). The steam and power needed in Phase III of the proposed project are all provided by the alkali recovery boiler, 3 newly added 220t/h circulating fluidized bed boilers (one for use and one spare) and auxiliary turbo-generators (100MW +2×50MW single exhaust condensing type turbo-generator). See the heat load and heat balance of the whole plant's production process in Table 3.2-3 [removed].

The scale of self-owned thermal power station includes 4 boilers and 3 machines (including an alkali recovery boiler) after the completion of the proposed project. The fixed steam production volume of boilers reaches 958t/h and the total steam load of the plant reaches 751 t/h. The heat supply of the thermal power station can meet the demands on steam of the whole plant's production (including the steam used by the thermal power station itself).

#### b. Power supply

The auxiliary self-owned thermal power station of the proposed project carries out the principle of cogeneration and self-balance of heat and power. The installed capacity of Phase I is 100MW exhaust backpressure steam generator unit with annual power of 850 million kWh. The power load of Phase I reaches 729kWh/t pulp and annual power consumption volume reaches 0.66 billion kWh.

Phase II project sets a new 50MW extraction condensing generator unit with the annual power of 420 million kWh. The item of high quality card packing paper in Phase II shall add power load of 987kWh/t paper with the annually added power about 440 million kWh. After the Phase II is completed, the power supplied by self-owned thermal power station shall be 1.27 billion kWh and annual power consumption of the whole plant 1.1 billion kWh.

**Table 3.2-3      Table of Heat Balance in the Whole Plant [removed]**

Phase III project sets a new 50MW exhaust condensing generator unit with the annul power of 420 million kWh. The item of high quality card packing paper in Phase III shall add power load of 993kWh/t paper with the annually added power about 0.45billion kWh. After the Phase III is completed, the power supplied by self-owned thermal power station shall be 1.69 billion kWh and annual power consumption of the whole plant 1.55 billion kWh.

Thus, it indicates that the self-owned thermal power station can meet the demands of power needed in normal production of the whole plant (including the self-consumption of the thermal power station).

The heat and power station is operated in parallel with Beihai power network. Therefore, the superfluous and insufficient parts of power shall be balanced by Beihai power network.

See Table 3.2-4 for the details of production heat and power load in all phases of the panned project.

**Table 3.2-4 Table of Heat and Power Load in all Phases of the Proposed Project**

| Name of project      |                                                                                                    | Hourly steam consumption<br>volume<br>(t/h) | Steam pressure<br>(Mpa) | Average power load of the whole plant<br>(including self-consumed power of<br>thermal power station)<br>(MW) |
|----------------------|----------------------------------------------------------------------------------------------------|---------------------------------------------|-------------------------|--------------------------------------------------------------------------------------------------------------|
| Phase I<br>Project   | Project of eucalptus chemical pulp<br>with annual production capacity of<br>900000 tons            | 249                                         | 1.1                     | 77.21                                                                                                        |
|                      |                                                                                                    | 209                                         | 0.5                     |                                                                                                              |
| Phase II<br>Project  | Project of high quality card<br>packing paper with annual<br>production capacity of 450000<br>tons | 21                                          | 1.1                     | 52.33                                                                                                        |
|                      |                                                                                                    | 118                                         | 0.5                     |                                                                                                              |
| Phase III<br>Project | Project of high quality fine paper<br>with annual production capacity of<br>450000 tons            | 7                                           | 1.1                     | 52.64                                                                                                        |
|                      |                                                                                                    | 118                                         | 0.5                     |                                                                                                              |
| Total                |                                                                                                    | 277                                         | 1.1                     | 182.18                                                                                                       |
|                      |                                                                                                    | 445                                         | 0.5                     |                                                                                                              |

#### (4) Circulation Cooling Water Project

The circulation cooling water volume of the proposed project is 43000m<sup>3</sup>/h. The circulation cooling water volume for process equipment in the proposed project reaches 43000m<sup>3</sup>/h with the temperature difference of inlet and outlet water about 10°C. Therefore, process equipment circulation cooling water is produced by mechanical ventilation cooling tower method. The circulation cooling water volume of thermal power station equipment is 24000m<sup>3</sup>/h with the temperature difference of inlet and outlet water about 8°C. Therefore, circulation cooling water of thermal power station equipment is produced by countercurrent hyperbola natural ventilation cooling tower method.

Table 3.2-5 Circulation cooling water of thermal power station

|           | Circulation water volume (m <sup>3</sup> /h) | Water supplement (m <sup>3</sup> /d) | Water discharge (m <sup>3</sup> /d) | Designed concentration ratio |
|-----------|----------------------------------------------|--------------------------------------|-------------------------------------|------------------------------|
| Phase I   | 12000                                        | 5760                                 | 1152                                | 5                            |
| Phase II  | 7000                                         | 3360                                 | 672                                 | 5                            |
| Phase III | 5000                                         | 2400                                 | 480                                 | 5                            |

As shown in the table, the circulation cooling water of thermal power station in all phases of the planned project complies with the requirement of concentration ratio over 4 in China Water-saving Technology Policy.

#### 3.2.5 Thermal Power Station

The self-owned thermal power station of the proposed project includes 4 boilers and 3 machines. Phase I project is equipped an alkali recovery boiler and an auxiliary 100MW turbo-generator with black liquid as fuel. Phase II project is equipped with 2×220t/h circulation fluidized bed boilers (one for use and one spare) and an auxiliary 50MW turbo-generator with coals, crumbs, sludge, etc as fuel. See Chart 3.2-7 for the details of proportion of fuels in proposed Phase II and Phase III project. Phase III project adds a new 1×220t/h circulation fluidized bed boilers and an auxiliary 50MW turbo-generator with coals, crumbs, sludge, etc as fuel.

Self-owned thermal power station includes coal transportation system, chemical water treatment, cooling water system, boilers and generator unit. See Chart 3.2-7 for the details of process flow. According to the calculation formula, see table 3.2-7 for the index of the self-owned thermal power stations of the proposed Phase I, Phase II and Phase III project including heat-electricity ratio and thermal efficiency.

Table 3.2-6 Proportion of fuels in proposed Phase II and Phase III project

| Fuel       | Low calorific value (MJ/kg) | Phase II                    |                                 | Phase III                   |                                 |
|------------|-----------------------------|-----------------------------|---------------------------------|-----------------------------|---------------------------------|
|            |                             | Boiler thermal input (TJ/a) | Proportion of various fuels (%) | Boiler thermal input (TJ/a) | Proportion of various fuels (%) |
| Coal       | 20.2                        | 5434                        | 91.7                            | 10868                       | 95.6                            |
| Wood chips | 6.5                         | 480                         | 8.1                             | 480                         | 4.2                             |
| Sludge     | 0.2                         | 12                          | 0.2                             | 19                          | 0.2                             |

According to relevant national policies, fossil fuel shall be lower than 20% for biomass electric generating set, thus the self-owned thermal power stations in proposed Phase II and Phase III project are all non-biomass electric generating sets.

Heat-electricity ratio = heat output / (amount of generated electricity × 3600 kJ/kWh) × 100%

Total thermal efficiency = (heat output + electricity supply × 3600 kJ/kWh) / (total consumption of fuel × unit low calorific value of the fuel) × 100%

Table 3.2-7 Resource index of self-owned thermal power stations in proposed Phase I, Phase II and Phase III project

| Phase of project | Heat-electricity ratio (%) | Average annual total thermal efficiency (%) | Standard coal consumption for electricity-generating (g/kWh) | Standard coal consumption for thermal supply (Kg/GJ) |
|------------------|----------------------------|---------------------------------------------|--------------------------------------------------------------|------------------------------------------------------|
| Phase II         | 367                        | 67.1                                        | 297                                                          | 44.7                                                 |
| Phase III        | 266                        | 64.1                                        | 353                                                          | 41.1                                                 |
| Phase I          | 241                        | 62.3                                        | 349                                                          | 37.3                                                 |

As shown in table 3.2-6, self-owned thermal power stations in proposed Phase I, Phase II and Phase III project all comply with the regulation that annual heat-electricity ratio shall be higher than 50% and annual average total thermal efficiency shall be higher than 45% for thermal power units with single-machine capacity between 50 megawatt and 200 megawatt in JJC [2000] No. 1268 document, Regulation on Developing Combined Heat and Power Generation issued by State Development Planning Commission, Ministry of Construction and State Environmental Protection Administration. Self-owned thermal power stations include coal handling system, chemical water processing system, cooling water system, boiler and electric generating set. See chart 3.2-7 for detailed process flow.

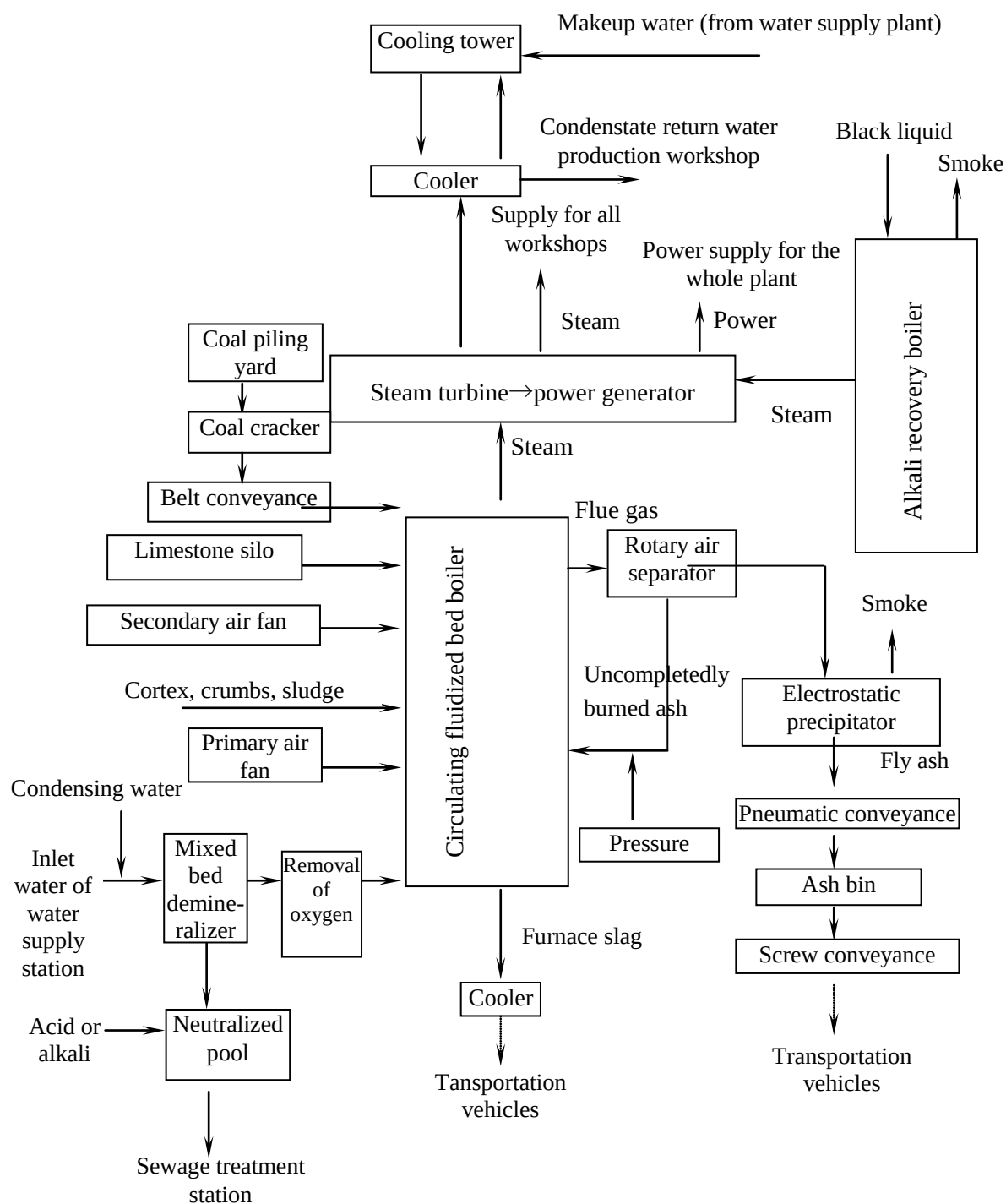


Chart 3.2-7 Process Flow of Self-owned Thermal Power Station

### (1) Coal Handling System

The coal supply system of the heat power station is composed of open air coal yard, dry coal shed, coal handling gallery, transfer station and broken building. The working time is 354 days annually with the schedule of 24 hours a day.

The fuel coals shall be transported to the coal storage yard of the plant by trucks and arranged by bulldozers and loaders. The yard occupies 6000 m<sup>2</sup> with the storage capacity of 7500t. The fuel coal shall be sent to the raw coal bin by belt conveyor, screened and crashed so as to meet the granularity requirement of boiler. Phase II and III project provides themselves the boiler for thermal power station, which uses the coal as the main fuel. The fuel coal and cortex and crumbs shall be sent to the storage bin in front of the furnace by belt and then to the boiler hearth for burning. The limestone shall be added to the hearth directly by pneumatic transmission.

### (2) Water-making System

The make-up water for circulating fluidized bed boiler and alkali recovery boiler is supplied by water-making system. Water from water supply station shall be supplied for boiler after the process of desalination through mixed bed ion exchange resin tank. The regeneration of ion exchange resin shall adopt the method of acid base regeneration and the acid base wastewater shall be sent to the sewage treatment station after the neutralization process through neutralized pool outside the water-making room.

The condensing water shall flow into the mixed bed via ultrafilter and make ion exchange in the mixed bed. After desalination, it shall be stored in barrels for boiler use.

### (3) Multi-fuel Circulation Fluid Bed Boiler and Generator Unit

The self-owned thermal power station of the proposed project shall be equipped with 3×220t/h multi-fuel circulating fluidized bed boilers (two for use and one spare). The sulfate content of the fuel coal is less than 0.8%, which shall conduct desulfurization by adding limestone in the boiler with the efficiency over 82.3%; the smoke applies electrostatic precipitator with four electric fields for dust removal, with the efficiency of 99.75%; since the circulating fluidized bed boiler applies low temperature burning and air stage feeding, the generation of NO<sub>x</sub> shall decrease significantly. After the process of dust removal and desulfurization, the emission concentration of pollutants can meet the requirement of B13223-2003 the *Emission Standard of Air Pollutants for Thermal Power Plants*, which requires the smoke and dust concentration below 50mg/Nm<sup>3</sup>, sulfur dioxide 400mg/Nm<sup>3</sup>, nitrogen oxide 450mg/Nm<sup>3</sup>.

The smoke shall be discharged via the 120mH×Φ2.7m chimney.

The ash and slag handling system of boiler applies the dry removal by separating the ash and slag. The bottom slag from the boiler shall be cooled by slag cooler, pumped to the slag storage bucket and loaded by vehicles for comprehensive utilization outside the plant.

The fly ash collected by electrostatic precipitator shall be stored in ash storehouse, and bag-type dust remover will be set on top of which to purify ash air. The fly ash shall be carried out of the factory by tank vehicles for comprehensive utilization. The whole system is of a closed type.

The fly ash will be stored in ash storehouse, and cyclone dust remover and bag-type dust remover will be set to prevent ash from flying.

The 3×220t/h multi-fuel circulating fluidized bed boilers (two for use and one spare) are equipped with 2×50MW turbine-generator units for the power supply of production.

See Table 3.2-5 for the main equipment and environmental protection facilities of the thermal power station of the proposed project.

**Table 3.2-8 Overview of the Main Equipment and Environment Protected Facilities of Thermal Power Station of the Proposed Project**

| Project                       |                               | Phase I Project       |                                                            | Phase II Project |                                                                     | Phase III Project |                                                                     |  |
|-------------------------------|-------------------------------|-----------------------|------------------------------------------------------------|------------------|---------------------------------------------------------------------|-------------------|---------------------------------------------------------------------|--|
| Boiler                        |                               | Category              | Alkali recovery boiler                                     |                  | Circulating fluidized bed boiler                                    |                   | Circulating fluidized bed boiler                                    |  |
|                               |                               | Evaporation capacity  | 4000 tds/d (steam yield of 518 t/h)                        |                  | 2×220t/h (on for use and one spare)                                 |                   | 1×220t/h                                                            |  |
| Steam turbine                 |                               | Category              | Exhaust backpressure steam turbine                         |                  | Single exhaust condensing type turbine                              |                   | Single exhaust condensing type turbine                              |  |
|                               |                               | Power                 | 100MW                                                      |                  | 50MW                                                                |                   | 50MW                                                                |  |
| Power generator               |                               | Category              | Water cooling brushless excitation                         |                  | Water cooling brushless excitation                                  |                   | Water cooling brushless excitation                                  |  |
|                               |                               | Capacity              | 100 MW                                                     |                  | 50MW                                                                |                   | 50MW                                                                |  |
| Smoke handling equipment      | Smoke desulfuration equipment | Category              | -                                                          |                  | Desulfurization by adding limestone to the boiler                   |                   | Desulfurization by adding limestone to the boiler                   |  |
|                               |                               | Efficiency            | -                                                          |                  | Desulfurization efficiency 82.3%                                    |                   | Desulfurization efficiency 80%                                      |  |
|                               | Smoke precipitator            | Category              | Electrostatic precipitator with three fields               |                  | Double-chamber electrostatic precipitator with four electric fields |                   | Double-chamber electrostatic precipitator with four electric fields |  |
|                               |                               | Efficiency            | Dust removal efficiency 99%                                |                  | Dust removal efficiency 99.75%                                      |                   | 99.75%                                                              |  |
|                               | Chimney                       | Type                  | Armoured concrete dual-flue chimney                        |                  | Armoured concrete tri-flue chimney                                  |                   | Armoured concrete tri-flue chimney                                  |  |
|                               |                               | Height                | 120 m                                                      |                  | 120 m                                                               |                   | 120 m                                                               |  |
|                               |                               | Outlet inner diameter | 4.6 m                                                      |                  | 2.7 m                                                               |                   | 2.7 m                                                               |  |
| Cooling water mode            |                               |                       | Countercurrent hyperbola natural ventilation cooling tower |                  |                                                                     |                   |                                                                     |  |
| Ash and slag treatment method |                               |                       | Dry method of removal by ash and slag separation           |                  |                                                                     |                   |                                                                     |  |

Remarks: The same chimney with tri-flue shall be shared in Phase II and III.



#### (4) Spare Ash and Slag Yard

Through initial calculation, the total yield of ash and slag shall be about 172000t after the completion of the proposed project. The construction unit is proposed to build the landfill site for solid wastes 500m away from the pulp-making plant. The solid wastes landfill site occupies 300 mu, which shall be prepared for ash and slag yard of the project.

### **3.3 Pulp and Water Balance for the Whole Plant in the Proposed Project**

#### **3.3.1 Pulp and Water Balance in the Proposed Project**

*Removed, see tables 3.2.1 and 3.2.2 for overall balance for EIA purposes*

#### **3.3.2 Pulp and Paper Balance in the Proposed Project**

*Removed; product composition is company proprietary information*

### 3.3.3 Project alkali balance

See chart 3.3-10 for alkali balance of Phase I project;

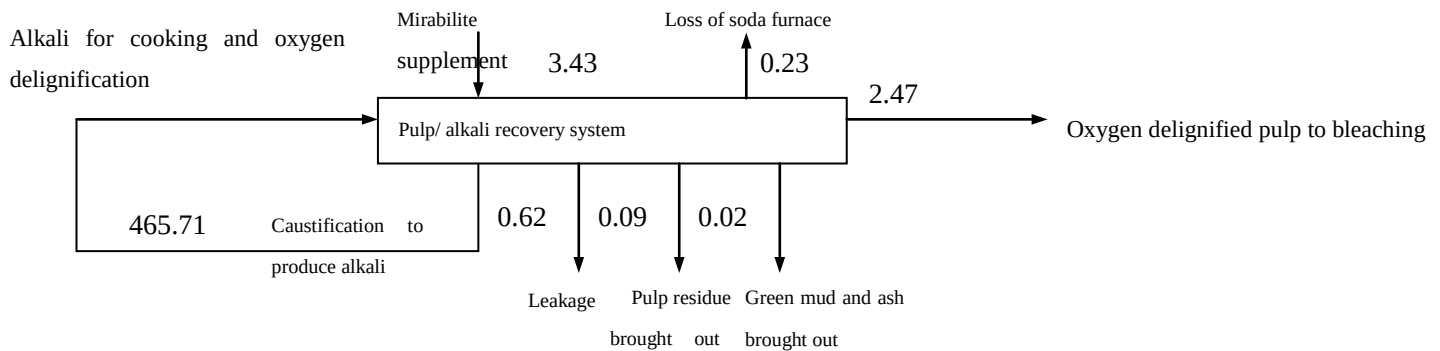


Chart 3.3-10 Alkali balance of Phase I project

### 3.4 Analysis on Pollutants Emission in the Proposed Project

See Table 3.4-1 for the main pollutants emission after the completion of the proposed project.

**Table 3.4-1 List of Main Pollutant Sources and Emission of the Proposed Project**

| SN | Workshop/procedure                                  | Pollutants emission                                                                        |
|----|-----------------------------------------------------|--------------------------------------------------------------------------------------------|
| 1  | Raw material preparation workshop                   | Bark, dust and wastewater                                                                  |
| 2  | Pulp-making workshop                                | Wastewater and odor from pulp making                                                       |
| 3  | Pulp board workshop                                 | A little pump seal water and vacuum pump sealing water, residual white water and pulp slag |
| 4  | Alkali recovery workshop                            | Green mud, lime slag, limekiln smoke, alkali boiler smoke and odor                         |
| 5  | Chemicals preparation workshop                      | Acid mist from chlorine dioxide section and wastewater                                     |
| 6  | High quality cardboard workshop                     | Residual white water and pulp slag                                                         |
| 7  | High quality fine paper workshop                    | Residual white water and pulp slag                                                         |
| 8  | Thermal power station                               | Waste water from regeneration of ion exchangers, boiler smoke and ash slag                 |
| 9  | Sewage treatment station                            | Mud, odor and up-to-standard wastewater                                                    |
| 10 | Additionally, noise produced by equipment operation |                                                                                            |

#### 3.4.1 Wastewater Effluent and Control Measures

The proposed project is scheduled in three phases. See Table 3.4-2 and 3.4-5 for the source, quality and volume of wastewater in each phase.

---

The designed capacity of sewage treatment state of the proposed project is 145000m<sup>3</sup>/d with the application of physic-chemical and secondary biochemical and physic-chemical technology. See Chart 3.4-1 for the process flow. The processed wastewater shall meet the relevant requirements in GB3544-2008 Discharge Standard of Water Pollutants for Pulp and Paper Industry (press release).The qualified wastewater shall be discharged to the deep sea.

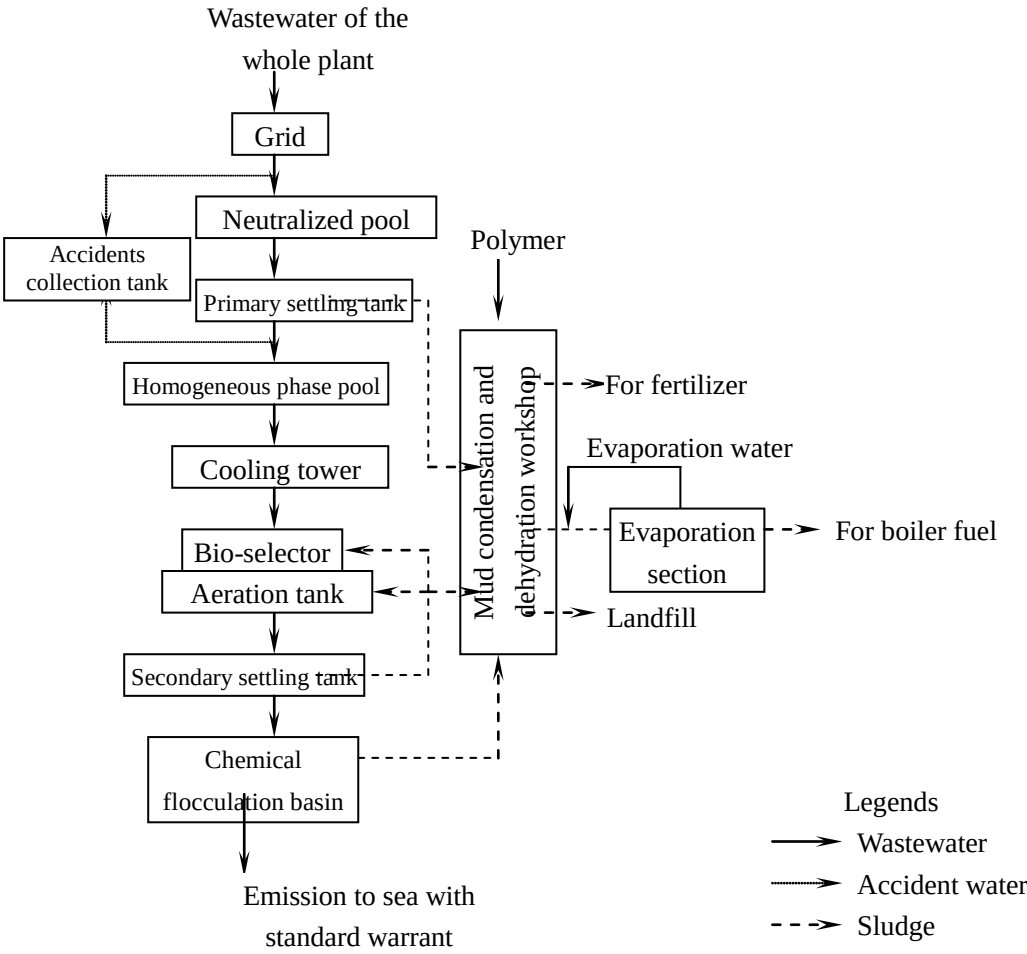


Chart 3.4-1 Process Flow of Sewage Treatment Station in the Proposed Project

**Table 3.4-2 List of Wastewater Quality and Volume in Proposed Project Phase I**

**Table 3.4-3List of Newly-added Wastewater Quality and Volume in Proposed Project Phase II**

**Table 3.4-4 List of Newly-added Wastewater Quality and Volume in Proposed Project Phase III**

Tables 3.4-2 to 3.4-4 are removed; refer to table 3.4-5 for summary of the information about the effluent balance

**Table 3.4-5 Inlet and Outlet Pollution Load of Sewage Treatment Station of the Proposed Project**

| Content                                                                        |        | Effluent<br>volume<br>(m <sup>3</sup> /d) | CODcr |        | BOD5 |        | SS   |        | AOX    |        | Dioxin<br>(pgTEQ/L) | Ammonia<br>nitrogen |       | Total nitrogen |       | Total<br>phosphorus |        | pH  | Chroma |
|--------------------------------------------------------------------------------|--------|-------------------------------------------|-------|--------|------|--------|------|--------|--------|--------|---------------------|---------------------|-------|----------------|-------|---------------------|--------|-----|--------|
|                                                                                |        |                                           | mg/L  | t/d    | mg/L | t/d    | mg/L | t/d    | mg/L   | t/d    |                     | mg/L                | t/d   | mg/L           | t/d   | mg/L                | t/d    |     |        |
| Phase I Project<br>of Sewage<br>Treatment<br>Station                           | Inlet  | 76260                                     | 1410  | 107.5  | 477  | 36.4   | 504  | 38.4   | < 7.47 | < 0.57 | < 6.19              | --                  | --    | --             | --    | --                  | --     | --  | --     |
|                                                                                | Outlet |                                           | < 100 | < 7.63 | < 20 | < 1.52 | < 50 | < 3.82 | < 5    | < 0.38 | < 6.19              | < 6                 | 0.46  | < 8            | 0.61  | < 0.8               | <0.06  | 6—9 | <50    |
| Phase II<br>Project of<br>Sewage<br>Treatment<br>Station (after<br>completion) | Inlet  | 93938                                     | 1250  | 117.4  | 431  | 40.6   | 544  | 51.15  | < 6.07 | < 0.57 | < 5.03              | --                  | --    | --             | --    | --                  | --     | --  | --     |
|                                                                                | Outlet |                                           | < 90  | < 8.46 | < 20 | < 1.88 | < 30 | < 2.82 | < 4    | < 0.38 | < 5.03              | < 6                 | <0.56 | < 8            | <0.75 | < 0.8               | <0.08  | 6—9 | <50    |
| Phase III<br>Project (after<br>completion)                                     | Inlet  | 109158                                    | 1136  | 124.0  | 398  | 43.5   | 551  | 60.19  | < 5.22 | < 0.57 | < 4.32              | --                  | --    | --             | --    | --                  | --     | --  | --     |
|                                                                                | Outlet |                                           | < 90  | < 9.82 | < 20 | < 2.18 | < 30 | < 3.28 | < 3.5  | < 0.38 | < 4.32              | < 6                 | <0.65 | < 8            | <0.87 | < 0.8               | < 0.09 | 6—9 | <50    |

Note: 1. The control standards adopt relevant requirements in GB3544-2008 Discharge Standard of Water Pollutants for Pulp and Paper Industry (press release);

2. CODcr is the measurement method for COD.

### 3.4.2 Exhaust Gas Emission and Control Measures

The pollution source of exhaust gas in the proposed project originates from the smoke discharged by alkali recovery boiler, limekiln and circulating fluidized bed boiler and the industrial exhaust gas from bleaching workshop. The alkali recovery boiler and limekiln apply the electrostatic precipitator with three electric fields, which promises an efficiency up to 99.7%. The exhaust gas shall be discharged through double-flue chimney (120mH). The exhaust gas from circulating fluidized bed boiler shall be controlled by the electrostatic precipitator with four electric fields, which promises an efficiency up to 99.7%. By adding limestone to the boiler, the efficiency of desulfurization shall be over 82%. The exhaust gas shall be discharged through tri-flue chimney (120mH×Φ2.7m). The acid gas produced by bleaching workshop shall be discharged after washing with base solution. See Table 3.4-6 for the air pollutants production and emission from the circulating fluidized bed boiler in the project and Table 3.4-7 for the main pollutants emission.

Furthermore, the proposed project sets an open air coal yard with the area of 6000m<sup>2</sup>, the storage capacity of which is 7500 ton coal. A 300 mu slag yard is proposed to be set 500m away in the southeast part of the plant, which is for preparation and landfill site for green mud, lime slag and the third class sludge. Through calculating by the following formula, the uncontrolled fugitive dust emission inventory from the open air coal yard and spare ash slag yard is in Table 3.4-8.

Estimated formula of fugitive dust emission inventory from coal yard:

$$Q_p = 6.13 \times 10^{-5} \times \frac{W}{C} \times V^{-4} \times A$$

Wherein:

$Q_p$ —fugitive dust emission inventory, kg/h;

$V$ —average wind speed, m/s;

$W$ —coal humidity, 13.22%;

$A$ —surface area of coal piles, m<sup>2</sup>.

Estimated formula of fugitive dust emission inventory from spare ash slag yard:

$$Q_L = 0.52(V - V_t)^3$$

Wherein:

$Q_L$ —fugitive dust emission inventory, kg/h;

$V$ —surface of ash pile/m, high wind speed m/s;

$V_t$ —start-up wind speed, m/s ;

$V_t = 1.932k + 3.02$

$K$ —water content of ash slag (20% count).

**Table 3.4-6 Air Pollutants Yield and Emission of Circulating Fluidized Bed Boiler in the Proposed Project**

| Content                               |                    | Smoke volume<br>(10 <sup>4</sup> Nm <sup>3</sup> /h) | Smoke          |                                     |                   |                                     | SO <sub>2</sub> |                                     |                   |                                     | NOx            |                                     |                   |                                     |
|---------------------------------------|--------------------|------------------------------------------------------|----------------|-------------------------------------|-------------------|-------------------------------------|-----------------|-------------------------------------|-------------------|-------------------------------------|----------------|-------------------------------------|-------------------|-------------------------------------|
|                                       |                    |                                                      | Yield<br>(t/h) | Concentration<br>mg/Nm <sup>3</sup> | Emission<br>(t/h) | Concentration<br>mg/Nm <sup>3</sup> | Yield<br>(t/h)  | Concentration<br>mg/Nm <sup>3</sup> | Emission<br>(t/h) | Concentration<br>mg/Nm <sup>3</sup> | Yield<br>(t/h) | Concentration<br>mg/Nm <sup>3</sup> | Emission<br>(t/h) | Concentration<br>mg/Nm <sup>3</sup> |
| Phase II<br>Project                   | Designed coal type | 26                                                   | 4.26           | 16385                               | 0.0106            | 41                                  | 0.47            | 1804                                | 0.083             | 319                                 | 0.078          | 300                                 | 0.078             | 300                                 |
|                                       | Checking coal type | 38                                                   | 6.50           | 17105                               | 0.0162            | 43                                  | 0.55            | 1453                                | 0.098             | 258                                 | 0.078          | 205                                 | 0.078             | 205                                 |
| Phase III<br>Project<br>(newly added) | Designed coal type | 26                                                   | 4.26           | 16385                               | 0.0106            | 41                                  | 0.47            | 1804                                | 0.083             | 319                                 | 0.078          | 300                                 | 0.078             | 300                                 |
|                                       | Checking coal type | 38                                                   | 6.50           | 17105                               | 0.0162            | 43                                  | 0.55            | 1453                                | 0.098             | 258                                 | 0.078          | 205                                 | 0.078             | 205                                 |

Remarks: 1. The circulating fluidized boiler of thermal power station in Phase II and III shares the same tri-flue chimney with the size of 120mH×Φ2.7m;

2. The smoke control of the circulating fluidized boiler in thermal power station complies with the third paragraph in GB13223-2003 the *Emission Standard of Air Pollutants for Thermal Power Plants*, i.e. 50mg/m<sup>3</sup>, SO<sub>2</sub>400 mg/m<sup>3</sup>, NOx450 mg/m<sup>3</sup> smoke.



**Table 3.4-7 Summary of Strong Source for Air Pollution in the Proposed Project (I)**

| Item                 |                                                                   |                       | Gas volume<br>(×10 <sup>4</sup> Nm <sup>3</sup> /h) | Smoke              |       | SO <sub>2</sub>    |       | NOx                |      | TRS                |      | Cl <sub>2</sub>    |      |
|----------------------|-------------------------------------------------------------------|-----------------------|-----------------------------------------------------|--------------------|-------|--------------------|-------|--------------------|------|--------------------|------|--------------------|------|
|                      |                                                                   |                       |                                                     | mg/Nm <sup>3</sup> | Kg/h  | mg/Nm <sup>3</sup> | Kg/h  | mg/Nm <sup>3</sup> | Kg/h | mg/Nm <sup>3</sup> | Kg/h | mg/Nm <sup>3</sup> | Kg/h |
| Phase I<br>Project   | Alkali boiler (518t/h)                                            |                       | 68.5                                                | 50                 | 34.25 | 200                | 137   | -                  | -    | 5                  | 3.4  | -                  | -    |
|                      | Limekiln boiler                                                   |                       | 13                                                  | 50                 | 6.5   | 450                | 58.5  | -                  | -    | 20                 | 2.6  | -                  | -    |
|                      | Bleaching workshop                                                |                       | 0.5                                                 | -                  | -     | -                  | -     | -                  | -    | -                  | -    | -                  | 0.05 |
|                      | Subtotal                                                          |                       | 82                                                  | -                  | 40.75 | -                  | 195.5 | -                  | -    | -                  | 6.0  | -                  | 0.05 |
| Phase II<br>Project  | Alkali boiler (518t/h)                                            |                       | 68.5                                                | 50                 | 34.25 | 200                | 137   | -                  | -    | 5                  | 3.4  | -                  | -    |
|                      | Limekiln boiler                                                   |                       | 13                                                  | 50                 | 6.5   | 450                | 58.5  | -                  | -    | 20                 | 2.6  | -                  | -    |
|                      | Bleaching workshop                                                |                       | 0.5                                                 | -                  | -     | -                  | -     | -                  | -    | -                  | -    | -                  | 0.05 |
|                      | Fuel coal boiler<br>(2×220t/h)<br>One for use<br>and one<br>spare | Designed<br>coal type | 26.0                                                | 41                 | 10.6  | 319                | 82.9  | 300                | 78   | -                  | -    | -                  | -    |
|                      |                                                                   | Checking<br>coal type | 38.0                                                | 43                 | 16.2  | 258                | 98    | 205                | 78   | -                  | -    | -                  | -    |
|                      | Subtotal                                                          |                       | 108                                                 | -                  | 51.35 | -                  | 289.5 | -                  | 78   | -                  | 6.0  | -                  | 0.05 |
| Phase III<br>Project | Alkali boiler (518t/h)                                            |                       | 68.5                                                | 50                 | 34.25 | 200                | 137   | -                  | -    | 5                  | 3.4  | -                  | -    |
|                      | Limekiln boiler                                                   |                       | 13                                                  | 50                 | 6.5   | 450                | 58.5  | -                  | -    | 20                 | 2.6  | -                  | -    |
|                      | Bleaching workshop                                                |                       | 0.5                                                 | -                  | -     | -                  | -     | -                  | -    | -                  | -    | -                  | 0.05 |
|                      | Fuel coal boiler<br>(3×220t/h)<br>Two for use<br>and one<br>spare | Designed<br>coal type | 52.0                                                | 41                 | 21.3  | 319                | 165.8 | 300                | 156  | -                  | -    | -                  | -    |
|                      |                                                                   | Checking<br>coal type | 76                                                  | 43                 | 32.5  | 258                | 196   | 205                | 156  | -                  | -    | -                  | -    |
|                      | Subtotals                                                         |                       | 134                                                 | -                  | 61.95 | -                  | 361.4 | -                  | 156  | -                  | 6.0  | -                  | 0.05 |

Remarks: 1. The control of smoke SO<sub>2</sub> and NOx from alkali recovery boiler complies with the third paragraph (comprehensive utilization of resource by boiler) of GB13223-2003 the *Emission Standard of Air Pollutants for Thermal Power Plants*, i.e. 200mg/m<sup>3</sup>, SO<sub>2</sub>800 mg/m<sup>3</sup> smoke; H<sub>2</sub>S emission implements GB14554-93 the *Emission Standards for Odor Pollutants*, i.e. H<sub>2</sub>S 21 Kg/h; the outlet temperature of smoke is 130°C and the emission speed is 12m/s.

2. The exhaust gas, smoke and SO<sub>2</sub> from limekiln meets Class II of GB9078-1996 the *Emission Standard of Air Pollutants for Industrial Kiln and Furnace*, i.e. 200mg/m<sup>3</sup>, SO<sub>2</sub>850 mg/m<sup>3</sup> smoke; H<sub>2</sub>S emission complies with GB14554-93 the *Emission Standards for Odor Pollutants*, i.e. H<sub>2</sub>S 21 Kg/h; the outlet temperature of smoke is 320°C and the emission speed is 12m/s.

3. The Cl<sub>2</sub> emission by acid gas collection washing tower in the bleaching workshop complies with Class II in GB16297-1996 the *Integrated Emission standard of Air Pollutants*, i.e. Cl<sub>2</sub>65 mg/Nm<sup>3</sup>, 5Kg/h (H=50m);

4. The control of smoke from circulating fluidized bed boiler in thermal power station complies with the third paragraph in GB13223-2003 the *Emission Standard of Air Pollutants for Thermal Power Plants*, i.e. 50mg/m<sup>3</sup>, SO<sub>2</sub>400 mg/m<sup>3</sup>, NOx450 mg/m<sup>3</sup> smoke; the outlet temperature of smoke is 145°C and the emission speed is 12m/s.

5. The alkali boiler and the limekiln share the same 120mH double-flue chimney; the fuel coal boiler in Phase II and III shares the same 120mH tri-flye chimney.

**Table 3.4-8 Summary of Strong Source for Air Pollution in Proposed Project (II)**

| Wind speed | Fugitive dust emission inventory of coal yard | Fugitive dust emission inventory of spare coal yard |
|------------|-----------------------------------------------|-----------------------------------------------------|
| 3.6m/s     | 0.625kg/h                                     | 0.004 kg/h                                          |
| 17m/s      | -                                             | 1305 kg/h                                           |
| 29m/s      | -                                             | 8714 kg/h                                           |

Two situations of abnormal emission of circulating fluidized bed boiler:

(1) Without desulfurization, the designed coal type about SO<sub>2</sub> emission concentration in Phase II is 1804mg/m<sup>3</sup> with the emission volume of 0.47t/h; after the completion of Phase III when both boilers are without desulfurization, the permitted SO<sub>2</sub> emission concentration of each is 1804mg/m<sup>3</sup> with the emission volume of 0.47t/h.

(2) The failure that could occur most in the smoke and dust removal equipment is the abnormality of one electric field. Suppose the efficiency of electrostatic precipitator decreases to 99%, the smoke discharge shall be 0.0426t/h with the concentration of 164mg/Nm<sup>3</sup>, based on the designed coal type in Phase II; after the completion of Phase III, each boiler shall discharge 0.0426t/h respectively, with the smoke concentration of 164mg/Nm<sup>3</sup>.

### 3.4.3 Solid Wastes Production and Control Measures

The solid wastes produced in the proposed project mainly include: cortexes and crumbs from material preparation workshop; pulp slag from pulp-making, pulp board and paper-making workshops; green mud by causticization section in the alkali recovery workshop; fuel coal ash and slag of thermal power station; sludge from sewage treatment station. See Table 3.4-9 for the production and disposal of solid wastes in each phase.

**Table 3.4-9 Summary of Solid Wastes Yield and Disposal after the Completion of Proposed Project**

| SN    | Emission source                                          | Yield after the completion of Phase I (t/a) | Yield after the completion of Phase II (t/a)                     | Yield after the completion of Phase III (t/a)                      | Treatment method                                                                                                              | Category              |
|-------|----------------------------------------------------------|---------------------------------------------|------------------------------------------------------------------|--------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| 1     | Wood wastes                                              | 73900 (water content 45%)                   | 73900 (water content 45%)                                        | 73900 (water content 45%)                                          | The comprehensive utilization before the production of Phase II and the burning in fuel coal boiler after the production.     | Common pollutant<br>s |
| 2     | Pulp slag                                                | 4280 (water content 70%)                    | 7430 (water content 70%)                                         | 14790 (water content 70%)                                          | Sell to the small paper plant                                                                                                 |                       |
| 3     | Green mud, ash and ballast                               | 37000 (water content 50%)                   | 37000 (water content 50%)                                        | 37000 (water content 50%)                                          | Landfill                                                                                                                      |                       |
| 4     | Class I sludge                                           | 35357 (water content 65%)                   | 61240 (water content 65%)                                        | 93770 (water content 65%)                                          | Send to the forest for fertilizer before the production of Phase II and the burning in fuel coal boiler after the production. |                       |
| 5     | Class II sludge                                          | 21737 (water content 80%)                   | 24637 (water content 80%)                                        | 30327 (water content 80%)                                          | Burning in the alkali boiler                                                                                                  |                       |
| 6     | Class III sludge                                         | 50052 (water content 80%)                   | 46502 (water content 80%)                                        | 41402 (water content 80%)                                          | Landfill                                                                                                                      |                       |
| 7     | Flyash                                                   | -                                           | Volume of ash and slag 86000<br>Wherein: ash 60000<br>Slag 26000 | Volume of ash and slag 172000<br>Wherein: ash 120000<br>Slag 52000 | Comprehensive utilization (concrete making, paving)                                                                           |                       |
| 8     | Others (including domestic garbage, construction wastes) | 7080 (water content 60%)                    | 14160 (water content 60%)                                        | 21240 (water content 60%)                                          | Landfill                                                                                                                      |                       |
| Total |                                                          | 229406                                      | 350869                                                           | 484429                                                             | -                                                                                                                             | -                     |

### 3.4.4 Noise

The main noise sources of the proposed project are from various equipment in production workshop, pumps, air compressors, coal crackers in thermal power station, blower and high pressure air evacuation etc. See Table 3.4-10 for the main equipment producing noise in the proposed project and the noise levels.

**Table 3.4-10 Main Equipment Producing Noise in Proposed Project and the Noise Levels**

Unit: dB (A)

| Category                            | Noise source                          | Noise level (Leq[dB(A)]) |
|-------------------------------------|---------------------------------------|--------------------------|
| Raw material preparation workshop   | Chipper                               | 104.0                    |
|                                     | Chip machine                          | 91.0                     |
| Pulp-making workshop                | Circulation pump, water pump          | 85.0-90.0                |
|                                     | Black liquor pump, pulp pump          | 84.0-88.0                |
|                                     | Knotter, prototype of pressure screen | 85.0-90.0                |
|                                     | Pulp pump                             | 84.0-88.0                |
| Pulp board workshop                 | Fourdrinier section, press section    | 92.0-97.0                |
|                                     | Pulp pump, water pump                 | 84.0-88.0                |
|                                     | Vacuum pump                           | 95.0-100.0               |
|                                     | Refrigerator                          | 96.0                     |
| Cardboard and paper making workshop | Hydrapulper                           | 95                       |
|                                     | Pulp pump                             | 85~88                    |
|                                     | Desander                              | 90                       |
|                                     | Fluffer                               | 92                       |
|                                     | Pan grinder                           | 96~107                   |
|                                     | Fan pump                              | 85~88                    |
|                                     | Vacuum pump                           | 85~90                    |
|                                     | Fourdrinier section                   | 92~97                    |
|                                     | Drying section                        | 87~94                    |
|                                     | Calendar                              | 95~100                   |
|                                     | Air compressor                        | 90~110                   |
|                                     |                                       |                          |
| Alkali recovery workshop            | Black liquid pump, pulp pump          | 84.0-88.0                |
|                                     | Air blower                            | 95.0                     |
|                                     | Induced draft fan                     | 100.0                    |
|                                     | Green liquid pump, water pump         | 84.0-88.0                |
|                                     | White liquid pump                     | 84.0-88.0                |
|                                     | Mud filter                            | 85.0-90.0                |
|                                     | Fan, induced draft fan                | 90.0                     |
| Chemicals preparation workshop      | Medical solution pump                 | 84.0-88.0                |
|                                     | Water pump                            | 84.0-88.0                |
| Thermal power station               | Induced draft fan                     | 85.0                     |
|                                     | Air blower                            | 90.0                     |
|                                     | Water supply pump                     | 85-90                    |
|                                     | Steam turbine                         | 90.0                     |
|                                     | Medium/low pressure outlet            | 88.0                     |
|                                     | Generator and exciter                 | 90.0                     |
| Sewage treatment station            | Fan                                   | 90.0                     |
| Cooling water circulation system    | Cooling tower                         | 80.0                     |

---

### 3.4.5 Odor

#### 3.4.5.1 Odor source

Gas generated in pulp making with the method of sulphate process shall produce the unique smell related to sulphate pulp plant. The main component of odor is  $\text{H}_2\text{S}$ , methanethiol, 2- methanethiol and dimethyl, 2-thioether, collectively called total reduced sulphur (TRS). The volume is calculated by the equivalence of  $\text{H}_2\text{S}$ . The odor from pulp plants is mainly classified to high and low concentration as follows:

##### (1) High concentration odor

Mainly originates from cooking tank, evaporation tank, dirty condensing water and stripping tower.

The concentration of total reduced sulfur in high concentration odor is generally 50000 ~ 200000mg/ $\text{Nm}^3$ .

##### (2) Low concentration odor

Mainly originates from the storage tank of alkali recovery and pulp-making line as well as emission from equipment and limekiln etc.

###### a. Emission from alkali boiler dissolving tank

The concentration of total reduced sulfur in emission from dissolving tank is generally less than 100~1500mg/ $\text{Nm}^3$ . The common treatment includes cooling and washing. After the washing process, the concentration of total reduced sulfur in dissolving tank shall be less than 50mg/ $\text{Nm}^3$ .

###### b. Smoke from alkali boiler and limekiln

Generally speaking, the concentration of total reduced sulfur in smoke is less than 1~50mg/ $\text{Nm}^3$ . In modern processes, the concentration of total reduced sulfur in smoke is generally less than 5mg/ $\text{Nm}^3$ , while that in limekiln is less than 30mg/ $\text{Nm}^3$ .

###### c. Decentralized odor

The decentralized odor mainly originates from drain, sewage treatment station, sludge disposal, solid wastes piling yard, etc.

Generally speaking, the concentration of total reduced sulfur in decentralized odor is less than 0~5mg/ $\text{Nm}^3$ . Since the effective control of odor source in modern pulp-making plant, the impact of decentralized odor on air quality is restrained.

The odor source in the proposed project is mainly from the cooking system, evaporation station, alkali recovery boiler and limekiln.

##### (1) Cooking Section

Cooking section applies compact cooking technology. The condensable gas from steam tube gas

filtration buffer and the extracted concentrated non-condensable gas (CNCG) get together in the concentrator and are sent into alkali boiler for burning.

## (2) Evaporation System

The evaporation of black liquid applies falling-film evaporator. The equipment can generate two kinds of odor, which originates from stripping tower and vacuum pump respectively. The former has high concentration with higher temperature and pressure, which is suitable for direct burning in the boiler, while the latter has low concentration and is mainly uncondensable gas during the evaporation, which requires pressure for further burning.

## (3) Alkali Recovery Boiler

Alkali recovery boiler applies low odor boiler for the treatment of mixed thick black liquid (from evaporation station, with the concentration of 75-80%) and supplemented mirabilite and influx into the alkali boiler for burning. The process abandons the traditional disc evaporator to reduce the sulfur bearing odor from the direct evaporation. Content of sulfur dioxide in smoke is related to the degree of boiling vulcanization. See Table 3.4-7 for  $H_2S$  emission.

Meanwhile, a spare burner for the circulating fluidized bed boiler shall be arranged in the proposed project. Suppose both burners stop running, the odor shall be sent to fuel torch for burning.

Low concentration odor in melts from dissolving tank shall be burned as part of secondary air for alkali boiler via the dilution of diluted base solution. When the secondary air of alkali boiler cannot burn low concentration odor, a spare washing tower shall be set for odor treatment.

## (4) Limekiln

Limekiln uses heavy oil as fuel. The emission of  $H_2S$  from it is partially induced by residual  $Na_2S$  in white mud. The white mud shall be dried under low temperature in limekiln, so that part of sulfur within  $Na_2S$  shall be discharged in the form of  $H_2S$ . White mud shall be completely washed, dehydrated and dried to 80-85% before entering the limekiln for burning, which shall reduce the emission of  $H_2S$ . When the proportion of air and fuel is inappropriate, in case of air shortness or fuel incomplete burning, the emission volume of  $H_2S$  produced by sulfur in fuel burning shall be high. The problem can be avoided by control on proportion of air and fuel in the boiler.

As TRS substances are acid and flammable, they can be washed by base solution and finally treated by burning. The project is designed to apply the two methods and the emission through high exhaust funnel to reduce the volume and control the effect of TRS odor. See Table 3.4-7 for the emission of TRS (counted on  $H_2S$ ) in odor source, the permitted volume of  $H_2S$  emission should be lower than the limit value given by GB14554-93 the *Emission Standards for Odor Pollutants* as listed in Table 2.

### 3.4.6 Organic Chloride Emission in Bleached Wastewater

#### 3.4.6.1 AOX emission in bleached wastewater

The lignin degradation products and the hydroxybenzene & organic chloride produced in the reaction of chloric bleacher contained in the bleached wastewater (acid wastewater, base wastewater) is mainly

the chlorophenol compound, based on TOCl (Total Organic Chlorinate) and AOX (Adsorbable Organic Halogen).

AOX yield is directly related to the active chlorine amount in bleaching process. With the increase of replacement of liquid chlorine with chlorine dioxide in the process, the yield of AOX shall decrease significantly. The proposed project shall apply the ECF bleaching and the bleaching sequence comprise the use of [chlorine dioxide, oxygen and hydrogen peroxide bleaching stages] ---. In the bleaching process, AOX yield is further reduced through applying hot chlorine dioxide bleaching process in the first stage and hydrogen peroxide bleaching process in the final stage. It is estimated that the yield of AOX < 0.22kg/ADt and AOX < 12mg/L in the effluent of pulping production line, thus meeting the limit requirement of  $\text{AOX} \leq 12\text{mg/L}$  (discharge port of pulping production line) in GB3544-2008 "Discharge Standard for Water Pollutants in Pulping and Paper-making Industry".

It is mentioned in the "best technical reference documents for pulping and paper-making industry" of Europe that 40-70% of AOX may usually be removed through the secondary bio-chemical treatment. Therefore, the amount of AOX emitted in the wastewater of the proposed project will be below 0.14kg/ADt, with a concentration less than 5mg/l, after undergoing the tertiary treatment.

Adsorbable Organic Halogen (AOX) only indicates the amount of halide in the wastewater, but failing to distinguish the toxic differences of halide in the same amount. Previously, AOX in the wastewater discharged by pulp mills was regarded as an important factor having potential and lasting environmental impact. Now, with the application of ECF bleaching technology, the content of AOX in the wastewater discharged by pulp mills is very low, basically in the range of 0.1~0.3kg. On the basis of long-term observation over fish and other aquatic organisms, the result shows that the concentration of AOX in the discharged wastewater is very low and almost has no impact to aquatic organisms if a modern sulphate pulp mill only uses ECF bleaching technology and modernized secondary bio-chemical wastewater treatment. In addition, studies also show that acute or chronic toxicity in the water discharged by pulp mills has nothing to do with AOX in the water discharged from the bleaching workshop (excerpted from "Influence of Bleaching Wastewater to Aquatic Environment", Tanna 1996, Helsinki, and Finish Environmental Agency). This further proves that the discussion of the United Nations Environment Programme (UNEP2006) – "Adsorbable Organic Halogen is not related to dioxin or furan.

#### 3.4.6.2 Dioxin emission in bleached wastewater

Among the chemicals listed in Appendix C of Stockholm Convention, only polychlorinated dibenzo-p-dioxin (PCDD) and polychlorinated dibenzo-furan (PCDF) are recognized being produced in the elemental chlorine bleaching process. Among the 17 PCDD/PCDF derivatives produced by chlorine through substituting on positions 2, 3, 7, 8, only two, 2,3,7,8-TCDD and 2,3,7,8-TCDF, are believed being produced in the chemical pulping process by using chlorine bleaching.

In 1998, US Environmental Protection Agency issued the discharge standard of dioxin in wastewater from bleaching workshops, requiring 2,3,7,8-TCDD below 10pg/L and 2,3,7,8-TCDF below 31.9 pg/L. according to the toxic equivalency factor revised by the World Health Organization, the limit for dioxin emission in the wastewater from a bleaching workshop is 13.19 pgTEQ/L. This is the strictest limit

requirement for dioxin in the bleaching wastewater in the pulping process. Along the application ECF bleaching process and adoption of modern pulping technology, the pulping industry in US has fully met this given requirement.

Based on the experiences of the same type of enterprises in US and other countries, the dioxin in the wastewater from the pulping production line of the proposed project is below 10 pg TEQ /L, thus meeting the requirement for the control limit of dioxin, 30 pgTEQ/L, specified in GB3544-2008 "Discharge Standard for Water Pollutants in Pulping and Paper-making Industry" of China.

### 3.4.7 Emission of CO<sub>2</sub>

CO<sub>2</sub> is mainly produced in alkali recovery boiler, limekiln, and circulating fluidized bed boiler, etc. in the project, and see Table 3.4-11 for the amount produced in each sector.

Table 3.4-11 Production of CO<sub>2</sub> in the Proposed Project

| Source of production                    | CO <sub>2</sub> emission volume (t/a) |
|-----------------------------------------|---------------------------------------|
| Alkali recovery boiler (biomass fuel)   | 1614240                               |
| Limekiln (heavy oil)                    | 127440                                |
| circulating fluidized bed boiler (coal) | 985536                                |
| Total                                   | 2727216                               |

## 3.5 Check of Main Pollutants after the Completion of Proposed Project

See Table 3.5-1 for the main pollutants after the completion of proposed project.

Table 3.5-1 Main Pollutants after the Completion of Proposed Project

| Content                                                   | Yield                      | Reduced volume             | Discharge volume     |
|-----------------------------------------------------------|----------------------------|----------------------------|----------------------|
| I. Wastewater                                             |                            |                            |                      |
| 1 Wastewater amount (10 <sup>5</sup> t/a)                 | 3864                       | 0                          | 3864                 |
| 2 COD <sub>Cr</sub> (t/a)                                 | 43896                      | 40420                      | 3476                 |
| 3 BOD <sub>5</sub> (t/a)                                  | 15399                      | 14627.3                    | 771.7                |
| 4 SS (t/a)                                                | 21307                      | 20145.9                    | 1161.1               |
| II. Exhaust gas                                           |                            |                            |                      |
| 1 Exhaust gas amount (10 <sup>4</sup> Nm <sup>3</sup> /a) | 1.18×10 <sup>6</sup>       | 0                          | 1.18×10 <sup>6</sup> |
| 2 SO <sub>2</sub> (t/a)                                   | 9647                       | 6577                       | 3070                 |
| 3 Smoke (t/a)                                             | 107007.1                   | 106480.8                   | 526.3                |
| 4 No <sub>x</sub> (t/a)                                   | 1325                       | 0                          | 1325                 |
| III. Solid wastes                                         |                            |                            |                      |
| 1 Wood wastes (t/a)                                       | 73900 (water content 50%)  | 73900 (water content 50%)  | 0                    |
| 2 Pulp slag (t/a)                                         | 14790 (water content 70%)  | 14790 (water content 70%)  | 0                    |
| 3 Green mud, ballast (t/a)                                | 37000 (water content 50%)  | 37000 (water content 50%)  | 0                    |
| 4 Flyash                                                  | 172000                     | 172000                     | 0                    |
| 5 Sludge in sewage treatment station (t/a)                | 165499 (water content 75%) | 165499 (water content 75%) | 0                    |
| 6 Others (domestic garbage, construction wastes)          | 21240 (water content 60%)  | 21240 (water content 60%)  | 0                    |



## 4 Investigation and Evaluation on Current Environmental Quality

### 4.1 Investigation and Evaluation on Current Environmental Air Quality

#### 4.1.1 Monitoring Scope and Layout of Monitoring Sites

Monitoring scope: a rectangle area centered upon the proposed plant site, with the axis in the same direction with the dominant wind direction during the monitoring, which extends northward for 10km and southward for 2 km (while the sea area lies beyond) and 6km towards the east and west end respectively, covering a total area of 144 km<sup>2</sup>.

Principles for the layout: Monitoring sites shall be set up taking into consideration of the meteorological features, various environmental functional areas, distribution of sensitive points, characteristics of the pollution sources of proposed projects in the evaluation area.

Layout of monitoring sites: 9 separated monitoring sites shall be set up for conventional items (SO<sub>2</sub>, NO<sub>2</sub>, TSP, PM<sub>10</sub>) at: 1<sup>#</sup> Beimu Salt Works, 2<sup>#</sup> Huangshao, 3<sup>#</sup> Houtang, 4<sup>#</sup> Banjiuchong Village, 5<sup>#</sup> Binchi, 6<sup>#</sup> administrative and residential zone in the port area, 7<sup>#</sup> Xinggang Township Government, 8<sup>#</sup> Nankang Town and 9<sup>#</sup> the southwest side of Beimu slag stockpile.

6 monitoring sites shall be set up for H<sub>2</sub>S around the four sides of the proposed plant site as well at the Villages of Yaxi and Binchi.

4 monitoring sites for odor concentration shall be set up within the proposed plant site.

See positions of all monitoring sites related to the proposed plant site in Table 4.1-1, 4.1-2 and Attached Drawing 2.

**Table 4.1-1 Positions of Monitoring Sites for Conventional Items and Monitoring Items**

| No. | Name of monitoring sites                             | Positions to the proposed plant site                    | Distance (km) | Monitoring items                                          |
|-----|------------------------------------------------------|---------------------------------------------------------|---------------|-----------------------------------------------------------|
| 1#  | Beimu Salt Works                                     | within the proposed plant site                          | /             | TSP, PM <sub>10</sub> , SO <sub>2</sub> , NO <sub>2</sub> |
| 2#  | Huangshao                                            | SW, crosswind                                           | 3.0           | TSP, PM <sub>10</sub> , SO <sub>2</sub> , NO <sub>2</sub> |
| 3#  | Houtang                                              | SW, downwind of annual dominant wind                    | 5.5           | TSP, PM <sub>10</sub> , SO <sub>2</sub> , NO <sub>2</sub> |
| 4#  | Banjiuchong Village                                  | SW, downwind of annual dominant wind                    | 4.8           | TSP, PM <sub>10</sub> , SO <sub>2</sub> , NO <sub>2</sub> |
| 5#  | Binchi                                               | NW, downwind to the secondary dominant wind of the year | 1.8           | TSP, PM <sub>10</sub> , SO <sub>2</sub> , NO <sub>2</sub> |
| 6#  | Administrative and residential zone in the port area | W, crosswind to the dominant wind of the year           | 8.0           | TSP, PM <sub>10</sub> , SO <sub>2</sub> , NO <sub>2</sub> |
| 7#  | Xinggang Township Government                         | N, crosswind to the dominant wind of the year           | 5.0           | TSP, PM <sub>10</sub> , SO <sub>2</sub> , NO <sub>2</sub> |
| 8#  | Nankang Town                                         | NW, downwind to the secondary dominant wind of the year | 8.0           | TSP, PM <sub>10</sub> , SO <sub>2</sub> , NO <sub>2</sub> |
| 9#  | Southwest of Beimu Salt Works                        | SW, downwind to the dominant wind of the year           | 0.5           | TSP                                                       |

**Table 4.1-2 Positions of Monitoring Sites for H<sub>2</sub>S & Odor and Monitoring Items**

| No.            | Monitoring sites            | Positions to the proposed plant site                                                  | Distance (m) | Monitoring items                     |
|----------------|-----------------------------|---------------------------------------------------------------------------------------|--------------|--------------------------------------|
| 1 <sup>#</sup> | North of the plant boundary | /                                                                                     | /            | H <sub>2</sub> S, odor concentration |
| 2 <sup>#</sup> | SW of the plant boundary    | /                                                                                     | /            | H <sub>2</sub> S, odor concentration |
| 3 <sup>#</sup> | SE of the plant boundary    | /                                                                                     | /            | H <sub>2</sub> S, odor concentration |
| 4 <sup>#</sup> | NW of the plant boundary    | /                                                                                     | /            | H <sub>2</sub> S, odor concentration |
| 5 <sup>#</sup> | Binchi Village              | NW to the proposed plant site, downwind to the secondary dominant wind of the year    | 1800         | H <sub>2</sub> S                     |
| 6 <sup>#</sup> | Yaxi Village                | North to the proposed plant site, downwind to the secondary dominant wind of the year | 120          | H <sub>2</sub> S                     |

#### 4.1.2 Monitoring and Analytical Methods

The monitoring and analytical methods adopt *Monitoring and Analytical Methods of Air and Exhaust Gas* (the 4<sup>th</sup> Edition) issued by State Environmental Protection Administration is adopted, as detailed in Table 4.1-3.

**Table 4.1-3 Monitoring & Analytical Methods and Determination Lower Limit**

Unit: mg/m<sup>3</sup> (excluding odor concentration)

| Monitoring items             | Analytical & sampling method                                                            | Instrument types (No.)                                                                                                     | Determination lower limit |
|------------------------------|-----------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|---------------------------|
| SO <sub>2</sub>              | Formaldehyde Absorption - Pararosaniline Hydrochloride Spectrophotometry (GB/T15262-94) | UV-2100 double-beam UV-spectrophotometer (040208)                                                                          | 0.007/hr on average       |
|                              |                                                                                         |                                                                                                                            | 0.003/day on average      |
| NO <sub>2</sub>              | Naphthodiamide Hydrochloride Spectrophotometry (GB8968-88)                              | UV-2100 double-beam UV-spectrophotometer (040208)                                                                          | 0.005/hr on average       |
|                              |                                                                                         |                                                                                                                            | 0.002/day on average      |
| Total suspended particles    | Gravimetric Method (GB/T15432-1995)                                                     | TH-150 intelligent medium flowrate total suspended particulate sampler & electronic analytical balance (30307121~30307127) | 0.001                     |
| Inhalable Particulate Matter | Gravimetric Method (GB/T15432-1995)                                                     | PM10-100 atmospheric inhalable particulate matter sampler & electronic balance (0307079~0307083)                           | 0.001                     |

| Monitoring items   | Analytical & sampling method                      | Instrument types (No.)               | Determination lower limit |
|--------------------|---------------------------------------------------|--------------------------------------|---------------------------|
| H <sub>2</sub> S   | Methylene Blue Spectrophotometry (GB/T14678-1993) | Spectrophotometer (007) modified 722 | 0.001                     |
| Odor Concentration | Triangle Odor Bag Method (GB/T14675-93)           | 5L vacuum bottle                     | Sensory threshold         |

#### 4.1.3 Monitoring Time and Frequency

The monitoring shall be divided into two terms in winter and summer respectively, which shall be timed from Feb. 26<sup>th</sup> to Mar. 4<sup>th</sup>, 2007 during winter and from July 20<sup>th</sup>-26<sup>th</sup>, 2007, both lasting for 7 days. Daily average concentration of SO<sub>2</sub> and NO<sub>2</sub> shall be kept under surveillance for 18 hours per day and the daily average concentration of TSP and PM<sub>10</sub> shall be 12 hours each day with 6 times a day for the hourly average concentration. Daily sampling shall be timed at 02:00, 07:00, 10:00, 14:00, 16:00 and 19:00 for 45 minutes each time. Various meteorological parameters such as wind direction, wind velocity, air temperature, air pressure, relative humidity, total cloudiness and low cloud cover shall be recorded synchronously.

Sampling of H<sub>2</sub>S for its concentration monitoring shall be taken 6 times a day at 02:00, 07:00, 10:00, 14:00, 16:00, and 19:00 precisely for 45 minutes each time. Samples shall be collected 6 times a day for the maximum determination value.

Sampling of odor concentration for its concentration monitoring shall be taken 4 times a day at 10:00, 12:00, 14:00, 16:00, with the interval of 2 hours. Samples shall be collected 4 times a day for the maximum determination value.

#### 4.1.4 Evaluation Standard

*Ambient Air Quality Standard* (GB3095-1996) (Class II) shall be adopted for SO<sub>2</sub>, NO<sub>2</sub>, TSP and PM<sub>10</sub>, while the *Hygienic Standards for the Design of Industrial Enterprises* (TJ36-79), with its provisions on the maximum allowable concentration of harmful substances in the atmosphere in residential areas, shall be maintained for the evaluation of H<sub>2</sub>S concentration in Binchi Village. Besides, Class II standard of the *Emission Standard for Odor Pollutants* (GB14554-93) shall be taken as the threshold in assessing the H<sub>2</sub>S and odor concentration at monitoring sites within the plant. See Table 4.1-4 for details.

#### 4.1.5 Evaluation Method

The single quality index method shall be adopted for the evaluation:

$$I_i = C_i / C_{oi}$$

Wherein:

I<sub>i</sub> ——single quality index for a certain pollutant;

C<sub>i</sub> ——measured concentration of a certain pollutant (mg/m<sup>3</sup>);

C<sub>oi</sub> ——evaluation standard for a certain pollutant (mg/m<sup>3</sup>).

**Table 4.1-4 Evaluation Standard**

| Pollutant                    | Sampling time  | Concentration limit |                         |
|------------------------------|----------------|---------------------|-------------------------|
|                              |                | Unit                | Class II                |
| SO <sub>2</sub>              | Annual average | mg/m <sup>3</sup>   | 0.06                    |
|                              | Daily average  |                     | 0.15                    |
|                              | Hourly average |                     | 0.50                    |
| NO <sub>2</sub>              | Annual average | mg/m <sup>3</sup>   | 0.04                    |
|                              | Daily average  |                     | 0.08                    |
|                              | Hourly average |                     | 0.12                    |
| Total suspended particles    | Annual average | mg/m <sup>3</sup>   | 0.20                    |
|                              | Daily average  |                     | 0.30                    |
| Inhalable particulate matter | Annual average | mg/m <sup>3</sup>   | 0.10                    |
|                              | Daily average  |                     | 0.15                    |
| H <sub>2</sub> S             | Hourly average | mg/m <sup>3</sup>   | 0.01 (residential area) |
|                              |                |                     | 0.06 (plant area)       |
| Odor concentration           |                | Non dimensional     | 20                      |
| Chlorine                     | Hourly average | mg/m <sup>3</sup>   | 0.10                    |

#### 4.1.6 Monitoring Results and Evaluation

Weather conditions in the evaluation area during the winter monitoring period are primarily overcast, with a dominant north wind at 2.6~3.5m/s. And for the summer monitoring period, it had been, for most of the time, overcast, or cloudy, with a dominant SE wind at 2.0~3.0m/s. Results from the various monitoring period are shown in Table 4.1-5~7.

##### 4.1.6.1 Results and Evaluation for the Winter Monitoring

SO<sub>2</sub>: Results of hourly average concentration, as well as the daily average concentration at the 8 monitoring sites all came up to the required standard, of which the maximum value of 0.017mg/m<sup>3</sup> (3.4% of the required standard) for hourly average concentration was recorded at the monitoring site of Banjiuchong Village and the maximum value of daily average concentration was recorded 0.013mg/m<sup>3</sup> (18.67% of the required standard) at Nankang Town.

NO<sub>2</sub>: Results of hourly average concentration, as well as the daily average concentration at the 8 monitoring sites all came up to the required standard, of which the maximum value of 0.023mg/m<sup>3</sup> (9.58% of the required standard) for hourly average concentration was recorded at the monitoring site of Xinggang Township Government and the maximum value of daily average concentration level was recorded 0.015mg/m<sup>3</sup> (12.5% of the required standard) at the administrative and residential zone in the port area.

Inhalable particulate matter: None of the monitoring values for daily average concentration at the 8 monitoring sites had ever exceeded the required standard, while the maximum value was recorded 0.083mg/m<sup>3</sup> (55.3% of the standard) at the 4# monitoring site of Banjiuchong Village for daily average concentration of PM<sub>10</sub>.

Total suspended particles: No exceeding standard ever occurred at the 9 monitoring sites of daily

average concentration, while the maximum value was recorded 0.089mg/m<sup>3</sup> (29.7% of the standard) at the 8# monitoring site of Nankang Town for daily average concentration of TSP.

H<sub>2</sub>S: All concentration values taken from the 4 monitoring sites within the plant were below the limit of 0.06 mg/m<sup>3</sup>, set for Class II in the *Emission Standard for Odor Pollutants* (GB14554-93), with no concentration of H<sub>2</sub>S at the 4 above-mentioned sites. Concentration values taken from monitoring sites at Villages of Yaxi and Binchi were also lower than the maximum allowable concentration limit of 0.01 mg/m<sup>3</sup> as prescribed in the *Hygienic Standards for the Design of Industrial Enterprises* (TJ36-79) for harmful pollutants in the atmosphere in residential areas, while the maximum value was recorded 0.089mg/m<sup>3</sup> (40% of the required limit) at the 5# monitoring site of Binchi Village.

Odor concentration: Monitoring results of odor concentration at the 4 monitoring sites within the plant all met the requirements for Class II as prescribed for the plant.

As shown in Table 4.1-7, all items of single quality index were less than 1, indicating there was no exceeding over the required standard and that the air quality within the evaluation area was good enough to meet the requirements of evaluation. By comparing the maximum value of single quality index for each of the monitoring item, SO<sub>2</sub> and NO<sub>2</sub> had been showing the least figure, while inhalable particulate matter was at the top, followed by total suspended particles, which indicated that the inhalable particulate matter was the dominant pollutant within the evaluation area.

#### 4.1.6.2 Results and Evaluation for the Summer Monitoring

SO<sub>2</sub>: Results of hourly average concentration, as well as the daily average concentration at the 8 monitoring sites all came up to the required standard, of which the maximum value of 0.019mg/m<sup>3</sup> (3.8% of the required standard) for hourly average concentration was recorded at the 4# monitoring site of Banjiuchong Village and the maximum value of daily average concentration was recorded 0.016mg/m<sup>3</sup> (10.7% of the required standard) at the 5# monitoring site of Binchi and 8# of Nankang Town.

NO<sub>2</sub>: Results of average concentration per hour, as well as the daily average concentration at the 8 monitoring sites all came up to the required standard, of which the maximum value of 0.026mg/m<sup>3</sup> (10.8% of the required standard) for hourly mean concentration level was recorded at the 7# monitoring site of Xinggang Township Government and the maximum value of daily average concentration was recorded 0.016mg/m<sup>3</sup> (13.3% of the required standard) at the administrative and residential zone in the port area.

Inhalable particulate matter: None of the monitoring values for daily average concentration at the 8 monitoring sites had ever exceeded the required standard, while the maximum value was recorded 0.087mg/m<sup>3</sup> (58% of the standard) at the 4# monitoring site of Banjiuchong Village for daily average concentration of PM<sub>10</sub>.

Total suspended particles: No exceeding standard ever occurred at the 9 monitoring sites of daily average concentration, while the maximum value was recorded 0.099mg/m<sup>3</sup> (33% of the standard) at the 8# monitoring site of Nankang Town for daily average concentration of TSP.

H<sub>2</sub>S: All concentration value taken from the 4 monitoring sites within the plants were below the limit of 0.06 mg/m<sup>3</sup>, set for Class II in the *Emission Standard for Odor Pollutants* (GB14554-93), with no concentration of H<sub>2</sub>S at the 1# monitoring sites to the north of the plant boundary and 4# to the NW. Concentration value taken from monitoring sites at Villages of Yaxi and Binchi were also lower than the

maximum allowable concentration limit of  $0.01 \text{ mg/m}^3$  as prescribed in the *Hygienic Standards for the Design of Industrial Enterprises* (TJ36-79) for harmful pollutants in the atmosphere in residential areas, while the maximum value was recorded  $0.005 \text{ mg/m}^3$  (50% of the required limit) at the 5# monitoring site of Binchi Village.

Odor Concentration: Monitoring results of odor concentration at the 4 monitoring sites within the plant all met the requirements for Class II as prescribed for the plant.

As shown in Table 4.1-7 and Table 4.1-10, all items of single quality index were less than 1, indicating there was no exceeding the required standard during both the winter and summer monitoring and that the air quality within the evaluation area was good enough to meet the requirements of evaluation. By comparing the maximum value of single quality index for each monitoring item,  $\text{SO}_2$  and  $\text{NO}_2$  had shown the least figure, while inhalable particulate matter was at the top, followed by total suspended particles, which indicated that the inhalable particulate matter was the dominant pollutant within the evaluation area.

**Table 4.1-5 Monitoring and Statistical Results of Ambient Air Quality in Winter (mg/m<sup>3</sup>)**

| Monitoring sites                   | Pollutant<br>Statistical items                         | SO <sub>2</sub> | NO <sub>2</sub> | Inhalable particulate matter | Total suspended particles |
|------------------------------------|--------------------------------------------------------|-----------------|-----------------|------------------------------|---------------------------|
| 1 <sup>#</sup><br>Beimu Salt Works | Hourly average concentration range                     | <0.007~0.013    | <0.005~0.021    | /                            | /                         |
|                                    | Max. multiple of hourly concentration                  | 0               | 0               | /                            | /                         |
|                                    | Over-standard rate of hourly average concentration (%) | 0               | 0               | /                            | /                         |
|                                    | Daily average concentration range                      | 0.005~0.007     | 0.005~0.009     | 0.021~0.066                  | 0.054~0.075               |
|                                    | Max. multiple of daily concentration                   | 0               | 0               | 0                            | 0                         |
|                                    | Over-standard rate of daily average concentration (%)  | 0               | 0               | 0                            | 0                         |
| 2 <sup>#</sup><br>Huangshao        | Hourly average concentration range                     | <0.007~0.015    | <0.005~0.020    | /                            | /                         |
|                                    | Max. multiple of hourly concentration                  | 0               | 0               | /                            | /                         |
|                                    | Over-standard rate of hourly average concentration (%) | 0               | 0               | /                            | /                         |
|                                    | Daily average concentration range                      | 0.005~0.011     | 0.005~0.012     | 0.023~0.065                  | 0.040~0.056               |
|                                    | Max. multiple of daily concentration                   | 0               | 0               | 0                            | 0                         |
|                                    | Over-standard rate of daily average concentration (%)  | 0               | 0               | 0                            | 0                         |
| 3 <sup>#</sup><br>Houtang          | Hourly average concentration range                     | <0.007~0.008    | <0.005~0.022    | /                            | /                         |

| Monitoring sites          | Pollutant<br>Statistical items                         | SO <sub>2</sub> | NO <sub>2</sub> | Inhalable<br>particulate<br>matter | Total<br>suspended<br>particles |
|---------------------------|--------------------------------------------------------|-----------------|-----------------|------------------------------------|---------------------------------|
|                           | Max. multiple of hourly concentration                  | 0               | 0               | /                                  | /                               |
|                           | Over-standard rate of hourly average concentration (%) | 0               | 0               | /                                  | /                               |
|                           | Daily average concentration range                      | 0.003~0.005     | 0.006~0.011     | 0.015~0.070                        | 0.051~0.078                     |
|                           | Max. multiple of daily concentration                   | 0               | 0               | 0                                  | 0                               |
|                           | Over-standard rate of daily average concentration (%)  | 0               | 0               | 0                                  | 0                               |
| 4#<br>Banjiuchong Village | Hourly average concentration range                     | <0.007~0.017    | <0.005~0.016    | /                                  | /                               |
|                           | Max. multiple of hourly concentration                  | 0               | 0               | /                                  | /                               |
|                           | Over-standard rate of hourly average concentration (%) | 0               | 0               | /                                  | /                               |
|                           | Daily average concentration range                      | 0.005~0.010     | 0.005~0.013     | 0.026~0.083                        | 0.042~0.050                     |
|                           | Max. multiple of daily concentration                   | 0               | 0               | 0                                  | 0                               |
|                           | Over-standard rate of daily average concentration (%)  | 0               | 0               | 0                                  | 0                               |
| 5#<br>Binchi              | Hourly average concentration range                     | <0.007~0.015    | <0.005~0.021    | /                                  | /                               |
|                           | Max. multiple of hourly concentration                  | 0               | 0               | /                                  | /                               |
|                           | Over-standard rate of hourly average concentration (%) | 0               | 0               | /                                  | /                               |



| Monitoring sites                                           | Pollutant<br>Statistical items                         | SO <sub>2</sub> | NO <sub>2</sub> | Inhalable<br>particulate<br>matter | Total<br>suspended<br>particles |
|------------------------------------------------------------|--------------------------------------------------------|-----------------|-----------------|------------------------------------|---------------------------------|
|                                                            | Daily average concentration range                      | 0.007~0.014     | 0.005~0.009     | 0.025~0.061                        | 0.045~0.075                     |
|                                                            | Max. multiple of daily concentration                   | 0               | 0               | 0                                  | 0                               |
|                                                            | Over-standard rate of daily average concentration (%)  | 0               | 0               | 0                                  | 0                               |
| 6#<br>Administrative and residential zone in the port area | Hourly average concentration range                     | <0.007~0.012    | <0.005~0.016    | /                                  | /                               |
|                                                            | Max. multiple of hourly concentration                  | 0               | 0               | /                                  | /                               |
|                                                            | Over-standard rate of hourly average concentration (%) | 0               | 0               | /                                  | /                               |
|                                                            | Daily average concentration range                      | 0.006~0.008     | 0.008~0.015     | 0.019~0.071                        | 0.043~0.062                     |
|                                                            | Max. multiple of daily concentration                   | 0               | 0               | 0                                  | 0                               |
|                                                            | Over-standard rate of daily average concentration (%)  | 0               | 0               | 0                                  | 0                               |
| 7#<br>Xinggang Township Government                         | Hourly average concentration range                     | 0.008~0.017     | 0.007~0.023     | /                                  | /                               |
|                                                            | Max. multiple of hourly concentration                  | 0               | 0               | /                                  | /                               |
|                                                            | Over-standard rate of hourly average concentration (%) | 0               | 0               | /                                  | /                               |
|                                                            | Daily average concentration range                      | 0.006~0.010     | 0.009~0.013     | 0.025~0.081                        | 0.041~0.076                     |
|                                                            | Max. multiple of daily concentration                   | 0               | 0               | 0                                  | 0                               |

| Monitoring sites                        | Pollutant<br>Statistical items                         | SO <sub>2</sub> | NO <sub>2</sub> | Inhalable<br>particulate<br>matter | Total<br>suspended<br>particles |
|-----------------------------------------|--------------------------------------------------------|-----------------|-----------------|------------------------------------|---------------------------------|
|                                         | Over-standard rate of daily average concentration (%)  | 0               | 0               | 0                                  | 0                               |
| 8#<br>Nankang Town                      | Hourly average concentration range                     | 0.007~0.015     | <0.005~0.019    | /                                  | /                               |
|                                         | Max. multiple of hourly concentration                  | 0               | 0               | /                                  | /                               |
|                                         | Over-standard rate of hourly average concentration (%) | 0               | 0               | /                                  | /                               |
|                                         | Daily average concentration range                      | 0.009~0.013     | 0.005~0.009     | 0.038~0.066                        | 0.062~0.089                     |
|                                         | Max. multiple of daily concentration                   | 0               | 0               | 0                                  | 0                               |
|                                         | Over-standard rate of daily average concentration (%)  | 0               | 0               | 0                                  | 0                               |
| 9#<br>Southwest of Beimu slag stockpile | Hourly average concentration range                     | /               | /               | /                                  | /                               |
|                                         | Max. multiple of hourly concentration                  | /               | /               | /                                  | /                               |
|                                         | Over-standard rate of hourly average concentration (%) | /               | /               | /                                  | /                               |
|                                         | Daily average concentration range                      | /               | /               | /                                  | 0.046~0.083                     |
|                                         | Max. multiple of daily concentration                   | /               | /               | /                                  | 0                               |
|                                         | Over-standard rate of daily average concentration (%)  | /               | /               | /                                  | 0                               |

| Monitoring sites | Pollutant<br>Statistical items                         | SO <sub>2</sub> | NO <sub>2</sub> | Inhalable particulate matter | Total suspended particles |
|------------------|--------------------------------------------------------|-----------------|-----------------|------------------------------|---------------------------|
| Region           | Hourly average concentration range                     | <0.007~0.017    | <0.005~0.023    |                              | /                         |
|                  | Max. multiple of hourly concentration                  | 0               | 0               | /                            | /                         |
|                  | Over-standard rate of hourly average concentration (%) | 0               | 0               |                              | /                         |
|                  | Daily average concentration range                      | 0.003~0.014     | 0.005~0.015     | 0.015~0.083                  | 0.040~0.089               |
|                  | Max. multiple of daily concentration                   | 0               | 0               | 0                            | 0                         |
|                  | Over-standard rate of daily average concentration (%)  | 0               | 0               | 0                            | 0                         |

**Table 4.1-6 Monitoring Results of H<sub>2</sub>S and Odor Concentration during Winter Time**

| Pollutant<br>Monitoring site   | H <sub>2</sub> S (mg/m <sup>3</sup> ) | Odor concentration (no dimensional) |
|--------------------------------|---------------------------------------|-------------------------------------|
| 1# North of the plant boundary | <0.001                                | <10                                 |
| 2# SW of the plant boundary    | <0.001                                | <10                                 |
| 3# SE of the plant boundary    | <0.001                                | <10                                 |
| 4# NW of the plant boundary    | <0.001                                | <10                                 |
| 5# Binchi Village              | <0.001~0.004                          | /                                   |
| 6# Yaxi Village                | <0.001~0.003                          | /                                   |
| Region                         | <0.001~0.004                          | <10                                 |

**4.1-7 Single Quality Index of Ambient Air Quality during Winter Time**

| Pollutant<br>Monitoring site | SO <sub>2</sub> | NO <sub>2</sub> | Inhalable particulate matter | Total suspended particles |
|------------------------------|-----------------|-----------------|------------------------------|---------------------------|
| 1# Beimu Salt Works          | 0.033~0.047     | 0.042~0.075     | 0.140~0.440                  | 0.180~0.250               |
| 2# Huangshao                 | 0.033~0.073     | 0.042~0.100     | 0.153~0.433                  | 0.133~0.187               |

| Pollutant<br>Monitoring site                                              | SO <sub>2</sub> | NO <sub>2</sub> | Inhalable<br>particulate matter | Total suspended<br>particles |
|---------------------------------------------------------------------------|-----------------|-----------------|---------------------------------|------------------------------|
| 3 <sup>#</sup> Houtang                                                    | 0.020~0.033     | 0.050~0.092     | 0.100~0.467                     | 0.170~0.260                  |
| 4 <sup>#</sup> Banjiuchong Village                                        | 0.033~0.067     | 0.042~0.108     | 0.173~0.553                     | 0.140~0.167                  |
| 5 <sup>#</sup> Binchi                                                     | 0.047~0.093     | 0.042~0.075     | 0.167~0.407                     | 0.150~0.250                  |
| 6 <sup>#</sup> Administrative and<br>residential zone in the port<br>area | 0.040~0.053     | 0.067~0.125     | 0.127~0.473                     | 0.143~0.207                  |
| 7 <sup>#</sup> Xinggang Township<br>Government                            | 0.040~0.067     | 0.075~0.108     | 0.167~0.540                     | 0.147~0.260                  |
| 8 <sup>#</sup> Nankang Town                                               | 0.060~0.087     | 0.042~0.075     | 0.253~0.440                     | 0.137~0.253                  |
| 9 <sup>#</sup> Southwest of Beimu<br>slag stockpile                       | /               | /               | /                               | 0.153~0.277                  |
| Region                                                                    | 0.020~0.093     | 0.042~0.125     | 0.100~0.553                     | 0.133~0.277                  |

**Table 4.1-8 Monitoring and Statistical Results of Ambient Air Quality during Summer Time**

(Unit: mg/m<sup>3</sup>)

| Monitoring site                       | Pollutant<br>Statistical item                          | SO <sub>2</sub> | NO <sub>2</sub> | Inhalable particulate matter | Total suspended particles |
|---------------------------------------|--------------------------------------------------------|-----------------|-----------------|------------------------------|---------------------------|
| 1 <sup>#</sup><br>Beimu Salt Works    | Hourly average concentration range                     | <0.007~0.014    | <0.005~0.023    | /                            | /                         |
|                                       | Max. multiple of hourly concentration                  | 0               | 0               | /                            | /                         |
|                                       | Over-standard rate of hourly average concentration (%) | 0               | 0               | /                            | /                         |
|                                       | Daily average concentration range                      | 0.005~0.008     | 0.005~0.011     | 0.023~0.068                  | 0.056~0.078               |
|                                       | Max. multiple of daily concentration                   | 0               | 0               | 0                            | 0                         |
|                                       | Over-standard rate of average daily concentration (%)  | 0               | 0               | 0                            | 0                         |
| 2 <sup>#</sup><br>Huangshao           | Hourly average concentration range                     | <0.007~0.016    | <0.005~0.024    | /                            | /                         |
|                                       | Max. multiple of hourly concentration                  | 0               | 0               | /                            | /                         |
|                                       | Over-standard rate of hourly average concentration (%) | 0               | 0               | /                            | /                         |
|                                       | Daily average concentration range                      | 0.005~0.014     | 0.008~0.013     | 0.021~0.067                  | 0.044~0.061               |
|                                       | Max. multiple of daily concentration                   | 0               | 0               | 0                            | 0                         |
|                                       | Over-standard rate of average daily concentration (%)  | 0               | 0               | 0                            | 0                         |
| 3 <sup>#</sup><br>Houtang             | Hourly average concentration range                     | <0.007~0.008    | <0.005~0.024    | /                            | /                         |
|                                       | Max. multiple of hourly concentration                  | 0               | 0               | /                            | /                         |
|                                       | Over-standard rate of hourly average concentration (%) | 0               | 0               | /                            | /                         |
|                                       | Daily average concentration range                      | 0.003~0.005     | 0.006~0.012     | 0.014~0.077                  | 0.059~0.081               |
|                                       | Max. multiple of daily concentration                   | 0               | 0               | 0                            | 0                         |
|                                       | Over-standard rate of average daily concentration (%)  | 0               | 0               | 0                            | 0                         |
| 4 <sup>#</sup><br>Banjiuchong Village | Hourly average concentration range                     | <0.007~0.019    | <0.005~0.018    | /                            | /                         |
|                                       | Max. multiple of hourly concentration                  | 0               | 0               | /                            | /                         |
|                                       | Over-standard rate of hourly average concentration (%) | 0               | 0               | /                            | /                         |
|                                       | Daily average concentration range                      | 0.005~0.011     | 0.005~0.014     | 0.030~0.087                  | 0.048~0.054               |
|                                       | Max. multiple of daily concentration                   | 0               | 0               | 0                            | 0                         |
|                                       | Over-standard rate of average daily concentration (%)  | 0               | 0               | 0                            | 0                         |

|                                                            |                                                        |              |              |             |             |
|------------------------------------------------------------|--------------------------------------------------------|--------------|--------------|-------------|-------------|
| 5#<br>Binchi                                               | Hourly average concentration range                     | <0.007~0.017 | <0.005~0.022 | /           | /           |
|                                                            | Max. multiple of hourly concentration                  | 0            | 0            | /           | /           |
|                                                            | Over-standard rate of hourly average concentration (%) | 0            | 0            | /           | /           |
|                                                            | Daily average concentration range                      | 0.007~0.016  | 0.005~0.010  | 0.027~0.063 | 0.047~0.081 |
|                                                            | Max. multiple of daily concentration                   | 0            | 0            | 0           | 0           |
|                                                            | Over-standard rate of average daily concentration (%)  | 0            | 0            | 0           | 0           |
| 6#<br>Administrative and residential zone in the port area | Hourly average concentration range                     | <0.007~0.013 | <0.005~0.018 | /           | /           |
|                                                            | Max. multiple of hourly concentration                  | 0            | 0            | /           | /           |
|                                                            | Over-standard rate of hourly average concentration (%) | 0            | 0            | /           | /           |
|                                                            | Daily average concentration range                      | 0.006~0.008  | 0.008~0.016  | 0.024~0.074 | 0.048~0.064 |
|                                                            | Max. multiple of daily concentration                   | 0            | 0            | 0           | 0           |
|                                                            | Over-standard rate of average daily concentration (%)  | 0            | 0            | 0           | 0           |
| 7#<br>Xinggang Township Government                         | Hourly average concentration range                     | 0.008~0.017  | 0.007~0.026  | /           | /           |
|                                                            | Max. multiple of hourly concentration                  | 0            | 0            | /           | /           |
|                                                            | Over-standard rate of hourly average concentration (%) | 0            | 0            | /           | /           |
|                                                            | Daily average concentration range                      | 0.006~0.010  | 0.009~0.014  | 0.027~0.084 | 0.044~0.078 |
|                                                            | Max. multiple of daily concentration                   | 0            | 0            | 0           | 0           |
|                                                            | Over-standard rate of average daily concentration (%)  | 0            | 0            | 0           | 0           |
| 8#<br>Nankang Town                                         | Hourly average concentration range                     | 0.007~0.017  | <0.005~0.021 | /           | /           |
|                                                            | Max. multiple of hourly concentration                  | 0            | 0            | /           | /           |
|                                                            | Over-standard rate of hourly average concentration (%) | 0            | 0            | /           | /           |
|                                                            | Daily average concentration range                      | 0.012~0.014  | 0.007~0.010  | 0.040~0.070 | 0.067~0.099 |
|                                                            | Max. multiple of daily concentration                   | 0            | 0            | 0           | 0           |
|                                                            | Over-standard rate of average daily concentration (%)  | 0            | 0            | 0           | 0           |
| 9#<br>Southwest of Beimu slag stockpile                    | Hourly average concentration range                     | /            | /            | /           | /           |
|                                                            | Max. multiple of hourly concentration                  | /            | /            | /           | /           |
|                                                            | Over-standard rate of hourly average concentration (%) | /            | /            | /           | /           |
|                                                            | Daily average concentration range                      | /            | /            | /           | 0.049~0.089 |

|        |                                                        |              |              |             |             |
|--------|--------------------------------------------------------|--------------|--------------|-------------|-------------|
|        | Max. multiple of daily concentration                   | /            | /            | /           | 0           |
|        | Over-standard rate of average daily concentration (%)  | /            | /            | /           | 0           |
| Region | Hourly average concentration range                     | <0.007~0.019 | <0.005~0.026 |             | /           |
|        | Max. multiple of hourly concentration                  | 0            | 0            | /           | /           |
|        | Over-standard rate of hourly average concentration (%) | 0            | 0            |             | /           |
|        | Daily average concentration range                      | 0.003~0.016  | 0.005~0.016  | 0.014~0.087 | 0.044~0.098 |
|        | Max. multiple of daily concentration                   | 0            | 0            | 0           | 0           |
|        | Over-standard rate of average daily concentration (%)  | 0            | 0            | 0           | 0           |

**Table 4.1-9 Monitoring Result of H<sub>2</sub>S and Odor Concentration during Summer Time**

| Pollutant<br>Monitoring site   | H <sub>2</sub> S (mg/m <sup>3</sup> ) | Odor concentration (no dimensional) |
|--------------------------------|---------------------------------------|-------------------------------------|
| 1# North of the plant boundary | <0.001                                | <10                                 |
| 2# SW of the plant boundary    | <0.001~0.003                          | <10                                 |
| 3# SE of the plant boundary    | <0.001~0.002                          | <10                                 |
| 4# NW of the plant boundary    | <0.001                                | <10                                 |
| 5# Binchi Village              | <0.001~0.005                          | /                                   |
| 6# Yaxi Village                | <0.001~0.004                          | /                                   |
| Region                         | <0.001~0.005                          | <10                                 |

**Table 4.1-10 Single Quality Index of Ambient Air Quality during Summer Time**

| Pollutant<br>Monitoring site                            | SO <sub>2</sub> | NO <sub>2</sub> | Inhalable particulate matter | Total suspended particles |
|---------------------------------------------------------|-----------------|-----------------|------------------------------|---------------------------|
| 1# Beimu Salt Works                                     | 0.033~0.053     | 0.042~0.092     | 0.153~0.453                  | 0.187~0.260               |
| 2# Huangshao                                            | 0.033~0.093     | 0.067~0.108     | 0.140~0.447                  | 0.147~0.203               |
| 3# Houtang                                              | 0.020~0.033     | 0.050~0.100     | 0.093~0.513                  | 0.197~0.270               |
| 4# Banjiuchong Village                                  | 0.033~0.073     | 0.042~0.117     | 0.200~0.580                  | 0.153~0.180               |
| 5# Binchi                                               | 0.047~0.107     | 0.042~0.083     | 0.180~0.420                  | 0.157~0.270               |
| 6# Administrative and residential zone in the port area | 0.040~0.053     | 0.067~0.133     | 0.160~0.493                  | 0.160~0.213               |

| Pollutant<br>Monitoring site                        | SO <sub>2</sub> | NO <sub>2</sub> | Inhalable<br>particulate matter | Total suspended<br>particles |
|-----------------------------------------------------|-----------------|-----------------|---------------------------------|------------------------------|
| 7 <sup>#</sup> Xinggang Township<br>Government      | 0.053~0.067     | 0.075~0.117     | 0.180~0.560                     | 0.147~0.260                  |
| 8 <sup>#</sup> Nankang Town                         | 0.080~0.093     | 0.088~0.13      | 0.34~0.58                       | 0.22~0.33                    |
| 9 <sup>#</sup> Southwest of Beimu<br>slag stockpile | /               | /               | /                               | 0.170~0.290                  |
| Region                                              | 0.020~0.107     | 0.042~0.133     | 0.093~0.580                     | 0.150~0.330                  |

## 4.2 Investigation and Evaluation on Current Water Environmental Quality

### 4.2.1 Layout of Monitoring Sites

The evaluation is graded as Level 1 and shall be carried out in line with the relevant provisions in the guiding principles of HJ/T2.3-93:

- Principles for layout: When water waste discharge of the project goes beyond 50000m<sup>3</sup>/d, there should be 1 sampling station set up within each 4 - 7km<sup>2</sup> range of area.
- Monitoring and investigation scope: Started from the sewage outlets; for the specified investigation scope, see the Chapter of General Principles in this report.
- Layout of sampling stations: Altogether 15 sampling stations were set for the monitoring on offshore water quality, according to the rising and ebb flow direction within the proposed plant site. For the detailed layout and positions of all 15 stations, see Table 4.2-1 and Attached Drawing 13.

**Table 4.2-1 Sampling Stations in Sea Water Environment**

| No. | Latitude and longitude of<br>the stations | Direction/Distance<br>to the proposed<br>plant site of<br>discharge outlet<br>(m) | Functional area                              | Implement<br>standard of<br>GB3097-1997 |
|-----|-------------------------------------------|-----------------------------------------------------------------------------------|----------------------------------------------|-----------------------------------------|
| 1#  | 21°34.38'N, 109°35.7'E                    | N, 6.3                                                                            | GX002DIV<br>Water quality<br>transition zone | Class III                               |
| 2#  | 21°32.87'N, 109°35.55'E                   | N, 3.6                                                                            | GX002DIII                                    | Class III                               |
| 3#  | 21°32.7'N, 109°38.7'E                     | NE, 6.0                                                                           | A01 I                                        | Class I                                 |
| 4#  | 21°30.69'N, 109°34.14'E                   | SW, 3.0                                                                           | GX002DIV                                     | Class IV                                |
| 5#  | 21°29.66'N, 109°35.51'E                   | S, 2.3                                                                            | GX003CIII                                    | Class III                               |
| 6#  | 21°28.07'N, 109°35.50'E                   | S, 5.1                                                                            | GX001B II                                    | Class II                                |
| 7#  | 21°30.00'N, 109°38.30'E                   | SE, 5.0                                                                           | GX001B II                                    | Class II                                |
| 8#  | 21°27.48'N, 109°33.25'E                   | SW, 7. 7                                                                          | GX004CIII                                    | Class III                               |
| 9#  | 21°25.05'N, 109°34.22'E                   | SW, 10. 8                                                                         | GX03DIII                                     | Class III                               |
| 10# | 21°23.82'N, 109°36.36'E                   | SE, 12. 7                                                                         | B06 I                                        | Class I                                 |



| No. | Latitude and longitude of the stations | Direction/Distance to the proposed plant site of discharge outlet (m) | Functional area                           | Implement standard of GB3097-1997 |
|-----|----------------------------------------|-----------------------------------------------------------------------|-------------------------------------------|-----------------------------------|
| 11# | 21°25.10'N, 109°31.42'E                | SE, 13.0                                                              | GX002DIV<br>Water quality transition zone | Class III                         |
| 12# | 21°22.86'N, 109°31.34'E                | SE, 16.4                                                              | GX001B II                                 | Class II                          |
| 13# | 21°22.30'N, 109°33.17'E                | SW, 16.1                                                              | GX001B II                                 | Class II                          |
| 14# | 21°20'20 N, 109°29'00 E                | SW, 22.5                                                              | A02 I                                     | Class I                           |
| 15# | 21°25'63 N, 109°27'38 E                | SW, 17.0                                                              | GX006B II                                 | Class II                          |

#### 4.2.2 Monitoring Factors and Analytical Method

The 11 indicators of salinity, pH, suspended matter, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand, volatile phenol, inorganic nitrogen, active phosphate, sulfides, petroleum, etc, were determined as the monitoring factors for water quality, with reference to the pollution characteristics of paper-making industry and environment features of the sea waters over proposed region for construction project.

Meteorological parameters as ocean wave height, wind direction and water temperature shall be recorded during the monitoring.

Monitoring on the sea waters shall be carried out in abiding by the relevant provisions in *Norms for Ocean Monitoring* (GB17378.4-1998). For details of analytical methods, see Table 4.2-2.

**Table 4.2-2 Monitoring Factors and Analytical Method for Seawater**

| Item                      |                  | Analytical method/basis                                         | Detection Limit          | Instrument and equipment            |              |           |
|---------------------------|------------------|-----------------------------------------------------------------|--------------------------|-------------------------------------|--------------|-----------|
|                           |                  |                                                                 |                          | Name                                | Type         | No.       |
| pH value                  |                  | Glass electrode (GB/T6920-1986)                                 | 0.1pH                    | Lab pH meter                        | pHSJ—4 A     | 123       |
| Dissolved oxygen          |                  | Iodimetry (GBT17378.4-1998)                                     | ——                       | Burette                             | 50mL         | 1-0400005 |
| Suspended matter          |                  | Gravimetric method (HY003.4-91)                                 | 2                        |                                     |              |           |
| Salinity                  |                  | method of Determining Silver Accurately (GB17378.4-1998)        | 2mg/L                    |                                     |              | 1-0400003 |
| Chemical oxygen demand    |                  | Potassium permanganate method (GB17378.4-1998)                  | 0.5mg/L                  | Burette                             | 50mL         | 1-0400002 |
| Biochemical oxygen demand |                  | Potassium permanganate method (GB17378.4-1998)                  | ——                       |                                     | 50mL         | 1-0400002 |
| Active phosphate          |                  | Phosphor molybdate blue spectrophotometry (GB17378.4-1998)      | ——                       | Ultraviolet spectrophotometer       | UV-mini      | 132       |
| Volatile phenol           |                  | 4-amino Antipyrine Extraction Spectrophotometry (GB7490-87)     | 0.001 mg/L               | Spectrophotometer                   | Modified 722 | 007       |
| Sulfide                   |                  | Methylene blue spectrophotometry (GB17378.4-1998)               | 0.0002 mg/L              | Spectrophotometer                   | Modified 722 | 007       |
| Petroleum                 |                  | Infrared spectrophotometry (GB17378.4-1998)                     | 0.003 mg/L (instrument ) | Infrared spectrometric oil detector | JDS-107 A    | 133       |
| Inorganic nitrogen        | Ammonia-nitrogen | Hypobromite oxidation (GB17378.4-1998)                          | ——                       | Spectrophotometer                   | Modified 722 | 007       |
|                           | Nitrate nitrogen | Cadmium reduction column (GB17378.4-1998)                       | ——                       | Spectrophotometer                   | Modified 722 | 007       |
|                           | Nitrite nitrogen | Naphthaline-ethylene diamine spectrophotometry (GB17378.4-1998) | 0.003mg/L                | Spectrophotometer                   | Modified 722 | 007       |

#### 4.2.3 Monitoring Time and Frequency

#### 4.2.4 Evaluation Method

All monitoring factors shall be evaluated by using the standard index method prescribed in the *Technical Guidelines for Environmental Impact Assessment*, of which the formula shall be:

$$Si,j=Ci,j/Csi$$

Wherein:

$Si,j$ —standard index of pollutant “i” at the monitoring site “j”;

$Ci,j$ —concentration level of pollutant “i” at the monitoring site “j”;

$Csi$ —criteria for sea water of water quality parameter “i”.

Standard index of DO shall be:

$$S_{DO,j} = \frac{|DO_f - DO_j|}{DO_f - DO_s} \quad DO_j \geq DO_s$$

$$S_{DO,j} = 10 - 9 \frac{DO_j}{DO_s} \quad DO_j < DO_s$$

$$DO_s = 468 / (31.6 + T)$$

Wherein:

$S_{DO,j}$ —standard index of dissolved oxygen at the monitoring site “j”;

$DO_f$ —concentration level of saturated dissolved oxygen (mg/L);

$DO_j$ —monitoring value/data of dissolved oxygen at the monitoring site “j” (mg/L);

$DO_s$ —criteria for sea water quality of dissolved oxygen (mg/L);

T—water temperature (°C).

c. Standard index of pH value shall be:

$$S_{pH,j} = \frac{pH_j - 7.0}{pH_{su} - 7.0} \quad pH_j > 7.0$$

$$S_{pH,j} = \frac{7.0 - pH_j}{7.0 - pH_{sd}} \quad pH_j \leq 7.0$$

Wherein:  $pH_j$ -- pH value at the monitoring site “j”;

$pH_{sd}$ —lower limit for pH value as in the required criteria for sea water quality;

$pH_{su}$ —upper limit for pH value as in the required criteria for sea water quality.

Standard index of water quality parameter  $>1$  indicates the water quality parameter has exceeded the limit prescribed in the criteria for sea water quality; the bigger the standard index of water quality parameter goes, the further it goes beyond the prescribed limits in the criteria.

#### 4.2.5 Evaluation Standard

According to GHGH [2007] No. 387 document about Reply Letter to Reconfirmation of the Environmental Impact Report on 900,000 ton Pulp and 900,000 ton Paper and Cardboard Project of Stora Enso (Guangxi) Pulp & Paper Co., Ltd (See Annex 4), the evaluation should be executed for different sea water areas according to GB3097-997 Marine Water Quality Standard. See Table 4.2-4 for the standard value for evaluation.

**Table 4.2-4 Evaluation Standards Unit: mg/L (excluding the pH value)**

| No. | Item                            | Evaluation standards                                                                                      |          |                                                                                                           |                                   |
|-----|---------------------------------|-----------------------------------------------------------------------------------------------------------|----------|-----------------------------------------------------------------------------------------------------------|-----------------------------------|
|     |                                 | Class I                                                                                                   | Class II | Class III                                                                                                 | Class IV                          |
| 1   | Salinity                        | Not listed in the standard                                                                                |          |                                                                                                           |                                   |
| 2   | pH value                        | 7.8~8.5<br>Meanwhile, not exceed the 0.2 pH<br>unit of normal varying range within<br>the sea waters area |          | 6.8~8.8<br>Meanwhile, not exceed the 0.5 pH<br>unit of normal varying range within<br>the sea waters area |                                   |
| 3   | Suspended<br>matter             | Extra dose added by man≤10                                                                                |          | Extra dose<br>added by<br>man≤100                                                                         | Extra dose<br>added by<br>man≤150 |
| 4   | Dissolved<br>oxygen             | >6                                                                                                        | >5       | >4                                                                                                        | >3                                |
| 5   | Chemical<br>oxygen<br>demand    | ≤2                                                                                                        | ≤3       | ≤4                                                                                                        | ≤5                                |
| 6   | Biochemical<br>oxygen<br>demand | ≤1                                                                                                        | ≤3       | ≤4                                                                                                        | ≤5                                |
| 7   | Inorganic<br>nitrogen (as<br>N) | ≤0.20                                                                                                     | ≤0.30    | ≤0.40                                                                                                     | ≤0.50                             |
| 8   | Volatile<br>phenol (as<br>p)    | ≤0.015                                                                                                    | ≤0.030   | ≤0.030                                                                                                    | ≤0.045                            |
| 9   | Petroleum                       | ≤0.05                                                                                                     | ≤0.05    | ≤0.30                                                                                                     | ≤0.50                             |
| 10  | Active<br>phosphate             | ≤0.005                                                                                                    | ≤0.005   | ≤0.010                                                                                                    | ≤0.050                            |
| 11  | Sulfides (as<br>S)              | ≤0.02                                                                                                     | ≤0.05    | ≤0.10                                                                                                     | ≤0.25                             |

#### 4.2.6 Monitoring and Evaluation Results

The investigation and monitoring on current sea water quality had covered the 11 indicators of salinity, pH, suspended matter, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand, volatile phenol, inorganic nitrogen, active phosphate, sulfides, petroleum, etc., of which the salinity is not enlisted in the *Sea Water Quality Standard* (GB3097-1997). Besides, provisions in the *Sea Water Quality Standard* (GB3097-1997) on the required standards for suspended matter had been stressing on the amount of extra dose add by man, with no specification on the limit of concentration level, which proved to be unsuitable for direct evaluation on the monitoring results. Therefore, the results taken of salinity and suspended matter shall be kept as background values, excluded from the list of evaluation items.

For the monitoring results out of the evaluation sea area in details, see Table 4.2-5 to Table 4.2-8; and Table 4.2-9 to Table 4.2-12 for the evaluation results, in which the details are presented respectively as divided into the rising and ebb flows of spring tides and neap tides

##### (1) At rising flows of the spring tide

The nine indicators of pH, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand,

volatile phenol, inorganic nitrogen, active phosphate, sulfides and petroleum at 3<sup>#</sup>, 10<sup>#</sup> and 14<sup>#</sup> sampling stations had all come up to the Class I standard in the *Sea Water Quality Standard* (GB3097-1997).

The nine indicators of pH, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand, volatile phenol, inorganic nitrogen, active phosphate, sulfides and petroleum at 6<sup>#</sup>, 7<sup>#</sup>, 12<sup>#</sup>, 13<sup>#</sup> and 15<sup>#</sup> sampling stations had all met the requirements of Class II standard in the *Sea Water Quality Standard* (GB3097-1997).

The nine indicators of pH, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand, volatile phenol, inorganic nitrogen, active phosphate, sulfides and petroleum at the 1<sup>#</sup>, 2<sup>#</sup>, 5<sup>#</sup>, 8<sup>#</sup>, 9<sup>#</sup> and 11<sup>#</sup> sampling stations had all reached the prescribed criteria for Class III in the *Sea Water Quality Standard* (GB3097-1997).

The nine indicators of pH, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand, volatile phenol, inorganic nitrogen, active phosphate, sulfides and petroleum at the 4<sup>#</sup> sampling station had all reached the prescribed criteria for Class IV in the *Sea Water Quality Standard* (GB3097-1997).

#### (2) At ebb flows of the spring tide

The nine indicators of pH, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand, volatile phenol, inorganic nitrogen, active phosphate, sulfides and petroleum at 3<sup>#</sup>, 10<sup>#</sup>, and 14<sup>#</sup> sampling stations had all come up to the required Class I standard in *Sea Water Quality Standard* (GB3097-1997).

The nine indicators of pH, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand, volatile phenol, inorganic nitrogen, active phosphate, sulfides and petroleum at the 6<sup>#</sup>, 7<sup>#</sup>, 12<sup>#</sup>, 13<sup>#</sup> and 15<sup>#</sup> sampling stations had all met the requirements of Class II standard in *Sea Water Quality Standard* (GB3097-1997).

The nine indicators of pH, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand, volatile phenol, inorganic nitrogen, active phosphate, sulfides and petroleum at the 1<sup>#</sup>, 2<sup>#</sup>, 5<sup>#</sup>, 8<sup>#</sup>, 9<sup>#</sup> and 11<sup>#</sup> sampling stations had all reached the Class III standard prescribed in the *Sea Water Quality Standard* (GB3097-1997).

The nine indicators of pH, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand, volatile phenol, inorganic nitrogen, active phosphate, sulfides and petroleum at the 4<sup>#</sup> sampling station had all reached the Class IV standard prescribed in the *Sea Water Quality Standard* (GB3097-1997).

#### (3) At rising flows of the neap tide

The nine indicators of pH, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand, volatile phenol, inorganic nitrogen, active phosphate, sulfides and petroleum at 3<sup>#</sup>, 10<sup>#</sup>, and 14<sup>#</sup> sampling stations had all come up to the required Class I standard in *Sea Water Quality Standard* (GB3097-1997).

The nine indicators of pH, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand, volatile phenol, inorganic nitrogen, active phosphate, sulfides and petroleum at the 6<sup>#</sup>, 7<sup>#</sup>, 12<sup>#</sup>, 13<sup>#</sup> and 15<sup>#</sup> sampling stations had all met the requirements of Class II standard in the *Sea Water Quality Standard* (GB3097-1997).

The nine indicators of pH, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand, volatile phenol, inorganic nitrogen, active phosphate, sulfides and petroleum at the 1<sup>#</sup>, 2<sup>#</sup>, 5<sup>#</sup>, 8<sup>#</sup>, 9<sup>#</sup> and 11<sup>#</sup> sampling stations had all reached the prescribed criteria for Class III in *Sea Water Quality Standard* (GB3097-1997).

The nine indicators of pH, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand, volatile phenol, inorganic nitrogen, active phosphate, sulfides and petroleum at the 4<sup>#</sup> sampling station had all reached the prescribed criteria for Class III in *Sea Water Quality Standard* (GB3097-1997).

(4) At ebb flows of the neap tide

The nine indicators of pH, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand, volatile phenol, inorganic nitrogen, active phosphate, sulfides and petroleum at 3<sup>#</sup>, 10<sup>#</sup>, and 14<sup>#</sup> sampling stations had all come up to the required Class I standard in *Sea Water Quality Standard* (GB3097-1997).

The nine indicators of pH, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand, volatile phenol, inorganic nitrogen, active phosphate, sulfides and petroleum at the 6<sup>#</sup>, 7<sup>#</sup>, 12<sup>#</sup>, 13<sup>#</sup> and 15<sup>#</sup> sampling stations had all met the requirements of Class II standard in the *Sea Water Quality Standard* (GB3097-1997).

The nine indicators of pH, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand, volatile phenol, inorganic nitrogen, active phosphate, sulfides and petroleum at the 1<sup>#</sup>, 2<sup>#</sup>, 5<sup>#</sup>, 8<sup>#</sup>, 9<sup>#</sup> and 11<sup>#</sup> sampling stations had all reached Class III standard prescribed in the *Sea Water Quality Standard* (GB3097-1997).

The nine indicators of pH, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand, volatile phenol, inorganic nitrogen, active phosphate, sulfides and petroleum at the 4<sup>#</sup> sampling stations had all reached Class IV standard prescribed in the *Sea Water Quality Standard* (GB3097-1997).

**Table 4.2-5 Monitoring and Statistical Results on Spring Tides at Rising Flows in Offshore Sea Areas**

**Unit: mg/L (excluding pH and salinity)**

| Sampling station | Statistical item       | Salinity | pH value | SS | DO   | Chemical oxygen demand | Biochemical oxygen demand | Inorganic nitrogen | Active phosphate | Petroleum | Volatile phenol | Sulfides |
|------------------|------------------------|----------|----------|----|------|------------------------|---------------------------|--------------------|------------------|-----------|-----------------|----------|
| 1#               | Mar. 28 <sup>th</sup>  | 33.1     | 7.8      | 10 | 7.49 | 1.26                   | 0.63                      | 0.186              | 0.01             | 0.035     | 0.001L          | 0.0005   |
|                  | Mar. 29 <sup>th</sup>  | 32.6     | 7.8      | 4L | 7.34 | 1.34                   | 0.60                      | 0.196              | 0.01L            | 0.045     | 0.001L          | 0.0006   |
|                  | Mar. 30 <sup>th</sup>  | 32.8     | 7.9      | 5  | 7.23 | 1.34                   | 0.63                      | 0.172              | 0.01L            | 0.043     | 0.001L          | 0.0007   |
|                  | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 2#               | Mar. 28 <sup>th</sup>  | 32.6     | 7.9      | 4L | 7.05 | 1.44                   | 0.59                      | 0.153              | 0.01L            | 0.045     | 0.001L          | 0.0006   |
|                  | Mar. 29 <sup>th</sup>  | 33.1     | 8.0      | 10 | 7.23 | 1.25                   | 0.66                      | 0.156              | 0.01L            | 0.042     | 0.001L          | 0.0007   |
|                  | Mar. 30 <sup>th</sup>  | 32.7     | 7.9      | 9  | 7.10 | 1.26                   | 0.61                      | 0.148              | 0.01L            | 0.036     | 0.001L          | 0.0006   |
|                  | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 3#               | Mar. 28 <sup>th</sup>  | 34.3     | 7.9      | 4L | 7.34 | 1.28                   | 0.54                      | 0.158              | 0.01             | 0.043     | 0.001L          | 0.0005   |
|                  | Mar. 29 <sup>th</sup>  | 32.5     | 7.8      | 4  | 7.46 | 1.06                   | 0.57                      | 0.18               | 0.01L            | 0.034     | 0.001L          | 0.0006   |
|                  | Mar. 30 <sup>th</sup>  | 33.0     | 7.8      | 5  | 7.24 | 1.26                   | 0.49                      | 0.164              | 0.01L            | 0.044     | 0.001L          | 0.0008   |
|                  | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 4#               | Mar. 28 <sup>th</sup>  | 32.4     | 7.8      | 4L | 7.43 | 1.46                   | 0.62                      | 0.158              | 0.01L            | 0.038     | 0.001L          | 0.0007   |
|                  | Mar. 29 <sup>th</sup>  | 33.1     | 8.0      | 8  | 7.36 | 1.38                   | 0.52                      | 0.157              | 0.01             | 0.038     | 0.001L          | 0.0007   |
|                  | Mar. 30 <sup>th</sup>  | 32.5     | 7.8      | 4L | 7.49 | 1.28                   | 0.66                      | 0.135              | 0.01L            | 0.034     | 0.001L          | 0.0006   |
|                  | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 5#               | Mar. 28 <sup>th</sup>  | 32.4     | 8.0      | 5  | 7.12 | 1.26                   | 0.57                      | 0.164              | 0.01             | 0.04      | 0.001L          | 0.0008   |
|                  | Mar. 29 <sup>th</sup>  | 32.3     | 7.9      | 5  | 7.32 | 1.23                   | 0.60                      | 0.182              | 0.01L            | 0.044     | 0.001L          | 0.0007   |
|                  | Mar. 30 <sup>th</sup>  | 34.6     | 7.9      | 12 | 7.15 | 1.37                   | 0.61                      | 0.175              | 0.01L            | 0.033     | 0.001L          | 0.0006   |
|                  | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 6#               | Mar. 28 <sup>th</sup>  | 32.8     | 8.0      | 5  | 7.49 | 1.4                    | 0.59                      | 0.17               | 0.01L            | 0.037     | 0.001L          | 0.0007   |
|                  | Mar. 29 <sup>th</sup>  | 33.5     | 7.9      | 4  | 7.34 | 1.37                   | 0.61                      | 0.165              | 0.01L            | 0.036     | 0.001L          | 0.0007   |
|                  | Mar. 30 <sup>th</sup>  | 32.7     | 7.8      | 5  | 7.02 | 1.19                   | 0.61                      | 0.181              | 0.01             | 0.043     | 0.001L          | 0.0005   |
|                  | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 7#               | Mar. 28 <sup>th</sup>  | 32.3     | 7.9      | 4  | 7.29 | 1.56                   | 0.52                      | 0.148              | 0.01L            | 0.04      | 0.001L          | 0.0006   |
|                  | Mar. 29 <sup>th</sup>  | 34.6     | 7.9      | 5  | 7.16 | 1.37                   | 0.65                      | 0.172              | 0.01L            | 0.036     | 0.001L          | 0.0008   |
|                  | Mar. 30 <sup>th</sup>  | 33.2     | 8.0      | 8  | 7.02 | 1.22                   | 0.56                      | 0.168              | 0.01L            | 0.043     | 0.001L          | 0.0006   |
|                  | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 8#               | Mar. 28 <sup>th</sup>  | 32.5     | 7.8      | 6  | 7.02 | 1.06                   | 0.66                      | 0.152              | 0.01L            | 0.044     | 0.001L          | 0.0005   |
|                  | Mar. 29 <sup>th</sup>  | 32.9     | 7.8      | 4  | 7.48 | 1.26                   | 0.56                      | 0.179              | 0.01L            | 0.034     | 0.001L          | 0.0006   |
|                  | Mar. 30 <sup>th</sup>  | 33.5     | 7.8      | 5  | 7.29 | 1.23                   | 0.64                      | 0.173              | 0.01             | 0.044     | 0.001L          | 0.0008   |
|                  | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 9#               | Mar. 28 <sup>th</sup>  | 32.8     | 7.9      | 4L | 7.34 | 1.54                   | 0.53                      | 0.172              | 0.01L            | 0.036     | 0.001L          | 0.0005   |
|                  | Mar. 29 <sup>th</sup>  | 32.9     | 8.0      | 6  | 7.39 | 1.34                   | 0.50                      | 0.182              | 0.01L            | 0.038     | 0.001L          | 0.0007   |
|                  | Mar. 30 <sup>th</sup>  | 33.5     | 7.9      | 4L | 7.26 | 1.34                   | 0.51                      | 0.164              | 0.01L            | 0.037     | 0.001L          | 0.0006   |
|                  | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 10#              | Mar. 28 <sup>th</sup>  | 32.8     | 7.8      | 4L | 7.34 | 1.34                   | 0.50                      | 0.158              | 0.01L            | 0.033     | 0.001L          | 0.0007   |
|                  | Mar. 29 <sup>th</sup>  | 33.5     | 8.0      | 4L | 7.02 | 1.34                   | 0.46                      | 0.182              | 0.01L            | 0.039     | 0.001L          | 0.0007   |
|                  | Mar. 30 <sup>th</sup>  | 32.7     | 7.8      | 8  | 7.34 | 1.34                   | 0.53                      | 0.176              | 0.01L            | 0.045     | 0.001L          | 0.0008   |
|                  | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 11#              | Mar. 28 <sup>th</sup>  | 32.5     | 8.0      | 8  | 7.02 | 1.06                   | 0.53                      | 0.186              | 0.01L            | 0.042     | 0.001L          | 0.0006   |
|                  | Mar. 29 <sup>th</sup>  | 33.0     | 7.8      | 4L | 7.39 | 1.26                   | 0.50                      | 0.146              | 0.01L            | 0.037     | 0.001L          | 0.0005   |
|                  | Mar. 30 <sup>th</sup>  | 31.9     | 8.0      | 6  | 7.26 | 1.23                   | 0.51                      | 0.156              | 0.01L            | 0.033     | 0.001L          | 0.0007   |
|                  | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |

| Sampling station | Statistical item       | Salinity | pH value | SS | DO   | Chemical oxygen demand | Biochemical oxygen demand | Inorganic nitrogen | Active phosphate | Petroleum | Volatile phenol | Sulfides |
|------------------|------------------------|----------|----------|----|------|------------------------|---------------------------|--------------------|------------------|-----------|-----------------|----------|
| 12#              | Mar. 28 <sup>th</sup>  | 32.3     | 7.8      | 5  | 7.49 | 1.34                   | 0.50                      | 0.182              | 0.01L            | 0.045     | 0.001L          | 0.0008   |
|                  | Mar. 29 <sup>th</sup>  | 34.6     | 7.9      | 4L | 7.34 | 1.34                   | 0.42                      | 0.175              | 0.01L            | 0.041     | 0.001L          | 0.0006   |
|                  | Mar. 30 <sup>th</sup>  | 33.2     | 7.9      | 8  | 7.28 | 1.54                   | 0.50                      | 0.164              | 0.01L            | 0.03      | 0.001L          | 0.0008   |
|                  | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 13#              | Mar. 28 <sup>th</sup>  | 32.5     | 7.9      | 10 | 7.34 | 1.34                   | 0.43                      | 0.142              | 0.01L            | 0.041     | 0.001L          | 0.0005   |
|                  | Mar. 29 <sup>th</sup>  | 33.0     | 8.0      | 4L | 7.49 | 1.34                   | 0.50                      | 0.197              | 0.01L            | 0.03      | 0.001L          | 0.0006   |
|                  | Mar. 30 <sup>th</sup>  | 31.9     | 7.8      | 5  | 7.02 | 1.26                   | 0.51                      | 0.172              | 0.01L            | 0.03      | 0.001L          | 0.0008   |
|                  | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 14#              | Mar. 28 <sup>th</sup>  | 31.0     | 8.0      | 4L | 7.26 | 0.87                   | 0.52                      | 0.151              | 0.01             | 0.027     | 0.003           | 0.0005   |
|                  | Mar. 29 <sup>th</sup>  | 30.0     | 7.8      | 6  | 7.34 | 1.10                   | 0.50                      | 0.109              | 0.01             | 0.025     | 0.003           | 0.0002L  |
|                  | Mar. 30 <sup>th</sup>  | 33.0     | 7.9      | 4  | 7.48 | 1.10                   | 0.49                      | 0.108              | 0.01             | 0.026     | 0.003           | 0.0005   |
|                  | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 15#              | Mar. 28 <sup>th</sup>  | 31.0     | 7.9      | 4  | 7.27 | 0.85                   | 0.52                      | 0.110              | 0.01             | 0.029     | 0.003           | 0.0008   |
|                  | Mar. 29 <sup>th</sup>  | 31.0     | 7.9      | 8  | 7.39 | 1.00                   | 0.42                      | 0.110              | 0.01             | 0.028     | 0.003           | 0.0001   |
|                  | Mar. 30 <sup>th</sup>  | 27.0     | 7.9      | 4L | 7.33 | 1.20                   | 0.43                      | 0.126              | 0.01             | 0.025     | 0.003           | 0.0002L  |
|                  | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |

Notes: L stands for not detected (the same below).

**Table 4.2-6 Monitoring and Statistical Results on Spring Tides at Ebb Flows in Offshore Sea Areas**  
Unit: mg/L (except for pH and salinity)

| Sampling station | Statistical item       | Salinity | pH value | SS | DO   | Chemical oxygen demand | Biochemical oxygen demand | Inorganic nitrogen | Active phosphate | Petroleum | Volatile phenol | Sulfides |
|------------------|------------------------|----------|----------|----|------|------------------------|---------------------------|--------------------|------------------|-----------|-----------------|----------|
| 1#               | Mar. 28 <sup>th</sup>  | 33.4     | 7.9      | 11 | 7.02 | 1.54                   | 0.63                      | 0.179              | 0.01L            | 0.030     | 0.001L          | 0.0006   |
|                  | Mar. 29 <sup>th</sup>  | 31.9     | 7.9      | 4L | 7.21 | 1.06                   | 0.68                      | 0.178              | 0.01L            | 0.040     | 0.001L          | 0.0008   |
|                  | Mar. 30 <sup>th</sup>  | 32.3     | 8.0      | 7  | 7.28 | 1.26                   | 0.63                      | 0.176              | 0.01L            | 0.035     | 0.001L          | 0.0006   |
|                  | Over-standard rate (%) | --       | 0        | -  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 2#               | Mar. 28 <sup>th</sup>  | 32.3     | 7.8      | 9  | 7.15 | 1.29                   | 0.59                      | 0.172              | 0.01L            | 0.034     | 0.001L          | 0.0005   |
|                  | Mar. 29 <sup>th</sup>  | 34.2     | 7.8      | 5  | 7.34 | 1.34                   | 0.62                      | 0.17               | 0.01             | 0.038     | 0.001L          | 0.0008   |
|                  | Mar. 30 <sup>th</sup>  | 32.4     | 7.8      | 8  | 7.06 | 1.54                   | 0.67                      | 0.144              | 0.01L            | 0.034     | 0.001L          | 0.0007   |
|                  | Over-standard rate (%) | --       | 0        | -  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 3#               | Mar. 28 <sup>th</sup>  | 33.7     | 7.9      | 6  | 7.02 | 1.19                   | 0.52                      | 0.135              | 0.01             | 0.036     | 0.001L          | 0.0009   |
|                  | Mar. 29 <sup>th</sup>  | 34.2     | 7.9      | 4L | 7.43 | 1.34                   | 0.47                      | 0.136              | 0.01L            | 0.042     | 0.001L          | 0.0007   |
|                  | Mar. 30 <sup>th</sup>  | 32.6     | 7.9      | 6  | 7.36 | 1.54                   | 0.49                      | 0.152              | 0.01L            | 0.036     | 0.001L          | 0.0005   |
|                  | Over-standard rate (%) | --       | 0        | -  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 4#               | Mar. 28 <sup>th</sup>  | 33.0     | 7.9      | 4L | 7.24 | 1.4                    | 0.67                      | 0.141              | 0.01L            | 0.039     | 0.001L          | 0.0005   |
|                  | Mar. 29 <sup>th</sup>  | 32.8     | 7.8      | 4L | 7.02 | 1.37                   | 0.62                      | 0.162              | 0.01L            | 0.036     | 0.001L          | 0.0008   |
|                  | Mar. 30 <sup>th</sup>  | 32.5     | 7.9      | 6  | 7.46 | 1.19                   | 0.66                      | 0.182              | 0.01L            | 0.042     | 0.001L          | 0.0007   |



| Sampling station | Statistical item       | Salinity | pH value | SS | DO   | Chemical oxygen demand | Biochemical oxygen demand | Inorganic nitrogen | Active phosphate | Petroleum | Volatile phenol | Sulfides |
|------------------|------------------------|----------|----------|----|------|------------------------|---------------------------|--------------------|------------------|-----------|-----------------|----------|
|                  | Over-standard rate (%) | --       | 0        | -  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 5#               | Mar. 28 <sup>th</sup>  | 33.0     | 7.9      | 4L | 7.02 | 1.29                   | 0.67                      | 0.152              | 0.01L            | 0.03      | 0.001L          | 0.0005   |
|                  | Mar. 29 <sup>th</sup>  | 33.4     | 7.8      | 13 | 7.05 | 1.34                   | 0.66                      | 0.161              | 0.01L            | 0.035     | 0.001L          | 0.0008   |
|                  | Mar. 30 <sup>th</sup>  | 33.9     | 7.8      | 4L | 7.23 | 1.54                   | 0.61                      | 0.153              | 0.01L            | 0.032     | 0.001L          | 0.0007   |
|                  | Over-standard rate (%) | --       | 0        | -  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 6#               | Mar. 28 <sup>th</sup>  | 33.4     | 7.8      | 5  | 7.26 | 1.38                   | 0.59                      | 0.142              | 0.01L            | 0.045     | 0.001L          | 0.0008   |
|                  | Mar. 29 <sup>th</sup>  | 33.2     | 8.0      | 4L | 7.49 | 1.28                   | 0.66                      | 0.146              | 0.01L            | 0.037     | 0.001L          | 0.0008   |
|                  | Mar. 30 <sup>th</sup>  | 31.9     | 7.8      | 6  | 7.34 | 1.06                   | 0.61                      | 0.154              | 0.01L            | 0.036     | 0.001L          | 0.0008   |
|                  | Over-standard rate (%) | --       | 0        | -  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 7#               | Mar. 28 <sup>th</sup>  | 33.4     | 7.8      | 4L | 7.08 | 1.34                   | 0.52                      | 0.174              | 0.01L            | 0.04      | 0.001L          | 0.0007   |
|                  | Mar. 29 <sup>th</sup>  | 33.9     | 7.8      | 6  | 7.18 | 1.54                   | 0.55                      | 0.18               | 0.01L            | 0.037     | 0.001L          | 0.0007   |
|                  | Mar. 30 <sup>th</sup>  | 32.6     | 7.8      | 4L | 7.34 | 1.35                   | 0.54                      | 0.166              | 0.01             | 0.036     | 0.001L          | 0.0008   |
|                  | Over-standard rate (%) | --       | 0        | -  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 8#               | Mar. 28 <sup>th</sup>  | 33.7     | 7.9      | 6  | 7.49 | 1.34                   | 0.66                      | 0.172              | 0.01L            | 0.041     | 0.001L          | 0.0008   |
|                  | Mar. 29 <sup>th</sup>  | 32.5     | 8.0      | 4L | 7.37 | 1.54                   | 0.63                      | 0.168              | 0.01L            | 0.042     | 0.001L          | 0.0007   |
|                  | Mar. 30 <sup>th</sup>  | 33.2     | 7.9      | 6  | 7.08 | 1.23                   | 0.64                      | 0.162              | 0.01L            | 0.036     | 0.001L          | 0.0005   |
|                  | Over-standard rate (%) | --       | 0        | -  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 9#               | Mar. 28 <sup>th</sup>  | 33.7     | 7.8      | 5  | 7.34 | 1.23                   | 0.53                      | 0.153              | 0.01L            | 0.033     | 0.001L          | 0.0007   |
|                  | Mar. 29 <sup>th</sup>  | 32.5     | 7.8      | 8  | 7.49 | 1.06                   | 0.56                      | 0.173              | 0.01L            | 0.039     | 0.001L          | 0.0005   |
|                  | Mar. 30 <sup>th</sup>  | 33.2     | 7.8      | 6  | 7.34 | 1.26                   | 0.48                      | 0.159              | 0.01             | 0.045     | 0.001L          | 0.0008   |
|                  | Over-standard rate (%) | --       | 0        | -  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 10#              | Mar. 28 <sup>th</sup>  | 33.4     | 7.9      | 4L | 7.49 | 1.23                   | 0.50                      | 0.178              | 0.01L            | 0.035     | 0.001L          | 0.0005   |
|                  | Mar. 29 <sup>th</sup>  | 33.2     | 7.8      | 6  | 7.34 | 1.06                   | 0.46                      | 0.173              | 0.01             | 0.037     | 0.001L          | 0.0006   |
|                  | Mar. 30 <sup>th</sup>  | 31.9     | 7.9      | 4L | 7.39 | 1.34                   | 0.54                      | 0.177              | 0.01             | 0.04      | 0.001L          | 0.0005   |
|                  | Over-standard rate (%) | --       | 0        | -  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 11#              | Mar. 28 <sup>th</sup>  | 34.2     | 8        | 4L | 7.34 | 1.34                   | 0.53                      | 0.172              | 0.01L            | 0.036     | 0.001L          | 0.0008   |
|                  | Mar. 29 <sup>th</sup>  | 32.6     | 7.9      | 5  | 7.49 | 1.54                   | 0.56                      | 0.165              | 0.01             | 0.043     | 0.001L          | 0.0008   |
|                  | Mar. 30 <sup>th</sup>  | 32.0     | 7.8      | 4L | 7.34 | 1.34                   | 0.59                      | 0.157              | 0.01             | 0.033     | 0.001L          | 0.0006   |
|                  | Over-standard rate (%) | --       | 0        | -  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 12#              | Mar. 28 <sup>th</sup>  | 33.4     | 8.0      | 5  | 7.02 | 1.06                   | 0.50                      | 0.173              | 0.01L            | 0.04      | 0.001L          | 0.0005   |
|                  | Mar. 29 <sup>th</sup>  | 33.9     | 8.0      | 6  | 7.34 | 1.26                   | 0.46                      | 0.178              | 0.01L            | 0.035     | 0.001L          | 0.0007   |
|                  | Mar. 30 <sup>th</sup>  | 32.6     | 7.8      | 4L | 7.46 | 1.55                   | 0.42                      | 0.157              | 0.01             | 0.045     | 0.001L          | 0.0005   |
|                  | Over-standard rate (%) | --       | 0        | -  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 13#              | Mar. 28 <sup>th</sup>  | 34.2     | 7.9      | 11 | 7.39 | 1.06                   | 0.46                      | 0.158              | 0.01L            | 0.035     | 0.001L          | 0.0007   |
|                  | Mar. 29 <sup>th</sup>  | 32.6     | 8.0      | 4L | 7.49 | 1.34                   | 0.50                      | 0.186              | 0.01             | 0.035     | 0.001L          | 0.0007   |
|                  | Mar. 30 <sup>th</sup>  | 32.0     | 7.9      | 7  | 7.34 | 1.54                   | 0.52                      | 0.176              | 0.01             | 0.045     | 0.001L          | 0.0005   |
|                  | Over-standard rate (%) | --       | 0        | -  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 14#              | Mar. 28 <sup>th</sup>  | 30.3     | 8.0      | 4  | 7.22 | 0.73                   | 0.46                      | 0.097              | 0.01             | 0.034     | 0.003           | 0.0001   |
|                  | Mar. 29 <sup>th</sup>  | 33.0     | 7.9      | 6  | 7.46 | 1.00                   | 0.49                      | 0.093              | 0.01             | 0.036     | 0.003           | 0.0008   |

| Sampling station | Statistical item       | Salinity | pH value | SS | DO   | Chemical oxygen demand | Biochemical oxygen demand | Inorganic nitrogen | Active phosphate | Petroleum | Volatile phenol | Sulfides |
|------------------|------------------------|----------|----------|----|------|------------------------|---------------------------|--------------------|------------------|-----------|-----------------|----------|
|                  | Mar. 30 <sup>th</sup>  | 31.0     | 8.0      | 8  | 7.30 | 1.00                   | 0.50                      | 0.108              | 0.01             | 0.031     | 0.003           | 0.0008   |
|                  | Over-standard rate (%) | --       | 0        | -  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 15#              | Mar. 28 <sup>th</sup>  | 33       | 7.9      | 4L | 7.20 | 0.69                   | 0.42                      | 0.115              | 0.01             | 0.031     | 0.003           | 0.0008   |
|                  | Mar. 29 <sup>th</sup>  | 29       | 8.0      | 4L | 7.31 | 0.69                   | 0.43                      | 0.115              | 0.01             | 0.031     | 0.003           | 0.0008   |
|                  | Mar. 30 <sup>th</sup>  | 29.3     | 8.0      | 6  | 7.28 | 1.00                   | 0.43                      | 0.115              | 0.01             | 0.031     | 0.003           | 0.0008   |
|                  | Over-standard rate (%) | --       | 0        | -  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
|                  |                        |          |          |    |      |                        |                           |                    |                  |           |                 |          |

**Table 4.2-7 Monitoring and Statistical Results on Neap Tides at Rising Flows in Offshore Sea Areas**  
**Unit: mg/L (excluding pH and salinity)**

| Sampling station | Statistical item       | Salinity | pH value | SS  | DO   | Chemical oxygen demand | Biochemical oxygen demand | Inorganic nitrogen | Active phosphate | Petroleum | Volatile phenol | Sulfides |
|------------------|------------------------|----------|----------|-----|------|------------------------|---------------------------|--------------------|------------------|-----------|-----------------|----------|
| 1#               | May 8 <sup>th</sup>    | 33.2     | 8.0      | 7   | 7.25 | 1.54                   | 0.68                      | 0.163              | 0.01             | 0.03      | 0.001L          | 0.0005   |
|                  | May 9 <sup>th</sup>    | 33.0     | 7.9      | 4 L | 7.34 | 1.34                   | 0.65                      | 0.146              | 0.01             | 0.04      | 0.001L          | 0.0005   |
|                  | May 10 <sup>th</sup>   | 32.5     | 7.8      | 4 L | 7.28 | 1.26                   | 0.63                      | 0.158              | 0.01L            | 0.039     | 0.001L          | 0.0007   |
|                  | Over-standard rate (%) | --       | 0        | --  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 2#               | May 8 <sup>th</sup>    | 33.0     | 7.9      | 4 L | 7.02 | 1.23                   | 0.60                      | 0.159              | 0.01L            | 0.042     | 0.001L          | 0.0008   |
|                  | May 9 <sup>th</sup>    | 32.8     | 7.9      | 6   | 7.46 | 1.37                   | 0.62                      | 0.153              | 0.01L            | 0.036     | 0.001L          | 0.0007   |
|                  | May 10 <sup>th</sup>   | 34.1     | 8.0      | 1 2 | 7.02 | 1.22                   | 0.66                      | 0.172              | 0.01L            | 0.03      | 0.001L          | 0.0005   |
|                  | Over-standard rate (%) | --       | 0        | --  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 3#               | May 8 <sup>th</sup>    | 31.9     | 7.8      | 8   | 7.02 | 1.23                   | 0.52                      | 0.146              | 0.01             | 0.037     | 0.001L          | 0.0008   |
|                  | May 9 <sup>th</sup>    | 33.1     | 7.9      | 4 L | 7.46 | 1.06                   | 0.46                      | 0.159              | 0.01             | 0.036     | 0.001L          | 0.0009   |
|                  | May 10 <sup>th</sup>   | 31.9     | 8.0      | 4   | 7.24 | 1.26                   | 0.50                      | 0.172              | 0.01L            | 0.030     | 0.001L          | 0.0008   |
|                  | Over-standard rate (%) | --       | 0        | --  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 4#               | May 8 <sup>th</sup>    | 34.1     | 7.8      | 8   | 7.02 | 1.06                   | 0.68                      | 0.164              | 0.01L            | 0.044     | 0.001L          | 0.0008   |
|                  | May 9 <sup>th</sup>    | 32.4     | 7.8      | 4 L | 7.41 | 1.26                   | 0.64                      | 0.172              | 0.01             | 0.040     | 0.001L          | 0.0007   |
|                  | May 10 <sup>th</sup>   | 33.1     | 7.9      | 4 L | 7.26 | 1.23                   | 0.66                      | 0.192              | 0.01             | 0.039     | 0.001L          | 0.0005   |
|                  | Over-standard rate (%) | --       | 0        | --  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 5#               | May 8 <sup>th</sup>    | 33.2     | 7.9      | 6   | 7.34 | 1.22                   | 0.66                      | 0.169              | 0.01             | 0.036     | 0.001L          | 0.0008   |
|                  | May 9 <sup>th</sup>    | 32.8     | 8.0      | 4 L | 7.06 | 1.46                   | 0.68                      | 0.178              | 0.01             | 0.042     | 0.001L          | 0.0007   |
|                  | May 10 <sup>th</sup>   | 33.0     | 7.8      | 6   | 7.49 | 1.38                   | 0.63                      | 0.162              | 0.01             | 0.036     | 0.001L          | 0.0005   |
|                  | Over-standard rate (%) | --       | 0        | --  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 6#               | May 8 <sup>th</sup>    | 33.5     | 7.9      | 8   | 7.39 | 1.34                   | 0.63                      | 0.17               | 0.01             | 0.033     | 0.001L          | 0.0005   |
|                  | May 9 <sup>th</sup>    | 32.9     | 7.9      | 4 L | 7.26 | 1.54                   | 0.66                      | 0.166              | 0.01L            | 0.039     | 0.001L          | 0.0006   |
|                  | May 10 <sup>th</sup>   | 32.8     | 7.9      | 8   | 7.49 | 1.34                   | 0.69                      | 0.156              | 0.01L            | 0.045     | 0.001L          | 0.0008   |
|                  | Over-standard rate (%) | --       | 0        | --  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 7#               | May 8 <sup>th</sup>    | 32.8     | 7.9      | 4 L | 7.34 | 1.48                   | 0.51                      | 0.156              | 0.01L            | 0.033     | 0.001L          | 0.0007   |
|                  | May 9 <sup>th</sup>    | 33.0     | 7.9      | 6   | 7.49 | 1.38                   | 0.54                      | 0.163              | 0.01L            | 0.039     | 0.001L          | 0.0008   |
|                  | May 10 <sup>th</sup>   | 34.3     | 7.9      | 4 L | 7.34 | 1.28                   | 0.56                      | 0.178              | 0.01L            | 0.045     | 0.001L          | 0.0006   |
|                  | Over-standard          | --       | 0        | --  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |

| Sampling station | Statistical item       | Salinity | pH value | SS  | DO   | Chemical oxygen demand | Biochemical oxygen demand | Inorganic nitrogen | Active phosphate | Petroleum | Volatile phenol | Sulfides |
|------------------|------------------------|----------|----------|-----|------|------------------------|---------------------------|--------------------|------------------|-----------|-----------------|----------|
|                  | rate (%)               |          |          |     |      |                        |                           |                    |                  |           |                 |          |
| 8#               | May 8 <sup>th</sup>    | 32.7     | 7.8      | 8   | 7.16 | 1.34                   | 0.66                      | 0.144              | 0.01             | 0.037     | 0.001L          | 0.0008   |
|                  | May 9 <sup>th</sup>    | 33.5     | 7.8      | 4 L | 7.02 | 1.54                   | 0.66                      | 0.152              | 0.01             | 0.036     | 0.001L          | 0.0009   |
|                  | May 10 <sup>th</sup>   | 32.9     | 7.9      | 4 L | 7.34 | 1.35                   | 0.63                      | 0.148              | 0.01             | 0.038     | 0.001L          | 0.0007   |
|                  | Over-standard rate (%) | --       | 0        | --  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 9#               | May 8 <sup>th</sup>    | 32.7     | 7.9      | 8   | 7.49 | 1.54                   | 0.56                      | 0.172              | 0.01L            | 0.04      | 0.001L          | 0.0005   |
|                  | May 9 <sup>th</sup>    | 33.5     | 7.9      | 4 L | 7.34 | 1.69                   | 0.53                      | 0.163              | 0.01L            | 0.036     | 0.001L          | 0.0007   |
|                  | May 10 <sup>th</sup>   | 32.9     | 8.0      | 6   | 7.49 | 1.34                   | 0.48                      | 0.146              | 0.01L            | 0.043     | 0.001L          | 0.0005   |
|                  | Over-standard rate (%) | --       | 0        | --  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 10#              | May 8 <sup>th</sup>    | 33.5     | 7.8      | 4 L | 7.49 | 1.26                   | 0.52                      | 0.164              | 0.01L            | 0.041     | 0.001L          | 0.0008   |
|                  | May 9 <sup>th</sup>    | 32.9     | 7.8      | 6   | 7.02 | 1.55                   | 0.49                      | 0.177              | 0.01L            | 0.03      | 0.001L          | 0.0008   |
|                  | May 10 <sup>th</sup>   | 33.7     | 7.8      | 4 L | 7.34 | 1.06                   | 0.50                      | 0.148              | 0.01L            | 0.04      | 0.001L          | 0.0008   |
|                  | Over-standard rate (%) | --       | 0        | --  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 11#              | May 8 <sup>th</sup>    | 33.1     | 7.8      | 5   | 7.49 | 1.06                   | 0.53                      | 0.159              | 0.01L            | 0.038     | 0.001L          | 0.0008   |
|                  | May 9 <sup>th</sup>    | 31.9     | 7.8      | 8   | 7.34 | 1.26                   | 0.54                      | 0.175              | 0.01             | 0.037     | 0.001L          | 0.0008   |
|                  | May 10 <sup>th</sup>   | 33.0     | 7.8      | 6   | 7.39 | 1.55                   | 0.56                      | 0.146              | 0.01L            | 0.04      | 0.001L          | 0.0008   |
|                  | Over-standard rate (%) | --       | 0        | --  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 12#              | May 8 <sup>th</sup>    | 32.8     | 8.0      | 4 L | 7.49 | 1.69                   | 0.50                      | 0.177              | 0.01L            | 0.04      | 0.001L          | 0.0008   |
|                  | May 9 <sup>th</sup>    | 33.0     | 7.9      | 5   | 7.34 | 1.34                   | 0.47                      | 0.176              | 0.01L            | 0.035     | 0.001L          | 0.0008   |
|                  | May 10 <sup>th</sup>   | 34.3     | 7.9      | 6   | 7.02 | 1.54                   | 0.45                      | 0.154              | 0.01L            | 0.043     | 0.001L          | 0.0008   |
|                  | Over-standard rate (%) | --       | 0        | --  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 13#              | May 8 <sup>th</sup>    | 33.1     | 8.0      | 7   | 7.21 | 1.34                   | 0.48                      | 0.163              | 0.01L            | 0.04      | 0.001L          | 0.0008   |
|                  | May 9 <sup>th</sup>    | 31.9     | 7.8      | 1 1 | 7.28 | 1.34                   | 0.50                      | 0.146              | 0.01             | 0.035     | 0.001L          | 0.0008   |
|                  | May 10 <sup>th</sup>   | 33.9     | 7.8      | 4 L | 7.06 | 1.54                   | 0.50                      | 0.158              | 0.01L            | 0.043     | 0.001L          | 0.0008   |
|                  | Over-standard rate (%) | --       | 0        | --  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 14#              | May 8 <sup>th</sup>    | 32.0     | 8.0      | 4 L | 7.47 | 0.33                   | 0.49                      | 0.142              | 0.01L            | 0.039     | 0.004           | 0.0007   |
|                  | May 9 <sup>th</sup>    | 33.3     | 7.8      | 4 L | 7.38 | 0.19                   | 0.47                      | 0.125              | 0.01L            | 0.042     | 0.004           | 0.0008   |
|                  | May 10 <sup>th</sup>   | 35.0     | 8.1      | 8   | 7.12 | 0.64                   | 0.51                      | 0.155              | 0.01L            | 0.039     | 0.004           | 0.0008   |
|                  | Over-standard rate (%) | --       | 0        | --  | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 15#              | May 8 <sup>th</sup>    | 32.9     | 7.9      | 5   | 7.39 | 0.49                   | 0.44                      | 0.156              | 0.01L            | 0.047     | 0.004           | 0.0008   |
|                  | May 9 <sup>th</sup>    | 32.1     | 8.1      | 4 L | 7.32 | 0.21                   | 0.53                      | 0.149              | 0.01             | 0.037     | 0.004           | 0.0005   |
|                  | May 10 <sup>th</sup>   | 32.1     | 8.1      | 4   | 7.22 | 0.76                   | 0.46                      | 0.144              | 0.01L            | 0.043     | 0.004           | 0.0005   |

| Sampling station | Statistical item       | Salinity | pH value | SS | DO | Chemical oxygen demand | Biochemical oxygen demand | Inorganic nitrogen | Active phosphate | Petroleum | Volatile phenol | Sulfides |
|------------------|------------------------|----------|----------|----|----|------------------------|---------------------------|--------------------|------------------|-----------|-----------------|----------|
|                  |                        |          |          | L  |    |                        |                           |                    |                  |           |                 |          |
|                  | Over-standard rate (%) | --       | 0        | -- | 0  | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |

**Table 4.2-8 Monitoring and Statistical Results on Neap Tides at Ebb Flows in Offshore Sea Areas**  
Unit: mg/L (excluding pH and salinity)

| Sampling position | Statistical item       | Salinity | pH value | SS | DO   | Chemical oxygen demand | Biochemical oxygen demand | Inorganic nitrogen | Active phosphate | Petroleum | Volatile phenol | Sulfides |
|-------------------|------------------------|----------|----------|----|------|------------------------|---------------------------|--------------------|------------------|-----------|-----------------|----------|
| 1#                | May 8 <sup>th</sup>    | 32.9     | 7.8      | 8  | 7.36 | 1.55                   | 0.65                      | 0.154              | 0.01L            | 0.043     | 0.001L          | 0.0008   |
|                   | May 9 <sup>th</sup>    | 33.0     | 8.0      | 4L | 7.15 | 1.34                   | 0.64                      | 0.142              | 0.01L            | 0.041     | 0.001L          | 0.0008   |
|                   | May 10 <sup>th</sup>   | 34.2     | 7.8      | 7  | 7.19 | 1.54                   | 0.67                      | 0.184              | 0.01             | 0.03      | 0.001L          | 0.0008   |
|                   | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 2#                | May 8 <sup>th</sup>    | 33.1     | 7.8      | 4L | 7.49 | 1.34                   | 0.66                      | 0.168              | 0.01L            | 0.044     | 0.001L          | 0.0006   |
|                   | May 9 <sup>th</sup>    | 32.5     | 7.9      | 8  | 7.34 | 1.54                   | 0.65                      | 0.146              | 0.01             | 0.04      | 0.001L          | 0.0008   |
|                   | May 10 <sup>th</sup>   | 33.9     | 8.0      | 4L | 7.46 | 1.35                   | 0.66                      | 0.163              | 0.01L            | 0.039     | 0.001L          | 0.0008   |
|                   | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 3#                | May 8 <sup>th</sup>    | 32.0     | 7.9      | 4L | 7.49 | 1.34                   | 0.50                      | 0.178              | 0.01L            | 0.043     | 0.001L          | 0.0005   |
|                   | May 9 <sup>th</sup>    | 32.8     | 8.0      | 5  | 7.43 | 1.34                   | 0.46                      | 0.1367             | 0.01L            | 0.042     | 0.001L          | 0.0006   |
|                   | May 10 <sup>th</sup>   | 31.5     | 7.8      | 4L | 7.36 | 1.54                   | 0.48                      | 0.185              | 0.01             | 0.024     | 0.001L          | 0.0007   |
|                   | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 4#                | May 8 <sup>th</sup>    | 33.9     | 7.9      | 12 | 7.46 | 1.34                   | 0.67                      | 0.19               | 0.01L            | 0.036     | 0.001L          | 0.0006   |
|                   | May 9 <sup>th</sup>    | 33.0     | 7.9      | 4L | 7.38 | 1.54                   | 0.64                      | 0.186              | 0.01L            | 0.03      | 0.001L          | 0.0008   |
|                   | May 10 <sup>th</sup>   | 33.7     | 8.0      | 7  | 7.24 | 1.34                   | 0.68                      | 0.148              | 0.01L            | 0.04      | 0.0011L         | 0.0006   |
|                   | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 5#                | May 8 <sup>th</sup>    | 32.6     | 7.9      | 4  | 7.1  | 1.35                   | 0.65                      | 0.15               | 0.01L            | 0.034     | 0.001L          | 0.0006   |
|                   | May 9 <sup>th</sup>    | 33.4     | 8.0      | 5  | 7.02 | 1.4                    | 0.68                      | 0.149              | 0.01L            | 0.044     | 0.001L          | 0.0008   |
|                   | May 10 <sup>th</sup>   | 35.0     | 7.9      | 8  | 7.46 | 1.37                   | 0.60                      | 0.144              | 0.01L            | 0.037     | 0.001L          | 0.0008   |
|                   | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 6#                | May 8 <sup>th</sup>    | 33.1     | 7.8      | 4L | 7.49 | 1.26                   | 0.65                      | 0.149              | 0.01L            | 0.038     | 0.001L          | 0.0009   |
|                   | May 9 <sup>th</sup>    | 32.7     | 7.8      | 5  | 7.34 | 1.23                   | 0.63                      | 0.144              | 0.01             | 0.037     | 0.001L          | 0.0007   |
|                   | May 10 <sup>th</sup>   | 32.9     | 8.0      | 6  | 7.02 | 1.06                   | 0.69                      | 0.134              | 0.01             | 0.041     | 0.001L          | 0.0007   |
|                   | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 7#                | May 8 <sup>th</sup>    | 33.4     | 7.8      | 5  | 7.39 | 1.4                    | 0.50                      | 0.159              | 0.01             | 0.038     | 0.001L          | 0.0006   |
|                   | May 9 <sup>th</sup>    | 35.0     | 7.8      | 8  | 7.26 | 1.37                   | 0.48                      | 0.152              | 0.01L            | 0.037     | 0.001L          | 0.0007   |
|                   | May 10 <sup>th</sup>   | 33.7     | 7.9      | 6  | 7.49 | 1.19                   | 0.44                      | 0.194              | 0.01L            | 0.04      | 0.001L          | 0.0007   |
|                   | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |

| Sampling position | Statistical item       | Salinity | pH value | SS | DO   | Chemical oxygen demand | Biochemical oxygen demand | Inorganic nitrogen | Active phosphate | Petroleum | Volatile phenol | Sulfides |
|-------------------|------------------------|----------|----------|----|------|------------------------|---------------------------|--------------------|------------------|-----------|-----------------|----------|
| 8#                | May 8 <sup>th</sup>    | 31.9     | 7.9      | 4L | 7.18 | 1.37                   | 0.65                      | 0.145              | 0.01L            | 0.043     | 0.001L          | 0.0005   |
|                   | May 9 <sup>th</sup>    | 33.1     | 7.9      | 5  | 7.34 | 1.22                   | 0.68                      | 0.153              | 0.01L            | 0.033     | 0.001L          | 0.0006   |
|                   | May 10 <sup>th</sup>   | 32.7     | 8.0      | 4L | 7.39 | 1.46                   | 0.63                      | 0.164              | 0.01             | 0.039     | 0.001L          | 0.0008   |
|                   | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 9#                | May 8 <sup>th</sup>    | 31.9     | 7.8      | 4L | 7.02 | 1.55                   | 0.46                      | 0.176              | 0.01             | 0.042     | 0.001L          | 0.0008   |
|                   | May 9 <sup>th</sup>    | 33.1     | 7.9      | 4L | 7.39 | 1.06                   | 0.43                      | 0.154              | 0.01L            | 0.037     | 0.001L          | 0.0008   |
|                   | May 10 <sup>th</sup>   | 32.7     | 8.0      | 8  | 7.26 | 1.26                   | 0.46                      | 0.142              | 0.01L            | 0.033     | 0.001L          | 0.0008   |
|                   | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 10#               | May 8 <sup>th</sup>    | 33.1     | 7.9      | 4L | 7.49 | 1.54                   | 0.45                      | 0.157              | 0.01L            | 0.035     | 0.001L          | 0.0007   |
|                   | May 9 <sup>th</sup>    | 32.7     | 7.9      | 8  | 7.34 | 1.69                   | 0.49                      | 0.149              | 0.01             | 0.045     | 0.001L          | 0.0005   |
|                   | May 10 <sup>th</sup>   | 34.6     | 7.9      | 4L | 7.34 | 1.34                   | 0.46                      | 0.156              | 0.01L            | 0.041     | 0.001L          | 0.0007   |
|                   | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 11#               | May 8 <sup>th</sup>    | 32.8     | 7.9      | 6  | 7.02 | 1.34                   | 0.48                      | 0.162              | 0.01L            | 0.039     | 0.001L          | 0.0007   |
|                   | May 9 <sup>th</sup>    | 31.5     | 7.9      | 4L | 7.34 | 1.54                   | 0.51                      | 0.185              | 0.01L            | 0.045     | 0.001L          | 0.0005   |
|                   | May 10 <sup>th</sup>   | 32.5     | 7.9      | 8  | 7.49 | 1.69                   | 0.46                      | 0.199              | 0.01             | 0.032     | 0.001L          | 0.0007   |
|                   | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 12#               | May 8 <sup>th</sup>    | 33.4     | 7.8      | 5  | 7.26 | 1.06                   | 0.46                      | 0.172              | 0.01             | 0.043     | 0.001L          | 0.0007   |
|                   | May 9 <sup>th</sup>    | 35.0     | 7.8      | 4L | 7.49 | 1.26                   | 0.47                      | 0.163              | 0.01L            | 0.03      | 0.001L          | 0.0005   |
|                   | May 10 <sup>th</sup>   | 33.7     | 7.8      | 8  | 7.34 | 1.23                   | 0.46                      | 0.146              | 0.01L            | 0.04      | 0.001L          | 0.0007   |
|                   | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 13#               | May 8 <sup>th</sup>    | 32.8     | 7.8      | 10 | 7.23 | 1.06                   | 0.48                      | 0.154              | 0.01L            | 0.043     | 0.001L          | 0.0007   |
|                   | May 9 <sup>th</sup>    | 31.5     | 7.9      | 4L | 7.27 | 1.26                   | 0.48                      | 0.142              | 0.01L            | 0.03      | 0.001L          | 0.0005   |
|                   | May 10 <sup>th</sup>   | 34.4     | 7.9      | 5  | 7.16 | 1.55                   | 0.43                      | 0.168              | 0.01             | 0.04      | 0.001L          | 0.0007   |
|                   | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 14#               | May 8 <sup>th</sup>    | 31.4     | 8.0      | 4L | 7.29 | 0.23                   | 0.45                      | 0.099              | 0.01L            | 0.044     | 0.004           | 0.0009   |
|                   | May 9 <sup>th</sup>    | 34.9     | 7.9      | 4L | 7.49 | 0.23                   | 0.47                      | 0.137              | 0.01             | 0.039     | 0.004           | 0.0006   |
|                   | May 10 <sup>th</sup>   | 33.9     | 8.0      | 4L | 7.28 | 0.74                   | 0.42                      | 0.125              | 0.01L            | 0.040     | 0.004           | 0.0006   |
|                   | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |
| 15#               | s                      | 33.8     | 7.9      | 9  | 7.28 | 0.58                   | 0.45                      | 0.13               | 0.01L            | 0.043     | 0.004           | 0.0009   |
|                   | May 9 <sup>th</sup>    | 37.5     | 7.9      | 4L | 7.28 | 0.16                   | 0.43                      | 0.109              | 0.01             | 0.04      | 0.004           | 0.0006   |
|                   | May 10 <sup>th</sup>   | 30.4     | 8.0      | 6  | 7.30 | 0.73                   | 0.46                      | 0.109              | 0.01L            | 0.046     | 0.004           | 0.0006   |
|                   | Over-standard rate (%) | --       | 0        | -- | 0    | 0                      | 0                         | 0                  | 0                | 0         | 0               | 0        |

**Table 4.2-9 Evaluation Results on Water Quality of Spring Tides at Rising Flows**

| Sampling position | Date                  | DO    | Chemical oxygen demand | Biochemical oxygen demand | Inorganic nitrogen | Active phosphate | Petroleum | Volatile phenol | Sulfides |
|-------------------|-----------------------|-------|------------------------|---------------------------|--------------------|------------------|-----------|-----------------|----------|
| 1#                | Mar. 28 <sup>th</sup> | 0.312 | 0.315                  | 0.158                     | 0.465              | 0.333            | 0.117     | 0.110           | 0.005    |
|                   | Mar 29 <sup>th</sup>  | 0.341 | 0.335                  | 0.150                     | 0.490              | 0.333            | 0.150     | 0.110           | 0.006    |
|                   | Mar 30 <sup>th</sup>  | 0.363 | 0.335                  | 0.158                     | 0.430              | 0.333            | 0.143     | 0.110           | 0.008    |
| 2#                | Mar. 28 <sup>th</sup> | 0.236 | 0.288                  | 0.148                     | 0.306              | 0.333            | 0.090     | 0.110           | 0.002    |
|                   | Mar 29 <sup>th</sup>  | 0.202 | 0.250                  | 0.165                     | 0.312              | 0.333            | 0.084     | 0.110           | 0.003    |
|                   | Mar 30 <sup>th</sup>  | 0.226 | 0.252                  | 0.152                     | 0.296              | 0.333            | 0.072     | 0.110           | 0.002    |
| 3#                | Mar. 28 <sup>th</sup> | 0.563 | 0.640                  | 0.540                     | 0.790              | 0.667            | 0.860     | 0.220           | 0.025    |
|                   | Mar 29 <sup>th</sup>  | 0.524 | 0.530                  | 0.570                     | 0.900              | 0.667            | 0.680     | 0.220           | 0.030    |
|                   | Mar 30 <sup>th</sup>  | 0.596 | 0.630                  | 0.490                     | 0.820              | 0.667            | 0.88      | 0.220           | 0.040    |
| 4#                | Mar. 28 <sup>th</sup> | 0.164 | 0.292                  | 0.155                     | 0.316              | 0.333            | 0.076     | 0.011           | 0.003    |
|                   | Mar 29 <sup>th</sup>  | 0.177 | 0.276                  | 0.130                     | 0.314              | 0.333            | 0.076     | 0.011           | 0.003    |
|                   | Mar 30 <sup>th</sup>  | 0.153 | 0.256                  | 0.165                     | 0.270              | 0.333            | 0.068     | 0.011           | 0.002    |
| 5#                | Mar. 28 <sup>th</sup> | 0.274 | 0.315                  | 0.142                     | 0.410              | 0.333            | 0.133     | 0.110           | 0.008    |
|                   | Mar 29 <sup>th</sup>  | 0.228 | 0.308                  | 0.150                     | 0.455              | 0.333            | 0.147     | 0.110           | 0.007    |
|                   | Mar 30 <sup>th</sup>  | 0.267 | 0.343                  | 0.152                     | 0.438              | 0.333            | 0.110     | 0.110           | 0.006    |
| 6#                | Mar. 28 <sup>th</sup> | 0.239 | 0.467                  | 0.197                     | 0.567              | 0.167            | 0.740     | 0.220           | 0.014    |
|                   | Mar 29 <sup>th</sup>  | 0.284 | 0.457                  | 0.203                     | 0.550              | 0.167            | 0.720     | 0.220           | 0.014    |
|                   | Mar 30 <sup>th</sup>  | 0.382 | 0.397                  | 0.203                     | 0.603              | 0.333            | 0.860     | 0.220           | 0.010    |
| 7#                | Mar. 28 <sup>th</sup> | 0.301 | 0.520                  | 0.173                     | 0.493              | 0.167            | 0.800     | 0.100           | 0.012    |

| Sampling position | Date                  | DO    | Chemical oxygen demand | Biochemical oxygen demand | Inorganic nitrogen | Active phosphate | Petroleum | Volatile phenol | Sulfides |
|-------------------|-----------------------|-------|------------------------|---------------------------|--------------------|------------------|-----------|-----------------|----------|
|                   | Mar 29 <sup>th</sup>  | 0.339 | 0.457                  | 0.217                     | 0.573              | 0.167            | 0.720     | 0.100           | 0.018    |
|                   | Mar 30 <sup>th</sup>  | 0.382 | 0.407                  | 0.187                     | 0.560              | 0.167            | 0.860     | 0.100           | 0.012    |
| 8#                | Mar. 28 <sup>th</sup> | 0.298 | 0.265                  | 0.165                     | 0.380              | 0.333            | 0.147     | 0.110           | 0.005    |
|                   | Mar 29 <sup>th</sup>  | 0.191 | 0.315                  | 0.140                     | 0.448              | 0.333            | 0.113     | 0.110           | 0.006    |
|                   | Mar 30 <sup>th</sup>  | 0.235 | 0.308                  | 0.160                     | 0.433              | 0.333            | 0.147     | 0.110           | 0.008    |
| 9#                | Mar. 28 <sup>th</sup> | 0.218 | 0.385                  | 0.133                     | 0.430              | 0.167            | 0.120     | 0.055           | 0.005    |
|                   | Mar 29 <sup>th</sup>  | 0.206 | 0.335                  | 0.125                     | 0.455              | 0.167            | 0.127     | 0.055           | 0.007    |
|                   | Mar 30 <sup>th</sup>  | 0.237 | 0.335                  | 0.128                     | 0.410              | 0.167            | 0.123     | 0.055           | 0.006    |
| 10#               | Mar. 28 <sup>th</sup> | 0.417 | 0.670                  | 0.500                     | 0.790              | 0.333            | 0.660     | 0.100           | 0.035    |
|                   | Mar 29 <sup>th</sup>  | 0.557 | 0.670                  | 0.460                     | 0.910              | 0.333            | 0.780     | 0.100           | 0.035    |
|                   | Mar 30 <sup>th</sup>  | 0.417 | 0.670                  | 0.530                     | 0.880              | 0.333            | 0.900     | 0.100           | 0.040    |
| 11#               | Mar. 28 <sup>th</sup> | 0.293 | 0.265                  | 0.133                     | 0.465              | 0.167            | 0.140     | 0.055           | 0.006    |
|                   | Mar 29 <sup>th</sup>  | 0.206 | 0.315                  | 0.125                     | 0.365              | 0.167            | 0.123     | 0.055           | 0.005    |
|                   | Mar 30 <sup>th</sup>  | 0.237 | 0.308                  | 0.128                     | 0.390              | 0.167            | 0.110     | 0.055           | 0.007    |
| 12#               | Mar. 28 <sup>th</sup> | 0.239 | 0.447                  | 0.167                     | 0.607              | 0.167            | 0.900     | 0.110           | 0.016    |
|                   | Mar 29 <sup>th</sup>  | 0.284 | 0.447                  | 0.140                     | 0.583              | 0.167            | 0.820     | 0.110           | 0.012    |
|                   | Mar 30 <sup>th</sup>  | 0.303 | 0.513                  | 0.167                     | 0.547              | 0.167            | 0.600     | 0.110           | 0.016    |
| 13#               | Mar. 28 <sup>th</sup> | 0.284 | 0.447                  | 0.143                     | 0.473              | 0.167            | 0.820     | 0.110           | 0.010    |
|                   | Mar 29 <sup>th</sup>  | 0.239 | 0.447                  | 0.167                     | 0.657              | 0.167            | 0.600     | 0.110           | 0.012    |
|                   | Mar                   | 0.38  | 0.420                  | 0.170                     | 0.573              | 0.167            | 0.600     | 0.110           | 0.016    |



| Sampling position | Date                  | DO    | Chemical oxygen demand | Biochemical oxygen demand | Inorganic nitrogen | Active phosphate | Petroleum | Volatile phenol | Sulfides |
|-------------------|-----------------------|-------|------------------------|---------------------------|--------------------|------------------|-----------|-----------------|----------|
|                   | 30 <sup>th</sup>      | 2     |                        |                           |                    |                  |           |                 |          |
| 14#               | Mar. 28 <sup>th</sup> | 0.352 | 0.435                  | 0.520                     | 0.755              | 0.667            | 0.540     | 0.600           | 0.025    |
|                   | Mar 29 <sup>th</sup>  | 0.417 | 0.550                  | 0.500                     | 0.545              | 0.667            | 0.500     | 0.600           | 0.005    |
|                   | Mar 30 <sup>th</sup>  | 0.443 | 0.550                  | 0.490                     | 0.540              | 0.667            | 0.520     | 0.600           | 0.025    |
| 15#               | Mar. 28 <sup>th</sup> | 0.305 | 0.283                  | 0.173                     | 0.367              | 0.333            | 0.580     | 0.600           | 0.016    |
|                   | Mar 29 <sup>th</sup>  | 0.269 | 0.333                  | 0.140                     | 0.367              | 0.333            | 0.560     | 0.600           | 0.002    |
|                   | Mar 30 <sup>th</sup>  | 0.286 | 0.400                  | 0.143                     | 0.420              | 0.333            | 0.500     | 0.600           | 0.002    |

Table 4.2-10 Evaluation Results on Water Quality of Spring Tides at Ebb Flows

| Sampling position | Date                  | DO    | Chemical oxygen demand | Biochemical oxygen demand | Inorganic nitrogen | Active phosphate | Petroleum | Volatile phenol | Sulfides |
|-------------------|-----------------------|-------|------------------------|---------------------------|--------------------|------------------|-----------|-----------------|----------|
| 1#                | Mar. 28 <sup>th</sup> | 0.404 | 0.385                  | 0.158                     | 0.448              | 0.333            | 0.100     | 0.110           | 0.006    |
|                   | Mar 29 <sup>th</sup>  | 0.367 | 0.265                  | 0.170                     | 0.445              | 0.333            | 0.133     | 0.110           | 0.008    |
|                   | Mar 30 <sup>th</sup>  | 0.353 | 0.315                  | 0.158                     | 0.440              | 0.333            | 0.117     | 0.110           | 0.006    |
| 2#                | Mar. 28 <sup>th</sup> | 0.217 | 0.258                  | 0.148                     | 0.344              | 0.333            | 0.068     | 0.110           | 0.002    |
|                   | Mar 29 <sup>th</sup>  | 0.181 | 0.268                  | 0.155                     | 0.340              | 0.333            | 0.076     | 0.110           | 0.003    |
|                   | Mar 30 <sup>th</sup>  | 0.234 | 0.308                  | 0.168                     | 0.288              | 0.333            | 0.068     | 0.110           | 0.003    |
| 3#                | Mar. 28 <sup>th</sup> | 0.668 | 0.595                  | 0.520                     | 0.675              | 0.667            | 0.720     | 0.220           | 0.045    |
|                   | Mar 29 <sup>th</sup>  | 0.534 | 0.670                  | 0.470                     | 0.680              | 0.667            | 0.840     | 0.220           | 0.035    |
|                   | Mar 30 <sup>th</sup>  | 0.557 | 0.770                  | 0.490                     | 0.760              | 0.667            | 0.720     | 0.220           | 0.025    |

| Sampling position | Date                  | DO    | Chemical oxygen demand | Biochemical oxygen demand | Inorganic nitrogen | Active phosphate | Petroleum | Volatile phenol | Sulfides |
|-------------------|-----------------------|-------|------------------------|---------------------------|--------------------|------------------|-----------|-----------------|----------|
| 4#                | Mar. 28 <sup>th</sup> | 0.195 | 0.280                  | 0.134                     | 0.282              | 0.111            | 0.078     | 0.110           | 0.002    |
|                   | Mar 29 <sup>th</sup>  | 0.237 | 0.274                  | 0.124                     | 0.324              | 0.111            | 0.072     | 0.110           | 0.003    |
|                   | Mar 30 <sup>th</sup>  | 0.154 | 0.238                  | 0.132                     | 0.364              | 0.111            | 0.084     | 0.110           | 0.003    |
| 5#                | Mar. 28 <sup>th</sup> | 0.298 | 0.323                  | 0.168                     | 0.380              | 0.333            | 0.100     | 0.110           | 0.005    |
|                   | Mar 29 <sup>th</sup>  | 0.291 | 0.335                  | 0.165                     | 0.403              | 0.333            | 0.117     | 0.110           | 0.008    |
|                   | Mar 30 <sup>th</sup>  | 0.249 | 0.385                  | 0.152                     | 0.383              | 0.333            | 0.107     | 0.110           | 0.007    |
| 6#                | Mar. 28 <sup>th</sup> | 0.309 | 0.460                  | 0.197                     | 0.473              | 0.167            | 0.900     | 0.110           | 0.016    |
|                   | Mar 29 <sup>th</sup>  | 0.239 | 0.427                  | 0.220                     | 0.487              | 0.167            | 0.740     | 0.110           | 0.016    |
|                   | Mar 30 <sup>th</sup>  | 0.284 | 0.353                  | 0.203                     | 0.513              | 0.167            | 0.720     | 0.110           | 0.016    |
| 7#                | Mar. 28 <sup>th</sup> | 0.368 | 0.447                  | 0.173                     | 0.580              | 0.167            | 0.800     | 0.100           | 0.014    |
|                   | Mar 29 <sup>th</sup>  | 0.337 | 0.513                  | 0.183                     | 0.600              | 0.167            | 0.740     | 0.100           | 0.014    |
|                   | Mar 30 <sup>th</sup>  | 0.284 | 0.450                  | 0.180                     | 0.553              | 0.553            | 0.720     | 0.100           | 0.016    |
| 8#                | Mar. 28 <sup>th</sup> | 0.188 | 0.335                  | 0.165                     | 0.430              | 0.333            | 0.137     | 0.110           | 0.008    |
|                   | Mar 29 <sup>th</sup>  | 0.216 | 0.385                  | 0.158                     | 0.420              | 0.333            | 0.140     | 0.110           | 0.007    |
|                   | Mar 30 <sup>th</sup>  | 0.284 | 0.308                  | 0.160                     | 0.405              | 0.333            | 0.120     | 0.110           | 0.005    |
| 9#                | Mar. 28 <sup>th</sup> | 0.218 | 0.308                  | 0.133                     | 0.383              | 0.167            | 0.110     | 0.055           | 0.007    |
|                   | Mar 29 <sup>th</sup>  | 0.183 | 0.265                  | 0.140                     | 0.433              | 0.167            | 0.130     | 0.055           | 0.005    |
|                   | Mar 30 <sup>th</sup>  | 0.218 | 0.315                  | 0.120                     | 0.398              | 0.333            | 0.150     | 0.055           | 0.008    |
| 10#               | Mar. 28 <sup>th</sup> | 0.352 | 0.615                  | 0.500                     | 0.890              | 0.333            | 0.700     | 0.100           | 0.025    |
|                   | Mar                   | 0.41  | 0.530                  | 0.460                     | 0.865              | 0.667            | 0.740     | 0.100           | 0.030    |

| Sampling position | Date                  | DO    | Chemical oxygen demand | Biochemical oxygen demand | Inorganic nitrogen | Active phosphate | Petroleum | Volatile phenol | Sulfides |
|-------------------|-----------------------|-------|------------------------|---------------------------|--------------------|------------------|-----------|-----------------|----------|
|                   | 29 <sup>th</sup>      | 7     |                        |                           |                    |                  |           |                 |          |
|                   | Mar 30 <sup>th</sup>  | 0.396 | 0.670                  | 0.540                     | 0.885              | 0.667            | 0.800     | 0.100           | 0.025    |
| 11#               | Mar. 28 <sup>th</sup> | 0.218 | 0.335                  | 0.133                     | 0.430              | 0.167            | 0.120     | 0.055           | 0.008    |
|                   | Mar 29 <sup>th</sup>  | 0.183 | 0.385                  | 0.140                     | 0.413              | 0.333            | 0.143     | 0.055           | 0.008    |
|                   | Mar 30 <sup>th</sup>  | 0.218 | 0.335                  | 0.148                     | 0.393              | 0.333            | 0.110     | 0.055           | 0.006    |
| 12#               | Mar. 28 <sup>th</sup> | 0.382 | 0.353                  | 0.167                     | 0.577              | 0.167            | 0.800     | 0.110           | 0.010    |
|                   | Mar 29 <sup>th</sup>  | 0.284 | 0.420                  | 0.153                     | 0.593              | 0.167            | 0.700     | 0.110           | 0.014    |
|                   | Mar 30 <sup>th</sup>  | 0.248 | 0.517                  | 0.140                     | 0.523              | 0.333            | 0.900     | 0.110           | 0.010    |
| 13#               | Mar. 28 <sup>th</sup> | 0.269 | 0.353                  | 0.153                     | 0.527              | 0.183            | 0.700     | 0.110           | 0.014    |
|                   | Mar 29 <sup>th</sup>  | 0.239 | 0.447                  | 0.167                     | 0.620              | 0.333            | 0.700     | 0.110           | 0.014    |
|                   | Mar 30 <sup>th</sup>  | 0.284 | 0.513                  | 0.173                     | 0.587              | 0.333            | 0.900     | 0.110           | 0.010    |
| 14#               | Mar. 28 <sup>th</sup> | 0.603 | 0.365                  | 0.460                     | 0.485              | 0.667            | 0.680     | 0.600           | 0.005    |
|                   | Mar 29 <sup>th</sup>  | 0.524 | 0.500                  | 0.490                     | 0.465              | 1.333            | 0.720     | 0.600           | 0.040    |
|                   | Mar 30 <sup>th</sup>  | 0.577 | 0.500                  | 0.500                     | 0.540              | 0.667            | 0.620     | 0.600           | 0.040    |
| 15#               | Mar. 28 <sup>th</sup> | 0.312 | 0.230                  | 0.140                     | 0.383              | 0.333            | 0.620     | 0.600           | 0.016    |
|                   | Mar 29 <sup>th</sup>  | 0.305 | 0.230                  | 0.177                     | 0.383              | 0.333            | 0.760     | 0.600           | 0.010    |
|                   | Mar 30 <sup>th</sup>  | 0.308 | 0.333                  | 0.143                     | 0.383              | 0.333            | 0.660     | 0.600           | 0.010    |

**Table 4.2-11 Evaluation Results on Water Quality of Neap Tides at Rising Flows**

| Sampling position | Date                 | DO    | Chemical oxygen demand | Biochemical oxygen demand | Inorganic nitrogen | Active phosphate | Petroleum | Volatile phenol | Sulfides |
|-------------------|----------------------|-------|------------------------|---------------------------|--------------------|------------------|-----------|-----------------|----------|
| 1#                | May 8 <sup>th</sup>  | 0.359 | 0.385                  | 0.170                     | 0.408              | 0.333            | 0.100     | 0.110           | 0.005    |
|                   | May 9 <sup>th</sup>  | 0.341 | 0.335                  | 0.162                     | 0.365              | 0.333            | 0.133     | 0.110           | 0.005    |
|                   | May 10 <sup>th</sup> | 0.353 | 0.315                  | 0.158                     | 0.395              | 0.333            | 0.130     | 0.110           | 0.007    |
| 2#                | May 8 <sup>th</sup>  | 0.242 | 0.246                  | 0.150                     | 0.318              | 0.333            | 0.084     | 0.110           | 0.003    |
|                   | May 9 <sup>th</sup>  | 0.158 | 0.274                  | 0.155                     | 0.306              | 0.333            | 0.072     | 0.110           | 0.003    |
|                   | May 10 <sup>th</sup> | 0.242 | 0.244                  | 0.165                     | 0.344              | 0.333            | 0.060     | 0.110           | 0.002    |
| 3#                | May 8 <sup>th</sup>  | 0.668 | 0.615                  | 0.520                     | 0.730              | 0.667            | 0.740     | 0.220           | 0.040    |
|                   | May 9 <sup>th</sup>  | 0.524 | 0.530                  | 0.460                     | 0.795              | 0.667            | 0.720     | 0.220           | 0.045    |
|                   | May 10 <sup>th</sup> | 0.596 | 0.630                  | 0.500                     | 0.860              | 0.667            | 0.600     | 0.220           | 0.040    |
| 4#                | May 8 <sup>th</sup>  | 0.237 | 0.212                  | 0.136                     | 0.328              | 0.111            | 0.088     | 0.011           | 0.003    |
|                   | May 9 <sup>th</sup>  | 0.163 | 0.252                  | 0.128                     | 0.344              | 0.222            | 0.080     | 0.011           | 0.003    |
|                   | May 10 <sup>th</sup> | 0.192 | 0.246                  | 0.132                     | 0.384              | 0.222            | 0.078     | 0.011           | 0.002    |
| 5#                | May 8 <sup>th</sup>  | 0.223 | 0.305                  | 0.165                     | 0.423              | 0.333            | 0.120     | 0.110           | 0.008    |
|                   | May 9 <sup>th</sup>  | 0.288 | 0.365                  | 0.170                     | 0.445              | 0.333            | 0.140     | 0.110           | 0.007    |
|                   | May 10 <sup>th</sup> | 0.188 | 0.345                  | 0.158                     | 0.405              | 0.333            | 0.120     | 0.110           | 0.005    |
| 6#                | May 8 <sup>th</sup>  | 0.269 | 0.447                  | 0.210                     | 0.567              | 0.333            | 0.660     | 0.110           | 0.010    |
|                   | May 9 <sup>th</sup>  | 0.309 | 0.513                  | 0.220                     | 0.553              | 0.167            | 0.780     | 0.110           | 0.012    |
|                   | May 10 <sup>th</sup> | 0.239 | 0.447                  | 0.230                     | 0.520              | 0.167            | 0.900     | 0.110           | 0.016    |
| 7#                | May 8 <sup>th</sup>  | 0.284 | 0.493                  | 0.170                     | 0.520              | 0.167            | 0.660     | 0.100           | 0.014    |

| Sampling position | Date                 | DO    | Chemical oxygen demand | Biochemical oxygen demand | Inorganic nitrogen | Active phosphate | Petroleum | Volatile phenol | Sulfides |
|-------------------|----------------------|-------|------------------------|---------------------------|--------------------|------------------|-----------|-----------------|----------|
|                   | May 9 <sup>th</sup>  | 0.239 | 0.460                  | 0.180                     | 0.543              | 0.167            | 0.780     | 0.100           | 0.016    |
|                   | May 10 <sup>th</sup> | 0.284 | 0.427                  | 0.187                     | 0.593              | 0.167            | 0.900     | 0.100           | 0.012    |
| 8#                | May 8 <sup>th</sup>  | 0.265 | 0.335                  | 0.165                     | 0.360              | 0.333            | 0.123     | 0.110           | 0.008    |
|                   | May 9 <sup>th</sup>  | 0.298 | 0.385                  | 0.165                     | 0.380              | 0.333            | 0.120     | 0.110           | 0.009    |
|                   | May 10 <sup>th</sup> | 0.223 | 0.338                  | 0.158                     | 0.370              | 0.333            | 0.127     | 0.110           | 0.007    |
| 9#                | May 8 <sup>th</sup>  | 0.183 | 0.385                  | 0.140                     | 0.430              | 0.167            | 0.133     | 0.055           | 0.005    |
|                   | May 9 <sup>th</sup>  | 0.218 | 0.423                  | 0.133                     | 0.408              | 0.167            | 0.120     | 0.055           | 0.007    |
|                   | May 10 <sup>th</sup> | 0.183 | 0.335                  | 0.120                     | 0.365              | 0.167            | 0.143     | 0.055           | 0.005    |
| 10#               | May 8 <sup>th</sup>  | 0.352 | 0.630                  | 0.520                     | 0.820              | 0.333            | 0.820     | 0.100           | 0.040    |
|                   | May 9 <sup>th</sup>  | 0.557 | 0.775                  | 0.490                     | 0.865              | 0.333            | 0.600     | 0.100           | 0.040    |
|                   | May 10 <sup>th</sup> | 0.417 | 0.530                  | 0.500                     | 0.740              | 0.333            | 0.800     | 0.100           | 0.040    |
| 11#               | May 8 <sup>th</sup>  | 0.183 | 0.265                  | 0.133                     | 0.398              | 0.167            | 0.127     | 0.055           | 0.008    |
|                   | May 9 <sup>th</sup>  | 0.218 | 0.315                  | 0.135                     | 0.438              | 0.333            | 0.123     | 0.055           | 0.008    |
|                   | May 10 <sup>th</sup> | 0.206 | 0.388                  | 0.140                     | 0.365              | 0.167            | 0.133     | 0.055           | 0.008    |
| 12#               | May 8 <sup>th</sup>  | 0.239 | 0.563                  | 0.167                     | 0.590              | 0.167            | 0.800     | 0.110           | 0.016    |
|                   | May 9 <sup>th</sup>  | 0.284 | 0.447                  | 0.157                     | 0.587              | 0.167            | 0.700     | 0.110           | 0.016    |
|                   | May 10 <sup>th</sup> | 0.382 | 0.513                  | 0.150                     | 0.513              | 0.167            | 0.860     | 0.110           | 0.016    |
| 13#               | May 8 <sup>th</sup>  | 0.324 | 0.447                  | 0.160                     | 0.543              | 0.167            | 0.800     | 0.110           | 0.016    |
|                   | May 9 <sup>th</sup>  | 0.303 | 0.447                  | 0.167                     | 0.487              | 0.333            | 0.700     | 0.110           | 0.016    |
|                   | May                  | 0.37  | 0.513                  | 0.167                     | 0.527              | 0.167            | 0.860     | 0.110           | 0.016    |

| Sampling position | Date                 | DO    | Chemical oxygen demand | Biochemical oxygen demand | Inorganic nitrogen | Active phosphate | Petroleum | Volatile phenol | Sulfides |
|-------------------|----------------------|-------|------------------------|---------------------------|--------------------|------------------|-----------|-----------------|----------|
|                   | 10 <sup>th</sup>     | 0     |                        |                           |                    |                  |           |                 |          |
| 14#               | May 8 <sup>th</sup>  | 0.521 | 0.165                  | 0.490                     | 0.710              | 0.333            | 0.780     | 0.800           | 0.035    |
|                   | May 9 <sup>th</sup>  | 0.550 | 0.095                  | 0.470                     | 0.625              | 0.333            | 0.840     | 0.800           | 0.040    |
|                   | May 10 <sup>th</sup> | 0.635 | 0.320                  | 0.510                     | 0.775              | 0.333            | 0.780     | 0.800           | 0.040    |
| 15#               | May 8 <sup>th</sup>  | 0.269 | 0.163                  | 0.147                     | 0.520              | 0.167            | 0.940     | 0.800           | 0.016    |
|                   | May 9 <sup>th</sup>  | 0.282 | 0.07                   | 0.177                     | 0.497              | 0.333            | 0.740     | 0.800           | 0.010    |
|                   | May 10 <sup>th</sup> | 0.322 | 0.253                  | 0.153                     | 0.480              | 0.167            | 0.860     | 0.800           | 0.010    |

**Table 4.2-12 Evaluation Results on Water Quality of Neap Tides at Ebb Flows**

| Sampling position | Date                 | DO    | Chemical oxygen demand | Biochemical oxygen demand | Inorganic nitrogen | Active phosphate | Petroleum | Volatile phenol | Sulfides |
|-------------------|----------------------|-------|------------------------|---------------------------|--------------------|------------------|-----------|-----------------|----------|
| 1#                | May 8 <sup>th</sup>  | 0.337 | 0.388                  | 0.162                     | 0.385              | 0.333            | 0.143     | 0.110           | 0.008    |
|                   | May 9 <sup>th</sup>  | 0.379 | 0.335                  | 0.160                     | 0.355              | 0.333            | 0.137     | 0.110           | 0.008    |
|                   | May 10 <sup>th</sup> | 0.371 | 0.385                  | 0.168                     | 0.460              | 0.333            | 0.100     | 0.110           | 0.008    |
| 2#                | May 8 <sup>th</sup>  | 0.153 | 0.268                  | 0.165                     | 0.336              | 0.333            | 0.088     | 0.110           | 0.002    |
|                   | May 9 <sup>th</sup>  | 0.181 | 0.308                  | 0.162                     | 0.292              | 0.333            | 0.080     | 0.110           | 0.003    |
|                   | May 10 <sup>th</sup> | 0.158 | 0.270                  | 0.165                     | 0.326              | 0.333            | 0.078     | 0.110           | 0.003    |
| 3#                | May 8 <sup>th</sup>  | 0.515 | 0.670                  | 0.500                     | 0.890              | 0.667            | 0.860     | 0.220           | 0.025    |
|                   | May 9 <sup>th</sup>  | 0.534 | 0.670                  | 0.460                     | 0.684              | 0.667            | 0.840     | 0.220           | 0.030    |
|                   | May 10 <sup>th</sup> | 0.557 | 0.770                  | 0.480                     | 0.925              | 0.667            | 0.480     | 0.220           | 0.035    |
| 4#                | May 8 <sup>th</sup>  | 0.154 | 0.268                  | 0.134                     | 0.380              | 0.111            | 0.072     | 0.011           | 0.002    |
|                   | May 9 <sup>th</sup>  | 0.16  | 0.308                  | 0.128                     | 0.372              | 0.111            | 0.060     | 0.011           | 0.003    |

| Sampling position | Date                 | DO    | Chemical oxygen demand | Biochemical oxygen demand | Inorganic nitrogen | Active phosphate | Petroleum | Volatile phenol | Sulfides |
|-------------------|----------------------|-------|------------------------|---------------------------|--------------------|------------------|-----------|-----------------|----------|
|                   |                      | 9     |                        |                           |                    |                  |           |                 |          |
|                   | May 10 <sup>th</sup> | 0.195 | 0.268                  | 0.136                     | 0.296              | 0.111            | 0.080     | 0.011           | 0.002    |
| 5#                | May 8 <sup>th</sup>  | 0.279 | 0.338                  | 0.162                     | 0.375              | 0.333            | 0.113     | 0.110           | 0.006    |
|                   | May 9 <sup>th</sup>  | 0.298 | 0.350                  | 0.170                     | 0.373              | 0.333            | 0.147     | 0.110           | 0.008    |
|                   | May 10 <sup>th</sup> | 0.195 | 0.343                  | 0.150                     | 0.360              | 0.333            | 0.123     | 0.110           | 0.008    |
| 6#                | May 8 <sup>th</sup>  | 0.239 | 0.420                  | 0.217                     | 0.497              | 0.167            | 0.760     | 0.110           | 0.018    |
|                   | May 9 <sup>th</sup>  | 0.284 | 0.410                  | 0.210                     | 0.480              | 0.333            | 0.740     | 0.110           | 0.014    |
|                   | May 10 <sup>th</sup> | 0.382 | 0.353                  | 0.230                     | 0.447              | 0.333            | 0.820     | 0.110           | 0.014    |
| 7#                | May 8 <sup>th</sup>  | 0.269 | 0.467                  | 0.167                     | 0.530              | 0.333            | 0.760     | 0.100           | 0.012    |
|                   | May 9 <sup>th</sup>  | 0.309 | 0.457                  | 0.160                     | 0.507              | 0.167            | 0.740     | 0.100           | 0.014    |
|                   | May 10 <sup>th</sup> | 0.239 | 0.397                  | 0.147                     | 0.647              | 0.167            | 0.800     | 0.100           | 0.014    |
| 8#                | May 8 <sup>th</sup>  | 0.260 | 0.343                  | 0.162                     | 0.363              | 0.333            | 0.143     | 0.110           | 0.005    |
|                   | May 9 <sup>th</sup>  | 0.223 | 0.305                  | 0.170                     | 0.383              | 0.333            | 0.110     | 0.110           | 0.006    |
|                   | May 10 <sup>th</sup> | 0.212 | 0.365                  | 0.158                     | 0.410              | 0.333            | 0.130     | 0.110           | 0.008    |
| 9#                | May 8 <sup>th</sup>  | 0.293 | 0.388                  | 0.115                     | 0.440              | 0.333            | 0.140     | 0.055           | 0.008    |
|                   | May 9 <sup>th</sup>  | 0.206 | 0.265                  | 0.108                     | 0.385              | 0.167            | 0.123     | 0.055           | 0.008    |
|                   | May 10 <sup>th</sup> | 0.237 | 0.315                  | 0.115                     | 0.355              | 0.167            | 0.110     | 0.055           | 0.008    |
| 10#               | May 8 <sup>th</sup>  | 0.352 | 0.770                  | 0.450                     | 0.785              | 0.333            | 0.700     | 0.100           | 0.035    |
|                   | May 9 <sup>th</sup>  | 0.417 | 0.845                  | 0.490                     | 0.745              | 0.667            | 0.900     | 0.100           | 0.025    |
|                   | May 10 <sup>th</sup> | 0.417 | 0.670                  | 0.460                     | 0.780              | 0.333            | 0.820     | 0.100           | 0.035    |
| 11#               | May 8 <sup>th</sup>  | 0.293 | 0.335                  | 0.120                     | 0.405              | 0.167            | 0.130     | 0.055           | 0.007    |

| Sampling position | Date                 | DO    | Chemical oxygen demand | Biochemical oxygen demand | Inorganic nitrogen | Active phosphate | Petroleum | Volatile phenol | Sulfides |
|-------------------|----------------------|-------|------------------------|---------------------------|--------------------|------------------|-----------|-----------------|----------|
|                   | May 9 <sup>th</sup>  | 0.218 | 0.385                  | 0.128                     | 0.463              | 0.167            | 0.150     | 0.055           | 0.005    |
|                   | May 10 <sup>th</sup> | 0.183 | 0.423                  | 0.115                     | 0.498              | 0.333            | 0.107     | 0.055           | 0.007    |
| 12#               | May 8 <sup>th</sup>  | 0.309 | 0.353                  | 0.153                     | 0.573              | 0.333            | 0.860     | 0.110           | 0.014    |
|                   | May 9 <sup>th</sup>  | 0.239 | 0.420                  | 0.157                     | 0.543              | 0.167            | 0.600     | 0.110           | 0.010    |
|                   | May 10 <sup>th</sup> | 0.284 | 0.410                  | 0.153                     | 0.487              | 0.167            | 0.800     | 0.110           | 0.014    |
| 13#               | May 8 <sup>th</sup>  | 0.318 | 0.353                  | 0.160                     | 0.513              | 0.167            | 0.860     | 0.110           | 0.014    |
|                   | May 9 <sup>th</sup>  | 0.306 | 0.420                  | 0.160                     | 0.473              | 0.167            | 0.600     | 0.110           | 0.010    |
|                   | May 10 <sup>th</sup> | 0.339 | 0.517                  | 0.143                     | 0.560              | 0.333            | 0.800     | 0.110           | 0.014    |
| 14#               | May 8 <sup>th</sup>  | 0.580 | 0.115                  | 0.450                     | 0.495              | 0.333            | 0.880     | 0.800           | 0.045    |
|                   | May 9 <sup>th</sup>  | 0.515 | 0.115                  | 0.470                     | 0.685              | 0.667            | 0.780     | 0.800           | 0.030    |
|                   | May 10 <sup>th</sup> | 0.583 | 0.370                  | 0.420                     | 0.625              | 0.333            | 0.800     | 0.800           | 0.030    |
| 15#               | May 8 <sup>th</sup>  | 0.306 | 0.193                  | 0.150                     | 0.433              | 0.167            | 0.860     | 0.800           | 0.018    |
|                   | May 9 <sup>th</sup>  | 0.306 | 0.050                  | 0.143                     | 0.363              | 0.333            | 0.800     | 0.800           | 0.012    |
|                   | May 10 <sup>th</sup> | 0.281 | 0.243                  | 0.153                     | 0.363              | 0.167            | 0.920     | 0.800           | 0.012    |

### 4.3 Investigation and Evaluation on Current Coastal Sediments Quality

#### 4.3.1 Monitoring Objectives and Layout of Monitoring Sites

Monitoring objectives: To get hold of the environmental quality background of coastal sediments quality under monitoring in an all-round and objective way.

Principles for layout of sites: Representative stations shall be set for monitoring according to the distribution of offshore functional areas as well as the technical requirements given in the *Specification for Marine Monitoring* (GB17378—1998).

Altogether 15 monitoring stations shall be set up at the sampling sites at the same locations as those for water quality monitoring. See the Chapter of Water Quality Monitoring.



### 4.3.2 Monitoring Time and Frequency

The monitoring had been carried out on May 2007, with the targeted samples being taken once at each station.

### 4.3.3 Sampling Methods and Monitoring Analysis

For the sampling and analytical methods, refer to the *Specification for Marine Monitoring* (GB17378—1998) with the analytical methods and lower limits in Table 4.3-1.

**Table 4.3-1 Analytical Methods for Sediments**

| Item           | Detection methods                                             | Detection limit       |
|----------------|---------------------------------------------------------------|-----------------------|
| Organic carbon | Potassium Dichromate redox volumetry (GB17378.5-1998)         | $0.01 \times 10^{-2}$ |
| Sulfides       | Methylene blue spectrophotometry (GB17378.5-1998)             | $0.3 \times 10^{-6}$  |
| Arsenic        | Hydrides-Atomic Absorption Spectrophotometry (GB17378.5-1998) | $3 \times 10^{-6}$    |
| Copper         | Flame atomic absorption spectrophotometry (GB17378.5-1998)    | $2 \times 10^{-6}$    |
| Total mercury  | Cold atomic absorption photometry (GB17378.5-1998)            | $5 \times 10^{-9}$    |
| Lead           | Lame atomic absorption spectrophotometry (GB17378.5-1998)     | $3 \times 10^{-6}$    |
| Cadmium        | Lame atomic absorption spectrophotometry (GB17378.5-1998)     | $0.05 \times 10^{-6}$ |
| Total chromium | Diphenylcarbazide spectrophotometry (GB17378.5-1998)          | $2 \times 10^{-6}$    |
| Petroleum      | Ultraviolet spectrophotometry (GB/T16488-1996)                | $3 \times 10^{-6}$    |

### 4.3.4 Evaluation Standards

Class I and III Standards as required by the *Marine Sediment Quality* (GB18668-2002) shall be adopted in the evaluation. For implementation at all stations, see Table 4.3-3.

**Table 4.3- 2 Standard for Marine Sediment Quality (GB18668-2002) Unit:  $\times 10^{-6}$**

| Item           | Class I Standard | Class II Standard | Class III Standard |
|----------------|------------------|-------------------|--------------------|
| Organic carbon | 2.0%             | 3.0%              | 4.0%               |
| Sulfides       | 300              | 500               | 600                |
| Petroleum      | 500              | 1000              | 1500               |
| Total mercury  | 0.2              | 0.50              | 1.00               |
| Copper         | 35               | 100               | 200                |
| Lead           | 60               | 130               | 250                |
| Zinc           | 150              | 350               | 600                |
| Cadmium        | 0.5              | 1.50              | 5.00               |

| Item     | Class I Standard | Class II Standard | Class III Standard |
|----------|------------------|-------------------|--------------------|
| Arsenic  | 20               | 65.0              | 93.0               |
| Chromium | 80               | 150               | 270                |

**Table 4.3-3 Implementation Standards for Each Monitoring Station**

| Monitoring station | Latitude & longitude of the station | Class of the implementing standard (GB18668-2002) |
|--------------------|-------------------------------------|---------------------------------------------------|
| 1                  | 21°34.38' N, 109°35.7' E            | Class III                                         |
| 2                  | 21°32.87' N, 109°35.55' E           | Class III                                         |
| 3                  | 21°32.7' N, 109°38.7' E             | Class I                                           |
| 4                  | 21°30.69' N, 109°34.14' E           | Class III                                         |
| 5                  | 21°29.66' N, 109°35.51' E           | Class III                                         |
| 6                  | 21°28.07' N, 109°35.50' E           | Class I                                           |
| 7                  | 21°30.00' N, 109°38.30' E           | Class I                                           |
| 8                  | 21°27.48' N, 109°33.25' E           | Class III                                         |
| 9                  | 21°25.05' N, 109°34.22' E           | Class III                                         |
| 10                 | 21°23.82' N, 109°36.36' E           | Class I                                           |
| 11                 | 21°25.10' N, 109°31.42' E           | Class III                                         |
| 12                 | 21°22.86' N, 109°31.34' E           | Class I                                           |
| 13                 | 21°22.30' N, 109°33.17' E           | Class I                                           |
| 14                 | 21° 20' 20" N, 109° 29' 00" E       | Class I                                           |
| 15                 | 21°25'63" N, 109°27'38" E           | Class I                                           |

#### 4.3.5 Evaluation Methods

Evaluation on the sediments quality shall be done by using the *Marine Sediment Quality* (GB18668-2002) with its required standards.

The single factor quality index method shall be adopted of the evaluation, with the formula as follows:

$$li = Ci / Si$$

Wherein:  $li$ —— quality index for pollutants in the sediments, indicating the sediments have been polluted with  $li > 1$ ;

$Ci$ —— content of pollutants in the sediments;

$Si$ ——evaluation standard.

#### 4.3.6 Monitoring and Evaluation Results

The evaluation on monitoring results was conducted in May 2007. See Table 4.3-4 for monitoring results of sediments and Table 4.3-5 for results of the evaluation.

**Table 4.3-4 Monitoring Results of Marine Sediments ( $\times 10^{-6}$ )**

| Item<br>Station | Organic<br>carbon<br>( $\times 10^{-2}$ ) | Sulfides | Petroleum | Arsenic | Copper | Lead | Total<br>mercury    | Cadmium | Total<br>chromium |
|-----------------|-------------------------------------------|----------|-----------|---------|--------|------|---------------------|---------|-------------------|
| 1#              | 0.63                                      | 5.1      | 16        | 5       | 9      | 4    | $7 \times 10^{-3}$  | <0.05   | 16                |
| 2#              | 0.52                                      | 5.1      | 16        | 6       | 10     | 5    | $7 \times 10^{-3}$  | <0.05   | 14                |
| 3#              | 0.37                                      | 12.6     | 12        | 8       | 9      | 4    | $13 \times 10^{-3}$ | <0.05   | 15                |
| 4#              | 0.36                                      | 3.4      | 14        | <3      | 8      | 4    | $<5 \times 10^{-3}$ | <0.05   | 7                 |
| 5#              | 0.18                                      | 4.6      | 12        | 4       | 17     | 5    | $<5 \times 10^{-3}$ | <0.05   | 9                 |
| 6#              | 0.4                                       | 9.6      | 15        | <3      | 8      | 4    | $11 \times 10^{-3}$ | <0.05   | 7                 |
| 7#              | 0.4                                       | 4.2      | 18        | <3      | 8      | 4    | $<5 \times 10^{-3}$ | <0.05   | 19                |
| 8#              | 0.54                                      | 6.8      | 23        | <3      | 2      | 5    | $18 \times 10^{-3}$ | 0.07    | 5                 |
| 9#              | 0.51                                      | 7.8      | 25        | <3      | 3      | 4    | $17 \times 10^{-3}$ | 0.06    | 10                |
| 10#             | 0.45                                      | 5.4      | 32        | <3      | 3      | 7    | $19 \times 10^{-3}$ | 0.07    | 6                 |
| 11#             | 0.38                                      | 6.3      | 19        | <3      | 3      | 10   | $18 \times 10^{-3}$ | 0.05    | 9                 |
| 12#             | 0.33                                      | 7.9      | 19        | 4       | 2      | 5    | $20 \times 10^{-3}$ | 0.07    | 7                 |
| 13#             | 0.3                                       | 9        | 18        | <3      | 3      | <3   | $18 \times 10^{-3}$ | 0.06    | 4                 |
| 14#             | 0.43                                      | 9.4      | 32        | <3      | 3      | 3    | $19 \times 10^{-3}$ | 0.07    | 12                |
| 15#             | 0.32                                      | 9.8      | 25        | <3      | 3      | 4    | $21 \times 10^{-3}$ | 0.06    | 12                |

Note: "<" stands for the analytical results less than the detection limits of the method adopted by the evaluation and shall be involved in the statistics with 1/2 of the detection limit.

**Table 4.3-5 Sediment Quality Index Table (I<sub>i</sub>)**

| Item<br>Station | Organic<br>carbon<br>(*10 <sup>-2</sup> ) | Sulfides | Petroleum | Arsenic | Copper | Lead | Total<br>mercury | Cadmium | Total<br>mercury |
|-----------------|-------------------------------------------|----------|-----------|---------|--------|------|------------------|---------|------------------|
| 1               | 0.16                                      | 0.01     | 0.01      | 0.05    | 0.05   | 0.02 | 0.01             | 0.01    | 0.06             |
| 2               | 0.13                                      | 0.01     | 0.01      | 0.06    | 0.05   | 0.02 | 0.01             | 0.01    | 0.05             |
| 3               | 0.19                                      | 0.04     | 0.02      | 0.40    | 0.26   | 0.07 | 0.07             | 0.05    | 0.19             |
| 4               | 0.09                                      | 0.01     | 0.01      | 0.02    | 0.04   | 0.02 | 0.00             | 0.01    | 0.03             |
| 5               | 0.05                                      | 0.01     | 0.01      | 0.04    | 0.03   | 0.02 | 0.00             | 0.01    | 0.03             |
| 6               | 0.20                                      | 0.03     | 0.03      | 0.08    | 0.23   | 0.07 | 0.06             | 0.05    | 0.09             |
| 7               | 0.10                                      | 0.01     | 0.01      | 0.02    | 0.23   | 0.02 | 0.02             | 0.01    | 0.07             |
| 8               | 0.14                                      | 0.01     | 0.02      | 0.02    | 0.01   | 0.02 | 0.02             | 0.01    | 0.02             |
| 9               | 0.13                                      | 0.01     | 0.02      | 0.02    | 0.02   | 0.02 | 0.02             | 0.01    | 0.04             |
| 10              | 0.23                                      | 0.02     | 0.06      | 0.08    | 0.09   | 0.12 | 0.10             | 0.14    | 0.08             |
| 11              | 0.10                                      | 0.01     | 0.01      | 0.02    | 0.02   | 0.04 | 0.02             | 0.01    | 0.03             |
| 12              | 0.17                                      | 0.03     | 0.04      | 0.20    | 0.06   | 0.08 | 0.10             | 0.14    | 0.09             |
| 13              | 0.15                                      | 0.03     | 0.04      | 0.08    | 0.09   | 0.03 | 0.09             | 0.12    | 0.05             |
| 14              | 0.22                                      | 0.03     | 0.06      | 0.08    | 0.09   | 0.05 | 0.10             | 0.14    | 0.15             |
| 15              | 0.16                                      | 0.03     | 0.05      | 0.08    | 0.09   | 0.07 | 0.11             | 0.12    | 0.15             |

The results shows that all monitoring factors had been recorded with  $I_i$  less than 1 and that all monitoring items had come up with the Class I & III standards for implementation in the relevant functional areas, as required by the *Quality Standard for Marine Sediments* (GB18668-2002).

## 4.4 Investigation and Evaluation on Current Marine Organisms Quality

### 4.4.1 Investigation Stations

The evaluation quoted the investigation results of current ecological situations of marine organisms conducted by Guangxi Marine Monitoring and Forecast Center from Dec 20th-21st, 2006 over the sea areas of Tieshan Port. Refer to Table 4.4-1 and Fig. 4.4-1 for the positions and layout of investigation stations.

**Table 4.4-1 Investigation Stations of Marine Organisms in Dec. 2006 (Winter)**

| Number of the investigation station | Latitude (N) | Longitude(E) |
|-------------------------------------|--------------|--------------|
| 1                                   | 109°32.87'   | 21°39.50'    |
| 2                                   | 109°35.48'   | 21°35.00'    |
| 3                                   | 109°38.71'   | 21°24.50'    |
| 4                                   | 109°27.87'   | 21°23.00'    |

### 4.4.2 Investigation items and analytical methods

6 items of investigation and analysis include petroleum hydrocarbon, total mercury, arsenic, copper, lead, cadmium. Refer to Table 4.4-2 for analytical methods.

**Table 4.4-2 Methods of sample analysis on current marine organisms' quality**

| Item                         | Analytical method                | Analytical instrument               | Detection limit( $10^{-6}$ ) |
|------------------------------|----------------------------------|-------------------------------------|------------------------------|
| <b>Petroleum hydrocarbon</b> | Fluorescence spectrophotometry   | Fluorophotometer                    | 0.50                         |
| <b>Total mercury</b>         | Atomic fluorescence spectrometry | Atomic fluorescence spectrometer    | 0.002                        |
| <b>Cadmium</b>               | Atomic absorption spectrometry   | Atomic absorption spectrophotometry | 0.02                         |
| <b>Lead</b>                  |                                  |                                     | 0.1                          |
| <b>Copper</b>                |                                  |                                     | 0.1                          |
| <b>Arsenic</b>               | Atomic fluorescence spectrometry | Atomic fluorescence spectrometer    | 0.2                          |

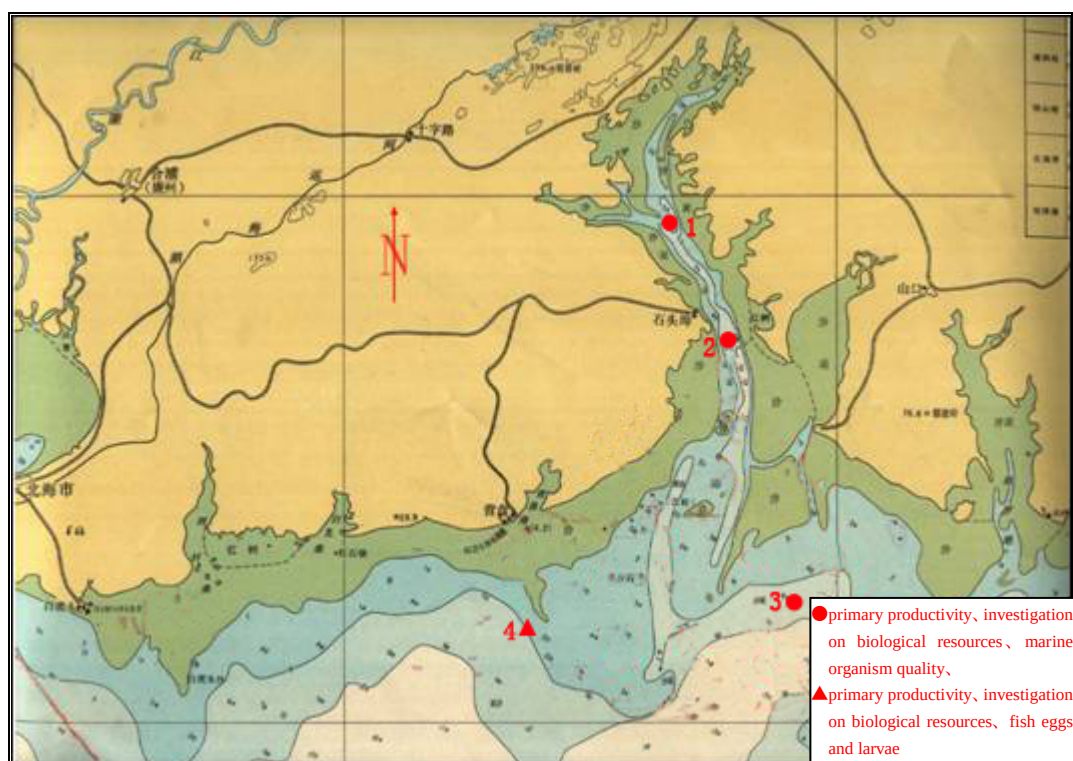


**Fig. 4.4-1 Layout of investigation stations of marine organism quality at Tieshan Port in Dec 2006 (Winter)**

#### 4.4.3 Evaluation standards and methods

Standard values of quality in the GB18421-2001 "Quality Standard for Marine Life" as for Category I (Applicable for marine fishery waters, mariculture areas, marine nature reserves and waters serving industrial use that are directly related to human food) should be applied for the evaluation. Refer to Table 4.4-3 for standard values of the various evaluations factors.

The standard index method is adopted for the evaluation method.

**Table 4.4-3 Standard Values of Shellfishes (Fresh weight): mg/kg**

| Item                           | Category I | Category II | Category III |
|--------------------------------|------------|-------------|--------------|
| <b>Total mercury</b> ≤         | 0.05       | 0.10        | 0.30         |
| <b>Petroleum hydrocarbon</b> ≤ | 15         | 50          | 80           |
| <b>Cadmium</b> ≤               | 0.2        | 2.0         | 5.0          |
| <b>Lead</b> ≤                  | 0.1        | 2.0         | 6.0          |
| <b>Copper</b> ≤                | 10         | 25          | 50           |
| <b>Arsenic</b> ≤               | 1.0        | 5.0         | 8.0          |

Note: Measured by fresh weight of the shelled part of shellfishes.

#### 4.4.4 Investigation and evaluation results

Clams are used as samples for the investigation. Refer to Table 4.4-4 for the analytical results and 4.4-5 for evaluation results.

According to the investigation and evaluation results, all single standard indexes were less than 1, except Pb. Generally, marine organisms' quality in the evaluation sea area is in good condition.

**Table 4.4-4 Situations of marine organism's quality ( $\times 10^{-6}$  wet weight)**

| No. of the station | Name of the organism sample | Total mercury | Cu  | Pb  | Cd   | As  | Petroleum hydrocarbon |
|--------------------|-----------------------------|---------------|-----|-----|------|-----|-----------------------|
| 1                  | Clam                        | 0.003         | 0.6 | 0.5 | 0.12 | 0.8 | 8.37                  |
| 2                  | Clam                        | 0.004         | 1.2 | 1.1 | 0.09 | 0.5 | 5.2                   |
| 3                  | Clam                        | 0.006         | 1.2 | 1.3 | 0.08 | 0.4 | 6.44                  |

**Table 4.4-5 Evaluation results of marine organisms' quality**

| Number of the investigation stations | Name of the organism sample | Total mercury | Cu   | Pb    | Cd   | As   | Petroleum hydrocarbon |
|--------------------------------------|-----------------------------|---------------|------|-------|------|------|-----------------------|
| 1                                    | Clam                        | 0.06          | 0.06 | 5.00  | 0.60 | 0.80 | 0.56                  |
| 2                                    | Clam                        | 0.08          | 0.12 | 11.00 | 0.45 | 0.50 | 0.35                  |
| 3                                    | Clam                        | 0.12          | 0.12 | 13.00 | 0.40 | 0.40 | 0.43                  |

### 4.5 Investigation on Current Situation of Marine Ecology

#### 4.5.1 Contents, stations and investigation methods

The investigation on current situation of marine ecology was carried out by means of methods combining field investigation and data/information collection.

#### 4.5.1.1 Field investigation

Field investigation for the evaluation sea areas at Tieshan Port was authorized by the Institute of Oceanography in South China Sea, Chinese Academy of Sciences on May 2007(summer time), including contents of chlorophyll-a, primary productivity, plankton and benthic animals collected by grab samples, fish eggs and larvae and including the major investigation items including species, quantity, biomass, dominant species, diversity index, uniformity and etc.

Considering the engineering features of the project and its tidal current characteristics in the neighboring sea areas, investigation stations for marine ecology are mainly distributed over the estuary adjacent to the project location and the offshore sea areas at Tieshan Port, including the west and southwest as areas at the further end to waste discharge areas of the project. Refer to Table 4.5-1 and Fig. 4.5-1 for the positions and layout of investigation stations for biological resources of marine ecology.

**Table 4.5-1 Positions of investigation stations for biological resources of marine ecology  
in May 1007 (Summer time)**

| Investigation station/station | Latitude(N) | Longitude(E) |
|-------------------------------|-------------|--------------|
| 1                             | 21°35.30'   | 109°35.47'   |
| 2                             | 21°32.17'   | 109°36.10'   |
| 3                             | 21°30.93'   | 109°38.75'   |
| 4                             | 21°29.53'   | 109°33.87'   |
| 5                             | 21°27.80'   | 109°35.83'   |
| 6                             | 21°26.6'    | 109°32.87'   |
| 7                             | 21°25.03'   | 109°40.20'   |
| 8                             | 21°23.40'   | 109°34.20'   |
| 9                             | 21°22.00'   | 109°28.17'   |
| 10                            | 21°19.77'   | 109°32.25'   |



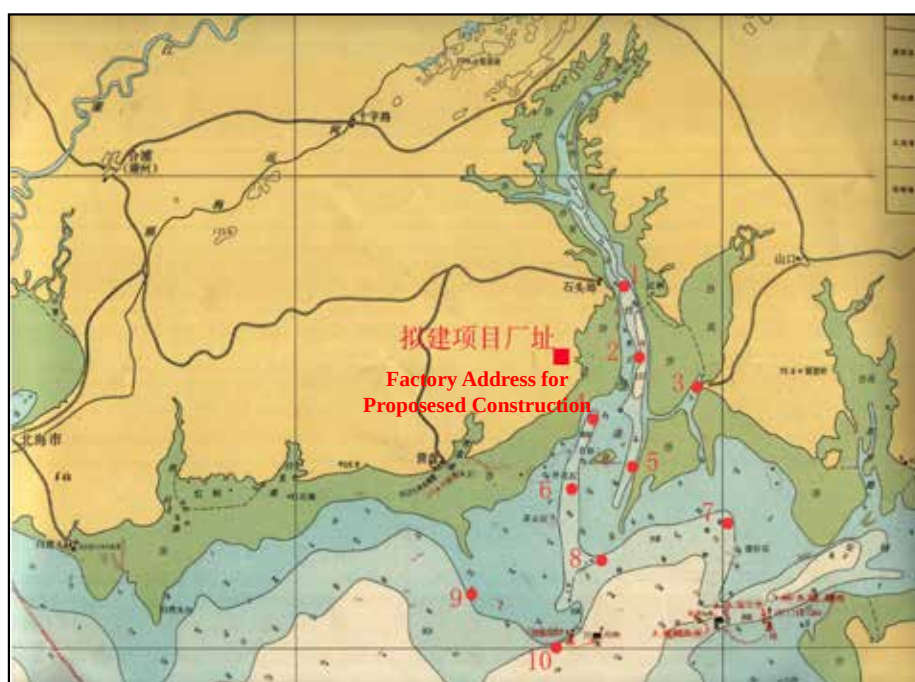


**Fig. 4.5-1 Layout of the investigation stations for biological resources of marine ecology in May 1007 (Summer time)**

#### 4.5.1.2 Data/information collection

(1) Investigation results from current situations of marine organism ecology done by Guangxi Marine Monitoring and Forecast Center during late December 2006, across sea areas at Tieshan Port were collected, including the studies and research on chlorophyll-a, primary productivity, plankton, benthonic animals and fish eggs and larvae. Refer to Table 4.4-1 and Fig. 4.4-1 for the position and layout of investigation stations.

(2) Data of the investigation done by Beihai Environmental Monitoring Center Station of South China Sea Branch, State Ocean Bureau, were collected in April 2005, including benthonic organism collected by trawling, intertidal benthos, fishery resources and etc. Refer to Table 4.5-2 and Fig. 4.5-2 for the position and layout of investigation stations.

**Table 4.5-2 Positions of investigation stations for marine organism, April 2005**

| Number of investigation station | Latitude (N) | Longitude (E) |
|---------------------------------|--------------|---------------|
| 1                               | 21°33.5′     | 109°36.0′     |
| 2                               | 21°29.0′     | 109°36.0′     |
| 3                               | 21°29.0′     | 109°39.0′     |
| 4                               | 21°25.0′     | 109°31.0′     |
| 5                               | 21°25.0′     | 109°33.5′     |
| 6                               | 21°25.0′     | 109°36.5′     |
| 7                               | 21°25.0′     | 109°39.5′     |
| 8                               | 21°22.0′     | 109°31.0′     |
| 9                               | 21°22.0′     | 109°34.0′     |
| 10                              | 21°22.0′     | 109°37.0′     |
| 11                              | 21°27.0′     | 109°33.0′     |
| 12                              | 21°31.2′     | 109°36.0′     |
| 13                              | 21°25.0′     | 109°27.0′     |
| 14                              | 21°24.0′     | 109°13.5′     |

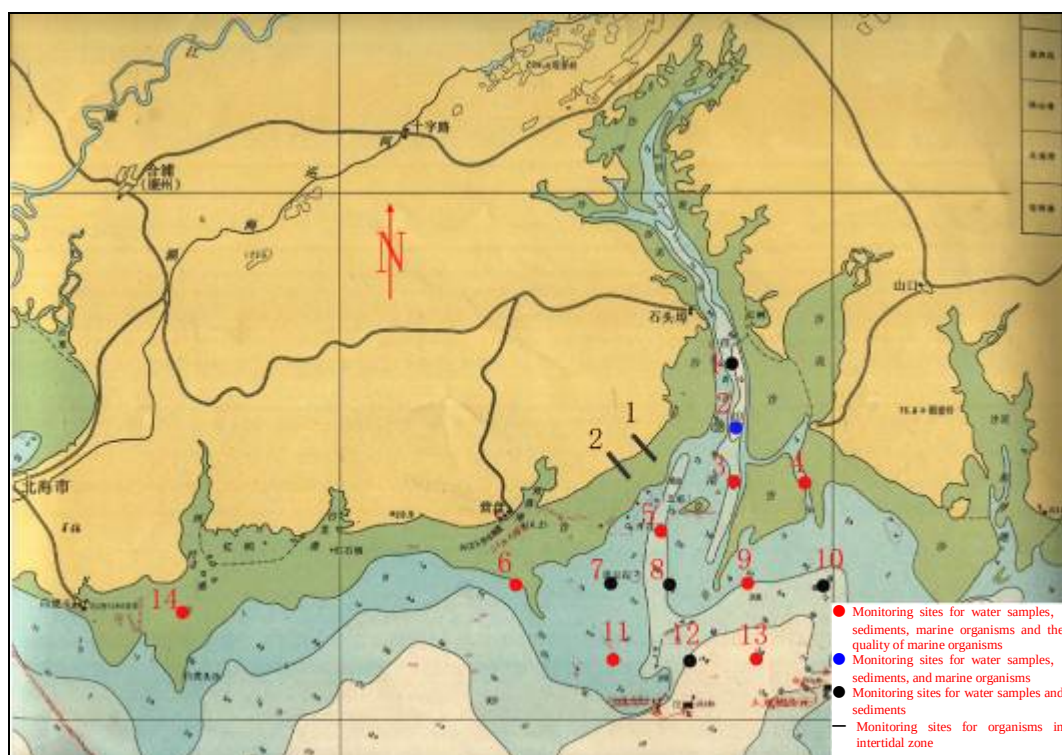


Fig. 4.5-2: Layout of investigation stations for marine organism, April 2005

#### 4.5.1.3 Investigation methods

- (1) Chlorophyll-a: Conduct according to the requirements of "Specification for marine monitoring (GB17378.7-1998)", using fluorimetry as the analytical method;
- (2) Plankton: Conduct according to the requirements of "The specification for oceanographic survey" and "The specification for marine monitoring (GB17378.7-1998)"
- (3) Benthic organism: Conduct according to the investigation method of quantities sampling, using the bottom samplers of 0.05m<sup>2</sup> in the gape opening, with samples being collected for twice at each of the investigation stations and citing g/m<sup>2</sup> as the unit of account in biomass weighting.
- (4) Fish eggs and larvae: Conduct by means of the plankton nets (50cm in opening diameter, 145cm in length and 0.525mm in mesh size), with the plankton nets being trawled vertically for once at each of the investigation stations, varying in the depth of sample-collecting with the water depth at different sites.

#### 4.5.2 Investigation results and evaluation

##### 4.5.2.1 Chlorophyll-a and primary productivity

##### (1) Summer

##### a. Chlorophyll-a

Refer to Table 4.5-3 and Fig. 4.5-3 for the analytical and statistical results of Chlorophyll-a contents at the various investigation stations. According to the investigation results, there had been certain difference of the distribution of Chlorophyll-a contents, with the maximum level of 5.50 mg/m<sup>3</sup> being

recorded at the 4# station and the minimum of  $1.58 \text{ mg/m}^3$  being recorded at the 6# station; While the average content level was  $2.78 \text{ mg/m}^3$  and the offshore sea area adjacent to the Tieshan Port gulf was taken as the high value center of Chlorophyll-a contents.

**Table 4.5-3 Content levels of Chlorophyll-a at the sea areas near the project location during summer ( $\text{mg/m}^3$ )**

| Number of station | 1    | 2    | 3    | 4   | 5    | 6    | 7    | 8   | 9    | 10  |
|-------------------|------|------|------|-----|------|------|------|-----|------|-----|
| Chlorophyll-a     | 2.57 | 4.08 | 3.04 | 5.5 | 2.38 | 1.58 | 2.41 | 2.2 | 1.53 | 2.5 |

According to the evaluation standards given by the US EPA (Environmental Protection Administration) No, no eutrophication of Chlorophyll-a had has ever appeared in the evaluation sea areas, with reference to the evaluation standards given by the US EPA( Environmental Protection Administration), ( $0.3 \sim 2.5 \text{ mg/m}^3$  is the oligotrophic threshold value, and  $50 \sim 140 \text{ mg/m}^3$  is eutrophication value).

#### b. Marine primary productivity

Refer to Table 4.5-4 and Fig. 4.5-4 for the investigation results of marine primary productivity, which had presented with a relatively higher marine primary productivity within the evaluation sea areas under evaluation, ranging from  $365$  to  $705 \text{ mg} \cdot \text{C/m}^2 \cdot \text{d}$ . The marine primary productivity of offshore waters was proved to be higher than that in the further end to the sea shore, with great difference of distribution, while the maximum level was recorded at 2# station and the minimum at 9# station. Besides, the gulf mouth of Tieshan Port was located as the high value area in the investigation.

**Table 4.5-4 Marine primary productivity during summer ( $\text{mg/m}^3$ )**

| Number of stations   | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  |
|----------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Primary productivity | 535 | 705 | 437 | 525 | 566 | 640 | 356 | 447 | 360 | 443 |

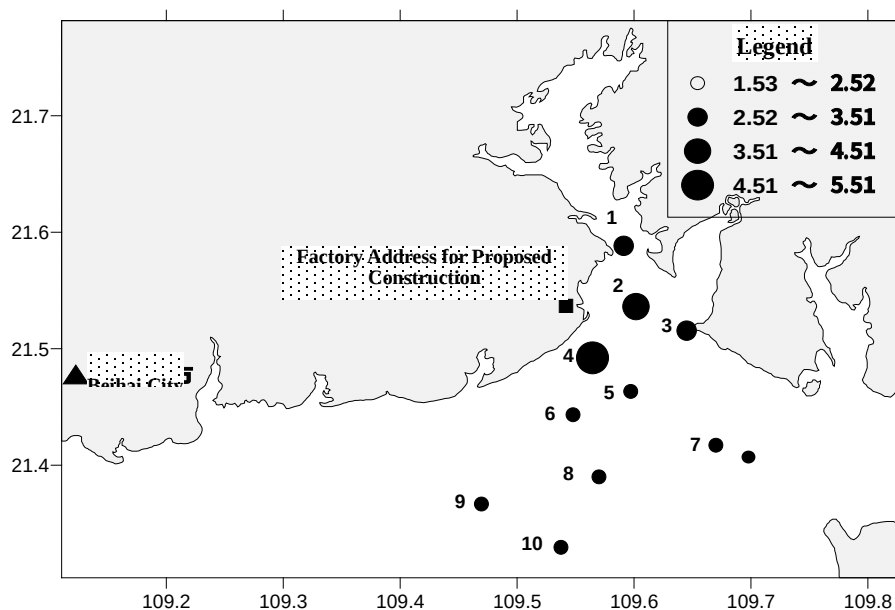


Fig. 4.5-3 Distribution of Chlorophyll-a Contents during Summer ( $\text{mg}/\text{m}^3$ )

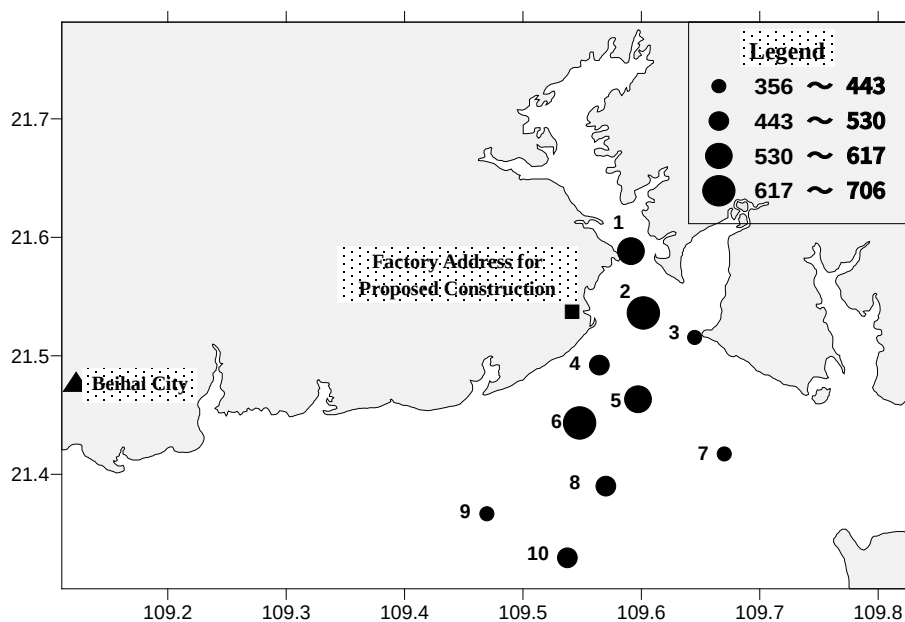


Fig. 4.5-4 Distribution of marine primary productivity during summer ( $\text{mg}\cdot\text{C}/\text{m}^2\cdot\text{d}$ )

## (2) Winter

Refer to Table 4.5-5 for the investigation and analytical results of Chlorophyll-a contents and the calculation results of primary productivity during winter. As shown in the investigation results, the maximum level of Chlorophyll-a contents was recorded  $242.28 \text{ mg}/\text{m}^3$  at 2# station, while the minimum was  $1.58 \text{ mg}/\text{m}^3$  at 4# station; Marine primary productivity ranged from  $53.04$  to  $242.28 \text{ mg}\cdot\text{C}/\text{m}^2\cdot\text{d}$ , with the maximum value at 1# station (inside the gulf), and minimum at 4# station (outside the gulf mouth). In the comparison with Data of summer, Chlorophyll-a contents during winter times were getting lower,

same as for the primary productivity. Meanwhile, values taken inside the gulf were, in all cases, larger than those outside the gulf mouth, during both summer and winter times.

**Table 4.5-5 Chlorophyll-a contents in the evaluation sea areas during winter (mg/m<sup>3</sup>)**

| Number of stations                           |               | 1      | 2      | 3     | 4     |
|----------------------------------------------|---------------|--------|--------|-------|-------|
| Chlorophyll-a(mg/m <sup>3</sup> )            | Surface layer | 2.02   | 2.41   | 1.28  | 1.73  |
|                                              | Bottom layer  | 6.12   | 2.70   | 1.20  | 0.41  |
| Primary productivity(mg·C/m <sup>2</sup> ·d) |               | 242.28 | 141.32 | 58.05 | 53.04 |

### 4.5.3 Phytoplankton (plant plankton)

#### 4.5.3.1 Summer

##### (1)Composition of species

As shown in the investigation results, phytoplankton in the evaluation sea areas were composed of 80 species of 17 genera (Varieties and forma included), among which 77 species of 15 genera of Bacillariophyta (varieties and forma included) account for 96.25% of total species, while 3 species of 2 genera of Pyrrophyta take up 3.75% of the total number. Refer to Annex I for the name list of phytoplankton species.

##### (2)Abundance distribution

As shown in the investigation results, numbers of phytoplankton in the evaluation sea areas fluctuated in great ranges from  $25.56 \sim 333.2 \times 10^6$  cells/m, average value  $116.99 \times 10^6$  cells/m<sup>3</sup>. Phytoplankton at 1# station were recorded to be largest in quantity and density, which amounted to  $333.2 \times 10^6$  cells/m<sup>3</sup>, taking up 28.48% of the total number; followed by 4# station with  $224.41 \times 10^6$  cells/m<sup>3</sup>, as 19.18% of the total number. Minimum density level was recorded at the 8# station of  $25.56 \times 10^6$  cells/m<sup>3</sup>, taking up 2.18% of total amount.

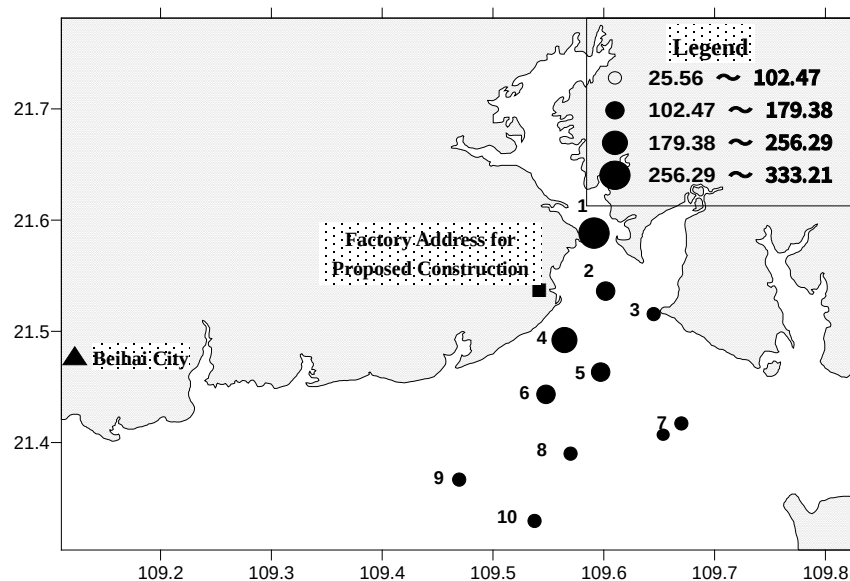


**Fig. 4.5-5 Distribution of phytoplankton in the evaluation sea areas during summer ( $10^6$  cells/ $m^3$ )**

### (3) Composition and abundance of dominant species

Distribution of the species and quantities of phytoplankton in the evaluation sea areas were relatively homogeneous and uniform. *Bacteriastrium* variants and *Bacteriastrium hyalinum* are the major dominant species, whose densities are respectively  $58.24 \times 10^6$  cells/ $m^3$  and  $11.51 \times 10^6$  cells/ $m^3$ .

### (4) Species diversity ( $H'$ ) and uniformity ( $J$ )

Species diversity indicates the amount of phytoplankton, and the functional relationship with regard to the quantitative distribution to each of the individual species, while the uniformity of species reflects the distribution of its total amount.

The following formula can be conducted in the calculation of species diversity index ( $H'$ ) and uniformity ( $J$ ):

$$H' = - \sum_{i=1}^S P_i \log_2 P_i$$

$$J = H' / \log_2 S$$

In which:  $P_i$ ——Ratio of the individuals of  $i$  - species to the total individuals at the specific station;

$S$ ——Total species.

Refer to Table 4.5-6 for the calculation results of  $H'$  and  $J$  of phytoplankton.

**Table 4.5-6 Species diversity (H') and uniformity (J) of phytoplankton during summer**

| Number of stations | Number of species | Diversity index (H') | Uniformity (J) |
|--------------------|-------------------|----------------------|----------------|
| 1                  | 37                | 3.17                 | 0.61           |
| 2                  | 34                | 3.41                 | 0.67           |
| 3                  | 42                | 3.55                 | 0.66           |
| 4                  | 38                | 2.66                 | 0.51           |
| 5                  | 28                | 2.36                 | 0.49           |
| 6                  | 39                | 2.54                 | 0.48           |
| 7                  | 36                | 3.13                 | 0.61           |
| 8                  | 35                | 3.22                 | 0.63           |
| 9                  | 55                | 3.11                 | 0.54           |
| 10                 | 43                | 2.61                 | 0.48           |
| Average            | 38.7              | 2.98                 | 0.57           |

As shown in Table 4.5-6, numbers of phytoplankton at various investigation stations varied from 28 to 55, species from 2.36 to 3.55, average value 2.98; Index of the species uniformity ranged from 0.48 to 0.67, with average number 0.57.

As shown in the investigation results, diversity index for phytoplankton in the evaluation areas was relatively high, without significant difference among the various sites. Meanwhile, distributions of uniformity index and diversity index were relatively consistent with each other, without obvious rules in the spatial distribution and relatively small difference of uniformity recorded at the various sites.

#### 4.5.3.2 Winter

##### (1) Composition of species

During the investigation, altogether 27 species of the 8 genera of phytoplankton were identified at 1# station, among which the diatoms were overwhelmingly dominant with its 26 species of 7 genera, while dinoflagellates accounted for only 1 species of 1 genera. And 45 species of the 15 genera of phytoplankton were identified at 2# station, all of which were of the diatom category. Altogether 63 species of the 22 genera of phytoplankton were identified at 3# station, of which the diatoms were overwhelmingly dominant with its 61 species of 20 genera. Both dinoflagellates and cyanobacterias had 1 species of 1 genus. 27 species of 13 genera of phytoplankton were identified at 4# station, all of which were of the diatom category. Refer to Annex I for the name list of phytoplankton species.

##### (2) Abundance distribution

As shown in the investigation results (Refer to Table 4.5-7), number of phytoplankton in the evaluation sea areas generally ranged from  $2.9 \sim 15 \times 10^6$  cells/m<sup>3</sup>. Maximum quantity and density of phytoplankton were recorded at 2# station, which amounted to  $15 \times 10^6$  cells/m<sup>3</sup>, taking up 43.1% of the total number,



followed by 3# station with  $12 \times 10^6$  cells/m<sup>3</sup>, taking 37.4% of the total number. Minimum density,  $2.9 \times 10^6$  cells/m<sup>3</sup>, was recorded at 4# station of, taking up 4.3% of total. Generally, recorded density of phytoplanktons in the gulf was larger than those out of the gulf.

**Table 4.5-7 Statistics from the investigation on the abundance of phytoplankton during winter times**

| Number of stations                            | 1    | 2     | 3     | 4    |
|-----------------------------------------------|------|-------|-------|------|
| Quantity(numbers)                             | 5724 | 16204 | 14061 | 1633 |
| Density( $\times 10^6$ cells/m <sup>3</sup> ) | 6.3  | 15    | 12    | 2.9  |

### (3) Composition and abundance of dominant species

Distribution of the species and quantities of phytoplankton in the evaluation sea areas are relatively inhomogeneous and ununiform. Cell abundance of phytoplankton at 1# station was recorded to be  $6.3 \times 10^6$  cell/L, of which *Rhizosolenia styliformis* came up with the largest number with  $3.9 \times 10^6$  in quantity, followed by *Thalassionemanitzschoides* with  $9.7 \times 10^5$  of abundance. Meanwhile cell abundance of phytoplankton recorded at 2# station amounted to  $1.5 \times 10^7$  cell/L, of which the *Rhizosolenia styliformis* came up with the largest number with  $1.2 \times 10^7$  in quantity, taking up 80% of the total cells, followed by *Thalassionemanitzschoides*, with  $1.0 \times 10^6$  of abundance. Cell abundance of phytoplankton was recorded  $1.2 \times 10^7$  cell/L at 3# station, dominated by the *Bacteriastrum*, *Chaetoceros* and *Rhizosolenia*. And cell abundance of phytoplankton recorded at 4# station amounted to  $2.9 \times 10^6$  cell/L, of which the *Rhizosolenia styliformis* came up with the largest number with  $1.7 \times 10^6$  in quantity, taking up 58.6% of the total cells, followed by *Thalassionemanitzschoides*, of  $3.7 \times 10^5$  in abundance.

As far as the entire areas under investigation were concerned, the major dominant species shall include *Rhizosolenia styliformis* and *Thalassiosira subtilis*, with  $17.1 \times 10^6$  cells/m<sup>3</sup> and  $3.9 \times 10^6$  cells/m<sup>3</sup> of density.

### (4) Species diversity (H') and uniformity (J)

Refer to Table 4.5-8 for the calculation results for H' and J of phytoplankton.

**Table 4.5-8 Species diversity (H') and uniformity (J) of phytoplankton during winter**

| Number of stations | Number of species | Diversity index (H') | Uniformity (J) |
|--------------------|-------------------|----------------------|----------------|
| 1                  | 27                | 2.18                 | 0.46           |
| 2                  | 44                | 1.59                 | 0.29           |
| 3                  | 62                | 3.76                 | 0.63           |
| 4                  | 26                | 2.11                 | 0.44           |
| Average            | 40                | 2.41                 | 0.46           |

As shown by Table 4.5-8, numbers of phytoplankton at the various investigation stations varied from 26 to 62, species diversity from 1.59 to 3.7, average value 2.41; Index of the species uniformity ranged from 0.29 to 0.63, average number 0.46.

#### (5) Comparison result

Compared to the investigation results of phytoplankton during the winter times, there was no significant difference between numbers of species and biodiversity indices of phytoplankton investigated during the summer and winter. Composition of species and numbers of their quantities had shown relatively large differences. The distribution laws could be summarized that phytoplankton at the side of Shatian sea areas had displayed more diversity than those at the side of Yingpan seas areas.

### 4.5.4 Zooplankton (animal plankton)

#### 4.5.4.1 Summer

##### (1) Composition of species and population structure

After close identification Zooplanktons of investigation include 54 species(including the 17 species of pelagic larvae) , with 4 species of medusae, 1 species of ctenophores, 3 species of copepods, 1 species of decapods, 5 species of chaetognaths, 2 species of tunicates and 17 groups or types of pelagic larvae. Investigation was carried out in coastal water areas of Beibu Gulf, where zooplanktons are mainly composed of neritic warm-water species due to coastal water mass of high temperature and high salinity of Beibu Gulf, including *Octophialucium indicum*, *Pseuevadne tergestina*, *Acartia erythraea*, *Calanopia thompsis*, *Pontellopsis yamadae*, *Tortanus forcipatus*, *Subeucalanus subcrassus*, *Oithona brevicornis*, *Sagitta delicate*, *Sagitta johorensis* and etc. Besides, the runoff stream flows had also brought up with some of the estuarine species, as *Acartia spinicauda* and *Pseudodiaptomus marinus*. Zooplanktons in the sea areas of evaluation according to the environmental conditions and their Composition of species and ecological habits are the groups inhabiting in the neritic warm-water.

Refer to Annex II for the name list of zooplanktons species.

##### (2) Biomass and density distribution

According to the investigation results (Refer to Table 4.5-9 and Fig. 4.5-6), biomass of zooplanktons in the sea areas of evaluation varied from 112 to 190  $\text{mg/m}^3$ , average value 148  $\text{mg/m}^3$ . Overall distribution of the total population was relatively uniform, while levels of biomass recorded at 3#, 4#, 5# and 6# station were relatively higher, all of which were above 150  $\text{mg/m}^3$ .

**Table 4.5-9 Biomass distribution of zooplanktons during summer ( $\text{mg/m}^3$ )**

| Number of stations | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | Average value |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---------------|
| Biomass            | 142 | 143 | 170 | 190 | 175 | 154 | 112 | 135 | 130 | 126 | 148           |

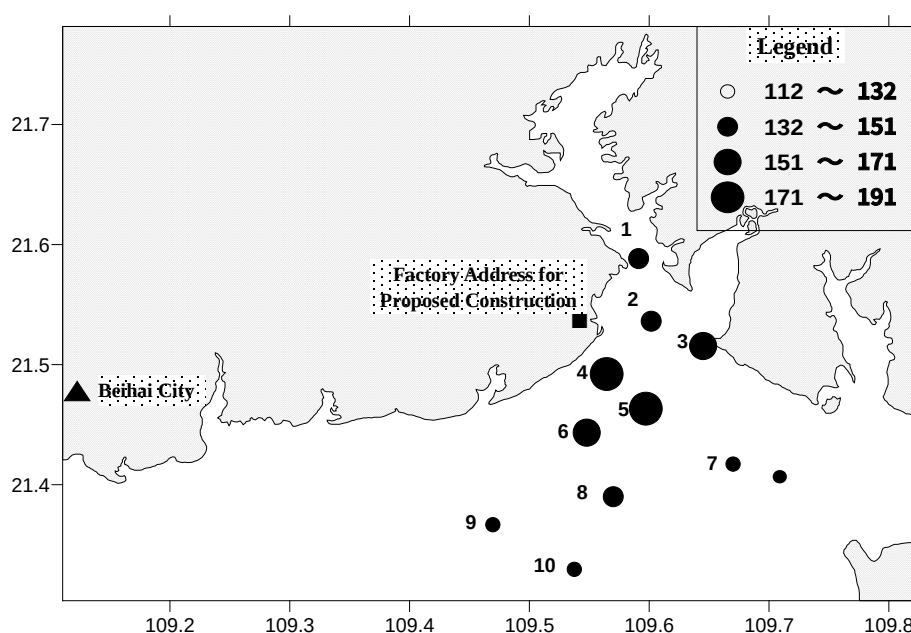


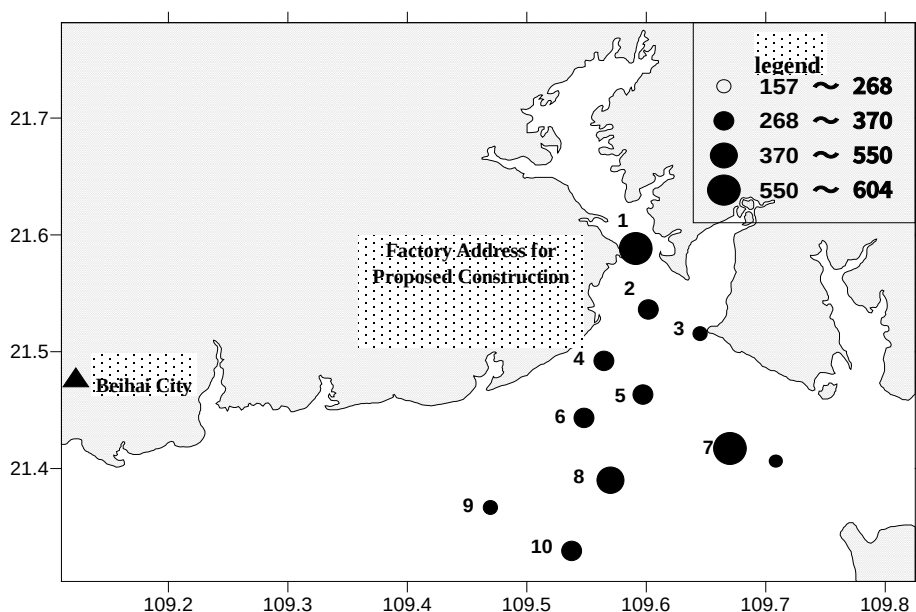
**Fig. 4.5-6 Biomass distribution of zooplanktons during summer ( $\text{mg/m}^3$ )**

Zooplanktons density in the sea areas of evaluation was relatively higher, average value reaching as much as 369.5  $\text{ind/m}^3$ , which were mainly concentrated at 1#, 7# and 8# station, with the numbers reaching 529  $\text{ind/m}^3$  (Refer to Table 4.5-10 and Fig. 4.5-7). Cirripedia nauplius and Brachyura zoea larva were main components at 1# station located near to the mouth of gulf, as the Brachyura zoea larvae and T.forcipaius.

Tendencies of biomass and total density distribution of Zooplanktons aren't entirely identical, mainly contributing to composition of species and individual size. Taking Cirripedia nauplius as an example, in spite of the abundance in quantity, their contribution to the total biomass remained insignificant due to their tiny size of each individual larva.

**Table 4.5-10 Quantitative distribution of individual zooplankton (ind/m<sup>3</sup>)**

| Number of stations | 1     | 2     | 3     | 4   | 5     | 6     | 7     | 8     | 9   | 10  | Average value |
|--------------------|-------|-------|-------|-----|-------|-------|-------|-------|-----|-----|---------------|
| Biomass            | 603.3 | 335.6 | 157.5 | 356 | 355.4 | 331.5 | 556.7 | 529.3 | 190 | 280 | 369.5         |

**Fig. 4.5-7 Distribution of total density of zooplanktons during summer(mg/m<sup>3</sup>)**

### (3) Dominant groups and their quantitative distribution

As shown by the investigation results, average density of zooplankton larvae was 221.3 ind/m<sup>3</sup>, taking up 59.9% of the total zooplanktons density, as the top 1 in the list. Numbers of larvae reached the maximum value at 1# station, which amounted to 468.3 in quantity and was followed by 7# station, while 9# station claimed to be the least with only 77.1 ind/m<sup>3</sup> Total number of population. Numbers recorded at the rest of the stations were relatively consistent with one other, varying between 117.1~249.3 ind/m<sup>3</sup> generally. In terms of their dominance among the total population of zooplankton, the larvae were sorted in order, from the highest to the lowest, as Brachyura zoea larvae, Cirripedia nauplius, fish eggs and macrura larvae.

Average density of copepods was 94.5 ind/m<sup>3</sup>, taking up 25.6% in the total density of zooplanktons, as the second one on the list, which were mainly distributed over the 7#, 8# and 10# station, with all values of density going higher than 114 ind/m<sup>3</sup>, while results taken from the other stations, in comparison, were all below 80 ind/m<sup>3</sup>. Of the copepods species, T.forcipaius was the overwhelming dominant figure.

### (4) Dominant species and their distribution

Dominant species are mainly composed of Brachyura zoea larvae, T.forcipaius, Cirripedia nauplius and etc. Densities of the above-mentioned dominant species, which were in general distribution over the entire evaluation sea areas, added up to 50.5% of total zooplanktons density (Refer to Table 4.5-11). Brachyura zoea larvae and T.forcipaius were mainly distributed over the 7#, 8# and 1# station, while Cirripedia nauplii were concentrated over the 1# station.

**Table 4.5-11 Dominant species of zooplanktons and their quantity proportion during summer**

| Species               | Average density (ind/m <sup>3</sup> ) | Proportion of the total zooplanktons density (%) |
|-----------------------|---------------------------------------|--------------------------------------------------|
| Brachyura zoea larvae | 81.3                                  | 22                                               |
| T.forcipaius          | 55.6                                  | 15.1                                             |
| Cirripedia nauplius   | 49.7                                  | 13.4                                             |

#### (5) Diversity index and uniformity

Refer to Table 4.5-12, Fig. 4.5-8 and 4.5-9 for the calculated results of diversity index and uniformity of zooplanktons herein of the evaluation. As it showed, zooplanktons of the evaluation sea areas were relatively diversified in their species, with relatively high values of diversity index, average value 3.436. Diversity index recorded at 3# station was comparatively lower, while the rest of the stations had shown little differences, with relatively uniform species distribution as a whole. Meanwhile, values of uniformity were also relatively high, average number 0.753, among which the maximum values were recorded at 9# and 3# station.

**Table 4.5-12 Diversity index and uniformity of zooplanktons**

| Number of stations | Number of species (S) | Diversity index (H') | Uniformity (J) |
|--------------------|-----------------------|----------------------|----------------|
| 1                  | 26                    | 3.088                | 0.657          |
| 2                  | 26                    | 3.643                | 0.775          |
| 3                  | 9                     | 2.64                 | 0.833          |
| 4                  | 25                    | 3.69                 | 0.795          |
| 5                  | 30                    | 3.689                | 0.752          |
| 6                  | 30                    | 3.827                | 0.78           |
| 7                  | 33                    | 3.431                | 0.68           |
| 8                  | 27                    | 3.299                | 0.694          |
| 9                  | 20                    | 3.632                | 0.84           |
| 10                 | 26                    | 3.423                | 0.728          |
| Average            | 25.2                  | 3.436                | 0.753          |

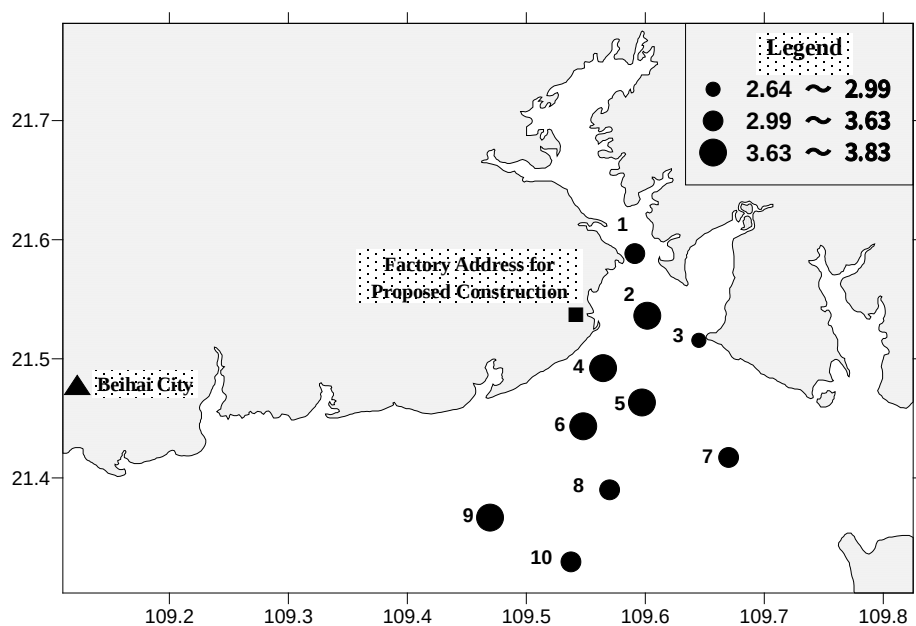


Fig. 4.5-8 Distribution of diversity index of zooplanktons during summer

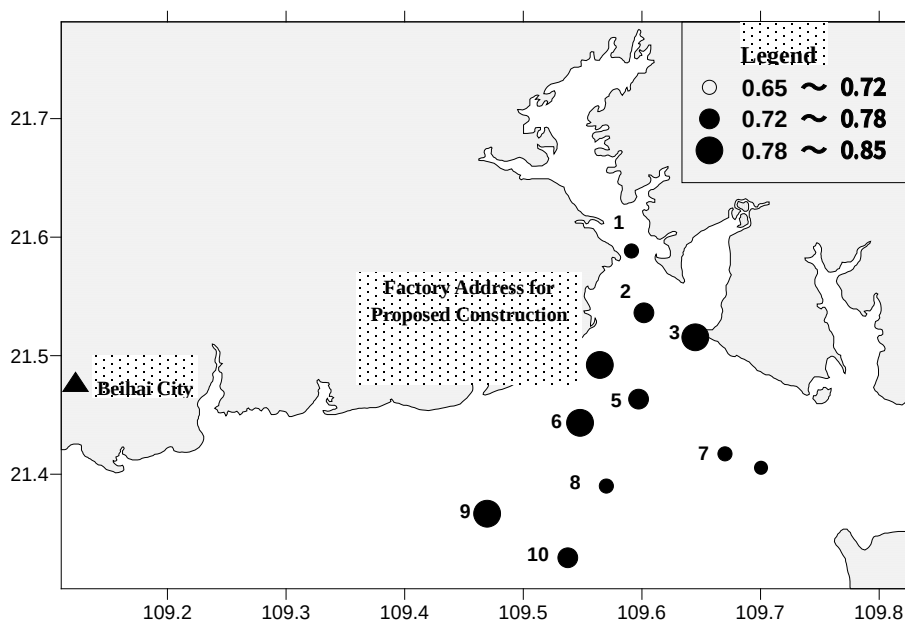


Fig. 4.5-9 Distribution of zooplanktons uniformity during summer

#### 4.5.4.2 Winter

##### (1) Composition of species and population structure

Zooplankton of investigation, after close identification, were named to be in 28 species of 6 categories, with 11 species of Clamorers, as 50% of the total number; followed by pelagic larvae, with 7 species as 32.1% of the total number; 4 species of chaetognaths, as 14.3% of the total number; 2 species of the Lucifer and 1 species of tunicates. Refer to Annex II for the name list of zooplanktons species.

##### (2) Biomass and density distribution

According to the investigation results (Refer to Table 4.5-13), biomass of zooplanktons in the evaluation

sea areas varied between 10.1 to 99.0mg/m<sup>3</sup>, with 54.3 mg/m<sup>3</sup> on average. The maximum biomass of zooplanktons was recorded at 4# station located at the south of Yingpan sea area.

Average uniformity of zooplanktons was 44.3ind/m<sup>3</sup>, with rather ununiform distribution, which mainly concentrated over the 3# station of about 84.0 ind/ m<sup>3</sup> in actual numbers.

**Table 4.5-13 Distribution of zooplankton biomass and uniformity during winter**

| Number of stations            | 1    | 2    | 3    | 4    | Average value |
|-------------------------------|------|------|------|------|---------------|
| Biomass                       | 10.1 | 48.5 | 59.5 | 99.0 | 54.3          |
| Density (ind/m <sup>3</sup> ) | 13.6 | 46.5 | 84.0 | 33.0 | 44.3          |

### (3) Dominant species and their distribution

Dominant species were mainly composed of: T.forcipaius at 1# station; Temora turbunata (Dana) at 2# station; Temora turbunata(Dana), Sagittaenflata and Cypris Larva (Balanus) at 3# station; Macrura larvae and Temora turbunata(Dana) at 4# station.

As far as the entire areas under investigation were concerned, the major dominant species shall include Temora turbunata(Dana), Tortanus forcipatus (Giesbrecht), Cypris Larva (Balanus) and etc, all of which were in common distribution in the evaluation sea area. Temora turbunata(Dana) and Cypris Larva (Balanus) were mainly distributed over 2# and 3# station, while Tortanus forcipatus (Giesbrecht) had displayed relatively uniform distribution in comparison.

### (5) Diversity index and uniformity

Refer to Table 4.5-14 for the calculation results of diversity index and uniformity of zooplanktons herein of the evaluation. As it showed, average diversity index of zooplanktons in the evaluation sea areas were 3.12, while the average value of uniformity were shown to be 0.84. Diversity index and values of uniformity recorded at 1# station was comparatively lower, while the rest of the stations had shown little differences, with relatively uniform species distribution as a whole.

**Table 4.5-14 Diversity index and uniformity of zooplanktons**

| Number of stations | Number of species (S) | Diversity index(H') | Uniformity(J) |
|--------------------|-----------------------|---------------------|---------------|
| 1                  | 6                     | 1.73                | 0.67          |
| 2                  | 16                    | 3.37                | 0.84          |
| 3                  | 18                    | 3.71                | 0.89          |
| 4                  | 14                    | 3.65                | 0.96          |
| Average            | 14                    | 3.12                | 0.84          |

## (6) Comparison result

Compared to the investigation results of zooplanktons during the summer times, there had been no significant difference between zooplanktons investigated during the summer and winter in their numbers of species and biodiversity indices, while the Composition of species and numbers of their quantities had shown relatively large differences, only as a result of the seasonal variation. The distribution laws could be summarized as it that zooplanktons at the gulf mouth areas had displayed more abundance in species than those inside the gulf.

### 4.5.5 Fish eggs and larvae

#### 4.5.5.1 Summer

##### (1) Species and quantitative composition of fish eggs

Samples of fish eggs and larvae-juvenile collected herein of the investigation were divided into 5 orders, 9 families, 10 species and 3 other unidentified species. Refer to Annex IV for the species of collected samples (name list of fish eggs and larvae-juvenile).

For species and quantitative composition of fish eggs collected herein of the investigation, please refer to Table 4.5-15, which showed that fish eggs were in relatively large quantity at 6# and 10 #station in nearby sea areas of the project location, respectively accounting for 18.24% and 45.29% of the total number, while the rest of the investigation stations had shown relatively lower amount of fish eggs. In terms of the Composition of species, fish eggs of the herrings were in the overwhelming dominant position in the evaluation sea areas, among which the *Sardinella* eggs had taken up 34.33% of total eggs in the evaluation sea areas.

**Table 4.5-15 Quantities and Composition of species of fish eggs during summer**

| Number of stations | Quantity (piece/m <sup>3</sup> ) | Proportion of the total amount of investigation % | Major Composition of species |          |                                                   |
|--------------------|----------------------------------|---------------------------------------------------|------------------------------|----------|---------------------------------------------------|
|                    |                                  |                                                   | Name                         | Quantity | Proportion of the total amount of investigation % |
| 1                  | 3.33                             | 3.06                                              | Genus <i>Leiognathus</i>     | 3.33     | 100                                               |
| 2                  | 12.4                             | 11.38                                             | Gilt sardines                | 10.4     | 83.87                                             |
|                    |                                  |                                                   | Genus <i>Leiognathus</i>     | 0.8      | 6.45                                              |
|                    |                                  |                                                   | unidentified species         | 1.2      | 9.68                                              |
| 3                  | 2.5                              | 2.29                                              | Genus <i>Leiognathus</i>     | 2.5      | 100                                               |
| 4                  | 4                                | 3.67                                              | Genus <i>Leiognathus</i>     | 4        | 100                                               |
| 5                  | 6.15                             | 5.65                                              | <i>Sillago sihama</i>        | 2.31     | 37.5                                              |
|                    |                                  |                                                   | Genus <i>Leiognathus</i>     | 2.31     | 37.5                                              |
|                    |                                  |                                                   | unidentified species         | 1.53     | 25                                                |



| Number of stations | Quantity (piece/m <sup>3</sup> ) | Proportion of the total amount of investigation % | Major Composition of species  |          |                                                   |
|--------------------|----------------------------------|---------------------------------------------------|-------------------------------|----------|---------------------------------------------------|
|                    |                                  |                                                   | Name                          | Quantity | Proportion of the total amount of investigation % |
| 6                  | 38.5                             | 35.34                                             | Gilt sardines                 | 27       | 70.13                                             |
|                    |                                  |                                                   | Stolephorus anchovy           | 0.5      | 1.3                                               |
|                    |                                  |                                                   | Sillago sihama                | 1.5      | 3.89                                              |
|                    |                                  |                                                   | Genus Leiognathus             | 7        | 18.18                                             |
|                    |                                  |                                                   | Family Cynoglossidae          | 1        | 2.6                                               |
|                    |                                  |                                                   | unidentified species          | 1.5      | 3.9                                               |
| 7                  | 7.78                             | 7.14                                              | Genus Leiognathus             | 6.11     | 78.57                                             |
|                    |                                  |                                                   | Family Cynoglossidae          | 1.67     | 21.43                                             |
| 8                  | 12.86                            | 11.8                                              | T.mystax (Bloch et Schneider) | 1.43     | 11.11                                             |
|                    |                                  |                                                   | Genus Leiognathus             | 9.29     | 72.22                                             |
|                    |                                  |                                                   | unidentified species          | 2.14     | 16.67                                             |
| 9                  | 5.71                             | 5.24                                              | Genus Leiognathus             | 5.71     | 100                                               |
| 10                 | 15.71                            | 14.42                                             | Stolephorus anchovy           | 7.14     | 45.45                                             |
|                    |                                  |                                                   | Genus Leiognathus             | 8.57     | 54.55                                             |

## (2) Quantity and composition of species of fish larvae

For the quantity and Composition of species of fish larvae refer to Table 4.5-16, which showed that fish larvae herein of the investigation were found to be in relatively large quantity at 1# and 5 #station, respectively accounting for 24.01% and 25.86% of the total number. In terms of the Composition of species, fish larvae of the herrings were in the overwhelming dominant position, of which the Sardinella larvae had taken up 69.46% of the total number of larvae in the evaluation sea areas.

**Table 4.5-16 Quantities and Composition of species of fish larvae during summer**

| Number of stations | Quantity (piece/m <sup>3</sup> ) | Proportion of the total amount of investigation % | Major Composition of species |          |                                                   |
|--------------------|----------------------------------|---------------------------------------------------|------------------------------|----------|---------------------------------------------------|
|                    |                                  |                                                   | Name                         | Quantity | Proportion of the total amount of investigation % |
| 1                  | 10                               | 24.01                                             | Gilt sardines                | 9.17     | 91.67                                             |
|                    |                                  |                                                   | Genus Leiognathus            | 0.83     | 8.33                                              |
| 2                  | 1.6                              | 3.84                                              | Gilt sardines                | 0.4      | 25                                                |
|                    |                                  |                                                   | Family Mugilidae             | 0.4      | 25                                                |
|                    |                                  |                                                   | Family Gobiinae              | 0.8      | 50                                                |
| 3                  | 2.5                              | 6                                                 | Family Mugilidae             | 2.5      | 100                                               |
| 4                  | 8                                | 19.21                                             | Gilt sardines                | 6        | 75                                                |
|                    |                                  |                                                   | Cynoglossidae                | 2        | 25                                                |
| 5                  | 10.77                            | 25.86                                             | Gilt sardines                | 10       | 92.86                                             |
|                    |                                  |                                                   | Family Gobiinae              | 0.77     | 7.14                                              |
| 6                  | 2.5                              | 6                                                 | Gilt sardines                | 0.5      | 20                                                |
|                    |                                  |                                                   | Family Mugilidae             | 0.5      | 20                                                |
|                    |                                  |                                                   | Genus Leiognathus            | 1        | 40                                                |
|                    |                                  |                                                   | Cynoglossidae                | 0.5      | 20                                                |
| 7                  | 0.56                             | 1.34                                              | Nemipterus Japonicus         | 0.56     | 100                                               |
| 8                  | 1.43                             | 3.43                                              | Family Gobiinae              | 0.715    | 50                                                |
|                    |                                  |                                                   | Nemipterus Japonicus         | 0.715    | 50                                                |
| 9                  | 2.86                             | 6.87                                              | Gilt sardines                | 2.86     | 100                                               |
| 10                 | 1.43                             | 3.43                                              | Family Sciaenidae            | 1.43     | 100                                               |

Meanwhile, *ilishaelongata* (Chinese herring) of the family herreing also takes up for a large proportion in the catch volume of fishing products, in consistence with its dominance in the fish larvae.

#### 4.5.5.1 Winter

The winter investigation was only carried at 4 #station to collect fish eggs and larvae. For analytical results of the samples collected, refer to Table 4.5-17. Only one species of fish egg was at 4 #station, including *Therapon jarbus*, together with 3 species of fish larvae.

**Table 4.5-17 Quantities and Composition of species of fish eggs and larvae during winter**

| Name        | Number(m <sup>3</sup> ) | Species                                            |
|-------------|-------------------------|----------------------------------------------------|
| Fish eggs   | 3.0                     | <i>Therapon jarbus</i> (Forsk.)                    |
| Fish larvae | 2.0                     | <i>Sillago sihama</i> (Forsk.), Gobiidae, Soleidae |

#### 4.5.6 Benthic organisms

##### 4.5.6.1 Grab sampling Benthic organisms

##### (1) Composition of species and population structure

After close identification, grab sampling Benthic organisms of investigation include 35 species, 13 of which are polychaeta, 2 crustacea, 10 Mollusca, 8 Echinodermata, 1 Echiura and 1 Phylum Chordata. Refer to Annex III for the detailed name list of species. The polychaeta species occupies the first place. (Refer to Table 4.5-18 and 4.5-19)

**Table 4.5-18 Species numbers of benthic organism groups collected by grab samples**

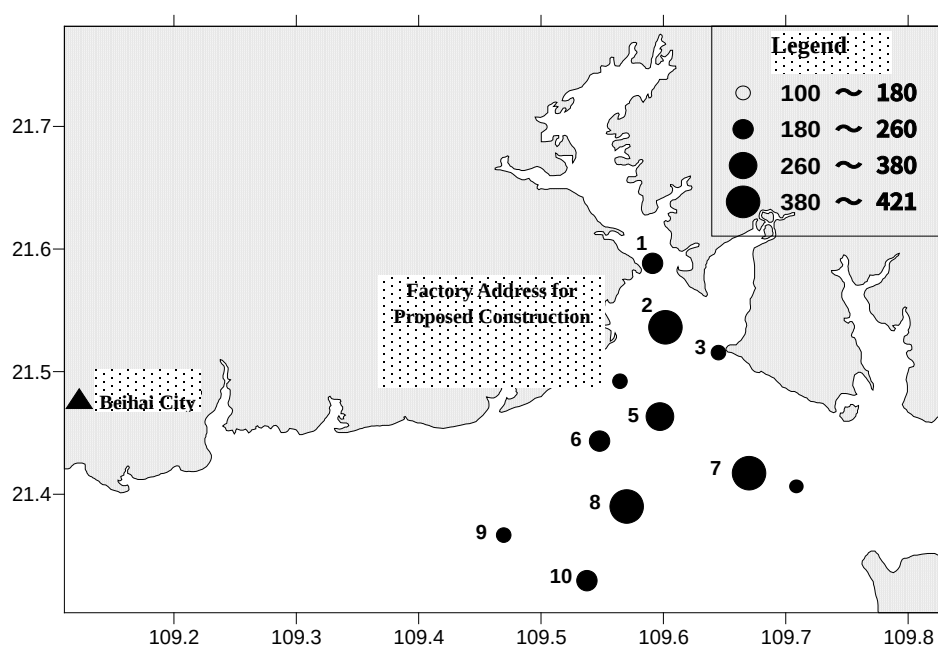
| Groups          | Species number | Percentage(%) |
|-----------------|----------------|---------------|
| Polychaeta      | 13             | 37.14         |
| Crustacea       | 2              | 5.71          |
| Mollusca        | 10             | 28.57         |
| Echinodermata   | 8              | 22.86         |
| Echiura         | 1              | 2.86          |
| Phylum Chordata | 1              | 2.86          |
| Total           | 35             | 100           |

**Table 4.5-19 Species of major organisms collected by grab samples at investigation stations**

| Site | Major species                                                 |
|------|---------------------------------------------------------------|
| 1    | <i>Capulus dilatatus</i> <i>Amphipholis loripes</i>           |
| 2    | <i>Melanella martini</i> <i>Mensamaria intercedens</i>        |
| 3    | <i>Aglaophamus vietnamensis</i> <i>Notomastus cf. aberans</i> |
| 4    | <i>Haploscoloplos elongatus</i>                               |
| 5    | <i>Ophiocentrus anomalus</i> <i>Turritella bacillum</i>       |
| 6    | <i>Moerella jodoensis</i> <i>Diopatra variabilis</i>          |
| 7    | <i>Branchiostoma belcheri</i>                                 |
| 8    | <i>Branchiostoma belcheri</i>                                 |
| 9    | <i>Lumbrineris nagaee</i>                                     |
| 10   | <i>Turritella bacillum</i>                                    |

**(2) Distribution of individual quantities**

According to the investigation, individual quantities of grab sampling Benthonic organisms varied between 100 to 420 ind/m<sup>3</sup>, average value 256 ind/m<sup>2</sup>, of with grab sampling Benthonic organisms at 7# and 8 #station were recorded with the largest number of quantity and density, which amounted to 420 ind/m<sup>2</sup>, dominated by *Branchiostoma belcheri*. Minimum density was recorded to be 100 ind/m<sup>2</sup> at 4# and 9 #station. (Refer to Fig. 4.5-10)

**Fig. 4.5-10 Distribution of inhabiting densities of grab sampling Benthonic organisms(ind/m<sup>2</sup>)**

Refer to Table 4.5-20 for the average density and proportion of various benthonic organism groups collected by grab samples. As we may see, the major groups of grab sampling Benthonic organisms in

the evaluation sea areas are mainly composed of Phylum Chordata, Mollusca and Polychaeta, whose average quantity are respectively 72 ind/m<sup>2</sup>, 62 ind/m<sup>2</sup> and 60 ind/m<sup>2</sup> of, taking up 28.13%, 24.22% and 23.44% of the total number herein of the grab sampling Benthonic organisms respectively, followed by Echinodermata, Crustacea and Echiura.

**Table 4.5-20 Inhabiting densities of grab sampling Benthonic organisms(ind/m<sup>2</sup>)**

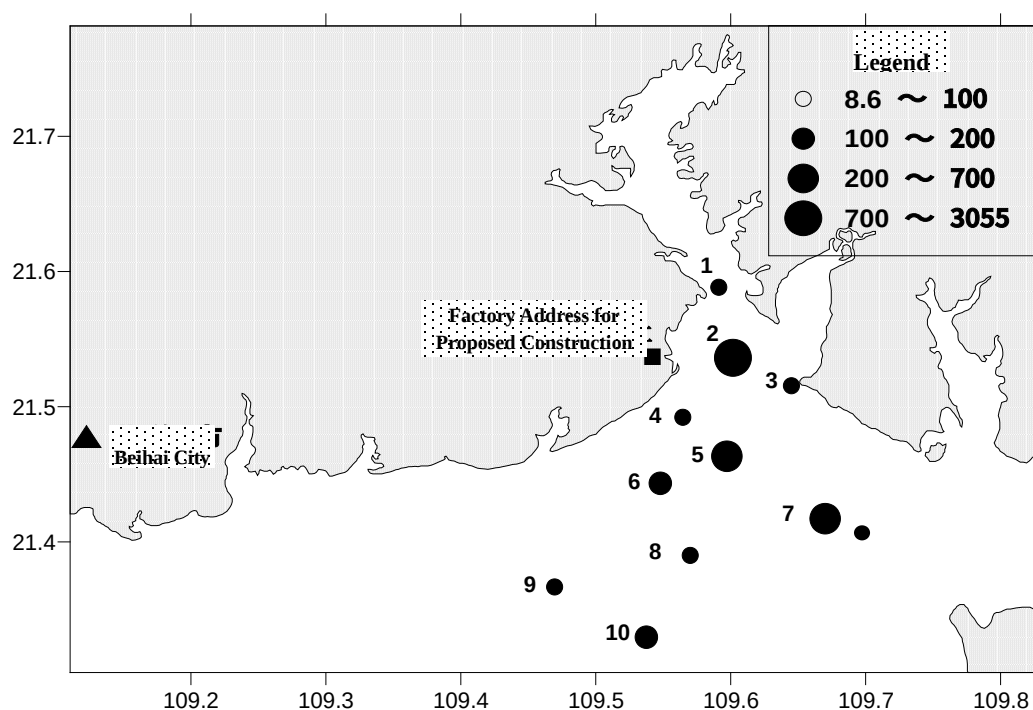
| No. of the station | Polychaeta | Crustacea | Mollusca | Echinodermata | Echiura | Phylum Chordata | Total |
|--------------------|------------|-----------|----------|---------------|---------|-----------------|-------|
| 1                  | 40         |           | 60       | 100           |         |                 | 200   |
| 2                  |            |           | 160      | 220           |         |                 | 380   |
| 3                  | 120        | 20        | 20       |               |         |                 | 160   |
| 4                  | 60         |           | 20       | 20            |         |                 | 100   |
| 5                  | 80         | 40        | 120      | 80            |         |                 | 320   |
| 6                  | 100        |           | 80       | 20            | 20      |                 | 220   |
| 7                  | 20         |           | 20       |               |         | 380             | 420   |
| 8                  | 40         |           | 20       | 40            |         | 320             | 420   |
| 9                  | 60         |           |          | 20            |         | 20              | 100   |
| 10                 | 80         |           | 120      | 40            |         |                 | 240   |
| Average            | 60         | 6         | 62       | 54            | 2       | 72              | 256   |
| Percentage%        | 23.44      | 2.34      | 24.22    | 21.09         | 0.78    | 28.13           | 100   |

### (3)Biomass

Biomass of grab sampling Benthonic organisms of the investigation ranged between 8.6 to 3054.2g/m<sup>2</sup>. (Refer to Fig. 4.5-11), with an average value of 459.96g/m<sup>2</sup>, most of which are Echinodermata and Mollusca (average values are respectively 224.58g/m<sup>2</sup> and 220.04g/m<sup>2</sup> of biomass at 10 investigation stations, taking up 48.83% and 47.84%), followed by Phylum Chordata (9.44g/m<sup>2</sup>, 2.05%), Polychaeta, Crustacea and Echiura in turn. (Refer to Table 4.5-21)

**Table 4.5-21 Biomasses of grab sampling Benthic organisms (g/m<sup>2</sup>)**

| No. of the station | Polychaeta | Crustacea | Mollusca | Echinodermata | Echiura | Phylum Chordata | Total  |
|--------------------|------------|-----------|----------|---------------|---------|-----------------|--------|
| 1                  | 1.6        |           | 5.4      | 72.2          |         |                 | 79.2   |
| 2                  |            |           | 961.6    | 2092.6        |         |                 | 3054.2 |
| 3                  | 13         | 3.4       | 6.2      |               |         |                 | 22.6   |
| 4                  | 4.4        |           | 2.6      | 1.6           |         |                 | 8.6    |
| 5                  | 4.4        | 9         | 503.4    | 7.4           |         |                 | 524.2  |
| 6                  | 6.8        |           | 175.6    | 1.6           | 3.8     |                 | 187.8  |
| 7                  | 1          |           | 391.4    |               |         | 63.2            | 455.6  |
| 8                  | 4          |           | 38.4     | 25.4          |         | 29.6            | 97.4   |
| 9                  | 5          |           |          | 15.2          |         | 1.6             | 21.8   |
| 10                 | 2.6        |           | 115.8    | 29.8          |         |                 | 148.2  |
| Average            | 4.28       | 1.24      | 220.04   | 224.58        | 0.38    | 9.44            | 459.96 |
| Percentage%        | 0.93       | 0.27      | 47.84    | 48.83         | 0.08    | 2.05            | 100    |

**Fig. 4.5-11 Biomass distribution grab sampling Benthic organisms (g/m<sup>2</sup>)**

Calculation method of dominance should be in consistence with that of the planktons. Refer to Table 4.5-22 for the major dominant species and their quantities of grab sampling Benthic organisms in the evaluation sea area.

**Table 4.5-22 Dominant species and their dominance of grab sampling Benthic organisms**

| Chinese name           | Percentage Total amount of grab sampling Benthic organisms (%) | Occurrence frequency at 10 investigation stations (%) | Dominance |
|------------------------|----------------------------------------------------------------|-------------------------------------------------------|-----------|
| Mensamaria intercedens | 29.15                                                          | 10                                                    | 0.1052    |
| Turritella bacillum    | 29.24                                                          | 25                                                    | 0.1290    |
| Callista erycina       | 8.51                                                           | 10                                                    | 0.0019    |

**(5) Species diversity ( $H'$ ) and uniformity ( $J$ )**

Calculation method of diversity indices and uniformity of grab sampling Benthic organisms should be in consistence with that of planktons.

Indices of grab sampling Benthic organisms of the investigation varied from 0.55 to 2.85 in species diversity, average value 2.00; uniformity varied from 0.35 to 0.96, average value 0.82. Refer to Table 4.5-23 for details.

For the distribution of diversity and uniformity indices of grab sampling Benthic organisms, refer to Fig. 4.5-12 and 4.5-13, which showed that there were no obvious rules in the distribution of diversity indices of grab sampling Benthic organisms in the evaluation sea area, relatively large differences exist among the various sites, similar to the distribution of uniformity indices.

**Table 4.5-23 Species diversity ( $H'$ ) and uniformity ( $J$ ) of organisms collected by grab samples**

| No. of station | Species diversity ( $H'$ ) | Uniformity |
|----------------|----------------------------|------------|
| 1              | 2.17                       | 0.93       |
| 2              | 1.72                       | 0.86       |
| 3              | 2.16                       | 0.93       |
| 4              | 1.92                       | 0.96       |
| 5              | 2.83                       | 0.94       |
| 6              | 2.85                       | 0.85       |
| 7              | 0.55                       | 0.35       |
| 8              | 1.25                       | 0.54       |
| 9              | 1.92                       | 0.96       |
| 10             | 2.58                       | 0.92       |

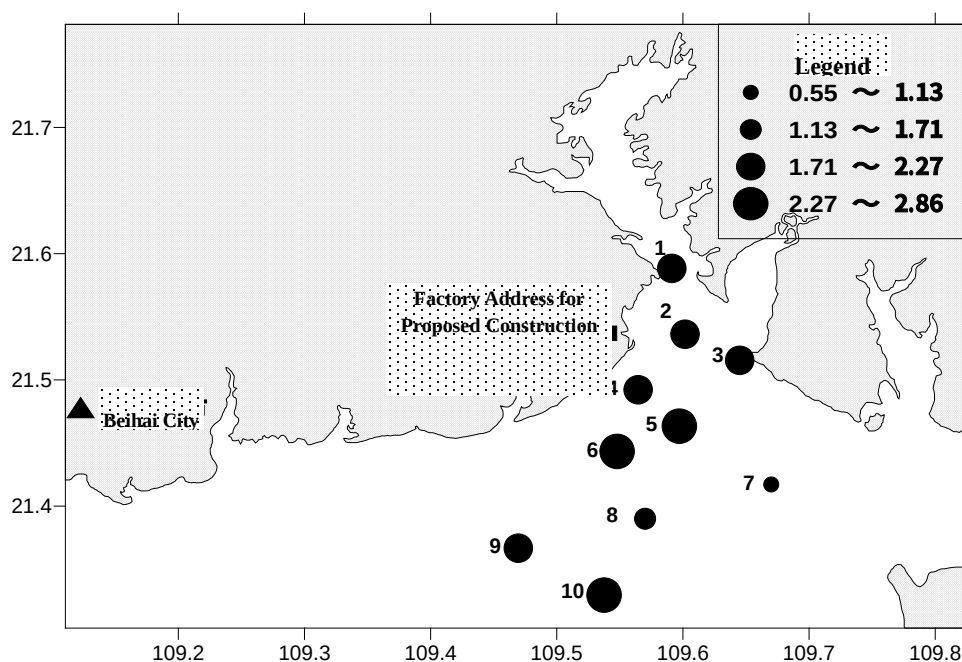


**Fig. 4.5-12 Distribution of indices for species diversity of grab sampling Benthic organisms (g/m<sup>2</sup>)**

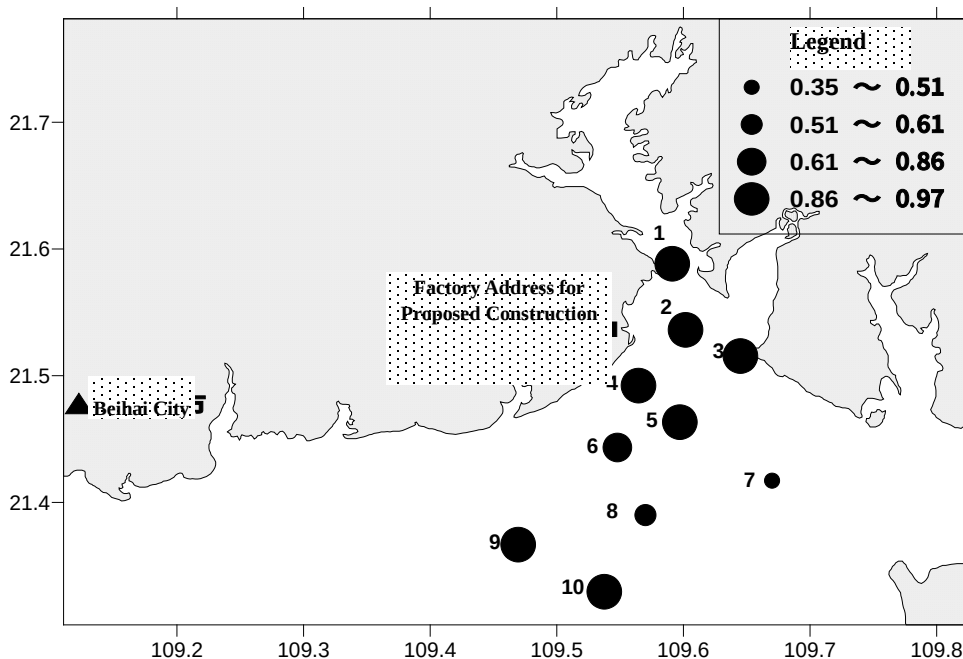


**Fig. 4.5-13 Distribution of uniformity indices of grab sampling Benthic organisms (g/m<sup>2</sup>)**

#### 4.5.6.2 Trawled Benthic organisms

##### (1) Composition of species and quantities

Survey Data of April 2005 were cited for the investigation on Trawled Benthic organisms. Trawled Benthic organisms of the investigation are divided into 154 species (including the genera in small quantities, same as below). Refer to Annex III for details. Among them, Arthropoda takes up the largest proportion--64 species, about 41.6% of the total, followed by Mollusca with 37 species, as about 24.0% of the total. Phylum Chordata had come up with the 23 species, taking up approximately 14.9% of the



total. Numbers of Annelida, Echinodermata, Sipuncula and the other species were respectively 14, 11, 2 and 3(1 for Tunicata, 1 for Spongiatia and 1 for Phaeophyta) respectively. Refer to Table 4.5-24 for details. As the investigation results showed, Composition of species s of bentonic organisms in the valuation sea area were mainly the warm water species and the eurythermal dispersed species.

**Table 4.5-24 Composition of species and distribution of bentonic organisms**

| Organism type   | No. of station    | 2    | 3    | 4    | 5    | 6    | 9    | 11   | 13   | 14   | Entire sea area |
|-----------------|-------------------|------|------|------|------|------|------|------|------|------|-----------------|
| Phylum Chordata | Number of species | 2    | 7    | 8    | 12   | 13   | 9    | 8    | 9    | 10   | 23              |
|                 | %                 | 12.5 | 21.9 | 23.5 | 22.6 | 23.6 | 26.5 | 23.5 | 36.0 | 18.2 | 14.9            |
| Arthropoda      | Number of species | 3    | 8    | 11   | 18   | 12   | 7    | 8    | 9    | 18   | 64              |
|                 | %                 | 18.8 | 25.0 | 32.4 | 34.0 | 21.8 | 20.6 | 23.5 | 36.0 | 32.7 | 41.6            |
| Mollusca        | Number of species | 3    | 5    | 5    | 11   | 15   | 11   | 13   | 5    | 17   | 37              |
|                 | %                 | 18.8 | 15.6 | 14.7 | 20.8 | 27.3 | 32.4 | 38.2 | 20.0 | 30.9 | 24.0            |
| Annelida        | Number of species | 7    | 5    | 3    | 7    | 6    | 7    | 1    | 1    | 7    | 14              |
|                 | %                 | 43.8 | 15.6 | 8.8  | 13.2 | 10.9 | 20.6 | 2.9  | 4.0  | 12.7 | 9.1             |
| Echinodermata   | Number of species | 1    | 6    | 4    | 5    | 3    | 0    | 3    | --   | 2    | 11              |
|                 | %                 | 6.3  | 18.8 | 11.8 | 9.4  | 5.5  | 0.0  | 8.8  | --   | 3.6  | 7.1             |
| Sipuncula       | Number of species | --   | 1    | --   | --   | 1    | --   | --   | 1    | --   | 2               |
|                 | %                 | --   | 3.1  | --   | --   | 1.8  | --   | --   | 4.0  | --   | 1.3             |
| Tunicata        | Number of species | --   | --   | 1    | --   | --   | --   | 1    | --   | 1    | 1               |
|                 | %                 | --   | --   | 2.9  | --   | --   | --   | 2.9  | --   | 1.8  | 0.6             |
| Spongiatia      | Number of species | --   | --   | 1    | --   | 1    | --   | --   | --   | --   | 1               |
|                 | %                 | --   | --   | 2.9  | --   | 1.8  | --   | --   | --   | --   | 0.6             |

|            |                   |    |    |     |    |     |    |    |    |    |     |
|------------|-------------------|----|----|-----|----|-----|----|----|----|----|-----|
| Phaeophyta | Number of species | -- | -- | 1   | -- | 2   | -- | -- | -- | -- | 1   |
|            | %                 | -- | -- | 2.9 | -- | 3.6 | -- | -- | -- | -- | 0.6 |
| Total      |                   | 16 | 32 | 34  | 53 | 53  | 34 | 34 | 25 | 55 | 154 |

Notes: "--" means the specific species of organisms was not found at this site.

## (2) Composition of biomass and inhibiting density

Refer to Table 4.5-25 for the biomass and inhibiting density of Trawled Benthic organisms at various investigation stations on April 2005. Fig. 24.5-14 and 4.5-15 show their distribution of biomass and inhibiting density over the same period

All results in the above lines had revealed that biomass distribution of benthic organisms in the evaluation area is ununiform. The central part of Tieshan Port estuary mouth is the region with high value of biomass, where maximum biomass, 42.80g/m<sup>2</sup>, was recorded at 3 #station. And the region of low biomass values was located outside the Tieshan Port estuary mouth, with the minimum biomass of, 3.90g/m<sup>2</sup>, was recorded at 9 #station.

Inhibiting density of benthic organisms in the evaluation area was also ununiformly distributed. The central part of Tieshan Port estuary mouth is the region with high value of inhibiting density, where the maximum value, 270.0 ind/m<sup>2</sup>, was recorded at 3 #station. And the region of low inhibiting density values was located to the south of Tieshan Port estuary mouth, minimum inhibiting density, 50.0 ind/m<sup>2</sup>, is recorded at 13 #station. Distribution of inhibiting density was in general conformity with that of the biomass of benthic organisms in the evaluation area as a whole.

Table 4.5-25

Biomass and inhibiting density of bentonic organisms

| No.<br>of<br>station | Inhibiting density |      |            |      |                 |      |          |      |               |      |           |      |                 |   |       | Biomass(g/m <sup>2</sup> ) | Water depth (m) | sediments |
|----------------------|--------------------|------|------------|------|-----------------|------|----------|------|---------------|------|-----------|------|-----------------|---|-------|----------------------------|-----------------|-----------|
|                      | Mollusca           | %    | Arthropoda | %    | Phylum Chordata | %    | Annelida | %    | Echinodermata | %    | Sipuncula | %    | Platyhelminthes | % | Total |                            |                 |           |
| 2                    | 10.0               | 6.7  | 0.0        | 0.0  | 20.0            | 13.3 | 120.0    | 80.0 | --            | --   | --        | --   | --              | - | 150   | 22.50                      | 12.0            | Sand      |
| 3                    | 10.0               | 3.7  | 10.0       | 3.7  | 120.0           | 44.4 | 70.0     | 25.9 | 40.0          | 14.8 | 20.0      | 7.4  | --              | - | 270.0 | 42.80                      | 8.5             | Silt      |
| 4                    | --                 | --   | --         | --   | 30.0            | 42.9 | 30.0     | 42.9 | 10.0          | 14.3 | --        | --   | --              | - | 70.0  | 5.30                       | 4.0             | Sand      |
| 5                    | 10.0               | 4.3  | 60.0       | 26.1 | 40.0            | 17.4 | 120.0    | 52.2 | --            | --   | --        | --   | --              | - | 230.0 | 4.00                       | 12.5            | Silt      |
| 6                    | 20.0               | 9.1  | 20.0       | 9.1  | 30.0            | 13.6 | 150.0    | 68.2 | --            | --   | --        | --   | --              | - | 220.0 | 4.80                       | 5.5             | Sand      |
| 9                    | 10.0               | 10.0 | 10.0       | 10.0 | 0.0             | 0.0  | 80.0     | 80.0 | --            | --   | --        | --   | --              | - | 100.0 | 3.90                       | 7.5             | Mud       |
| 11                   | --                 | --   | --         | --   | 60.0            | 85.7 | 10.0     | 14.3 | --            | --   | --        | --   | --              | - | 70.0  | 9.40                       | 4.5             | Sand      |
| 13                   | --                 | --   | 20.0       | 40.0 | --              | --   | 10.0     | 20.0 | --            | --   | 20.0      | 40.0 | --              | - | 50.0  | 7.50                       | 15.5            | Mud       |
| 14                   | 20.0               | 11.5 | 24.0       | 13.8 | 30.0            | 17.2 | 100.0    | 57.5 | --            | --   | --        | --   | --              | - | 174.0 | 36.30                      | 6.5             | Sand      |

Notes: "--"means the specific species of organisms was not found at this site.

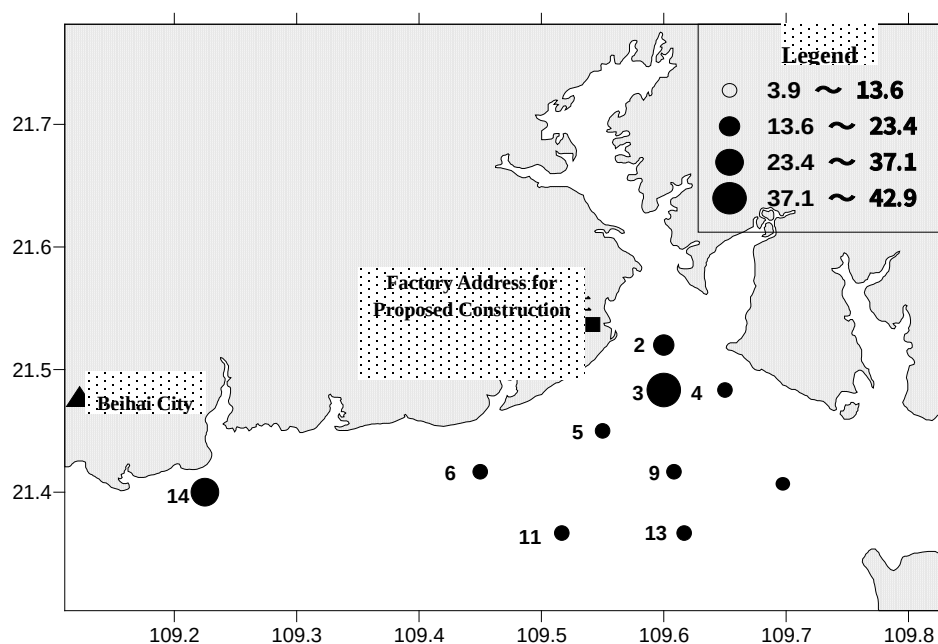


**Fig. 4.5-14 Biomass distribution of benthic organisms ( $\text{g}/\text{m}^2$ )**  
(April 2005, by trawls)

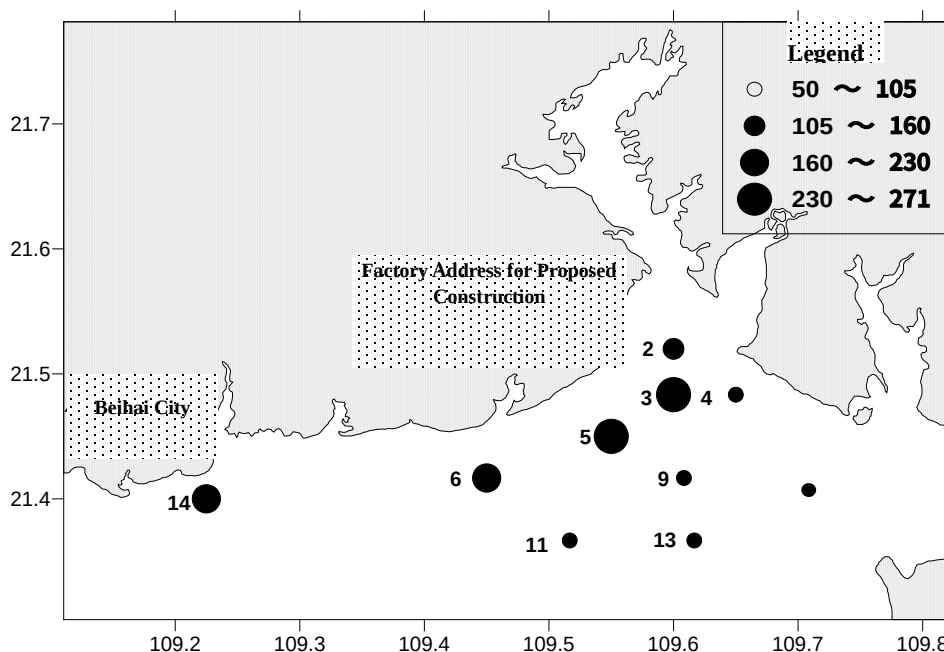


**Fig. 4.5-15 Distribution of inhibiting density of benthic organisms ( $\text{ind}/\text{m}^2$ )**  
(April 2005, by trawls)

### (3) Distribution of major groups and dominant species

Major dominant species in the investigation on benthic organisms in April 2005 are composed of 142 *Turritella bacillum* and 47 *Turricula nelliae* spurious from the Mollusca group, respectively taking up 45.7% and 15.1% in the group, 12.0% and 4.0% of total amount; 331 *Metapenaeopsis barbata* (De Haan), 90 *Rhinolambrus contraries* and 44 *Portunus hastatoides*(Fabricius) from the crustacean group, respectively taking up 59.9%, 16.3% and 8.0% in the group, 28.0%, 7.6% and 3.7% of total amount; 62

*Callionymus kaianus* Günther (Kai dragonet) from the Phylum Chordata, taking up 30.4% in the group and 5.2% of total amount.( Refer to Table 4.5-26)

**Table 4.5-26 Distribution of dominant species of bentonic organism**

| Organism type<br>(number)                            | 2  | 3   | 4   | 5  | 6  | 9  | 11 | 13 | 14 | Total |
|------------------------------------------------------|----|-----|-----|----|----|----|----|----|----|-------|
| <i>Turritella bacillum</i>                           | 1  | 131 | --  | 8  | -- | -- | -- | 2  | -- | 142   |
| <i>Turricula nelliae</i><br>spurious                 | -- | --  | --  | 41 | -- | 6  | -- | -- | -- | 47    |
| <i>Metapenaeopsis barbata</i> (De Haan)              | 7  | 3   | 100 | 26 | 6  | 99 | 16 | 80 | 3  | 340   |
| <i>Rhinolambrus contraries</i>                       | 1  | 1   | 14  | 4  | 59 | 1  | 69 | -- | 5  | 154   |
| <i>Portunus hastatoides</i> (Fabricius)              | -- | 1   | 15  | 16 | -- | 3  | 7  | 2  | -- | 44    |
| <i>Callionymus kaianus</i><br>Günther (Kai dragonet) | 1  | 2   | 4   | 6  | 13 | 3  | 43 | 3  | 11 | 86    |

Notes: "--"means the specific species of organisms was not found at this site

#### (4)Diversity index and uniformity

Semi-quantitative trawling data is used in the calculation for diversity index and uniformity of bentonic organisms. Calculation method is the same as the phytoplankton. Refer to Table 4.5-27 and Fig. 4.5-16, 4.5-17 for the calculation and statistical results.

On April 2005, diversity index of bentonic organisms in the evaluation area ranged from 1.77 to 4.28, average value 0.67. Minimum diversity index and uniformity value both appeared at 3 #station, mainly due to the *Turritella bacillum* emerging in large quantity. Different stations varied greatly from each other in diversity index and uniformity of bentonic organisms, some of which were found to be below the average value. But, on the whole, organism diversity of the entire sea area was normal, with stable environment for all bentonic organisms.

**Table 4.5-27 Diversity index and uniformity of bentonic organisms species**

| No. of the station | Number of species | H'   | J    |
|--------------------|-------------------|------|------|
| 2                  | 7                 | 2.37 | 0.84 |
| 3                  | 22                | 1.77 | 0.40 |
| 4                  | 29                | 3.27 | 0.67 |
| 5                  | 42                | 4.28 | 0.79 |
| 6                  | 50                | 3.94 | 0.70 |
| 9                  | 28                | 2.88 | 0.60 |
| 11                 | 33                | 3.54 | 0.70 |

| No. of the station | Number of species | H'        | J         |
|--------------------|-------------------|-----------|-----------|
| 13                 | 32                | 2.37      | 0.47      |
| 14                 | 45                | 4.65      | 0.85      |
| Average            | 30                | 3.23      | 0.67      |
| Range              |                   | 1.77~4.28 | 0.40~0.84 |

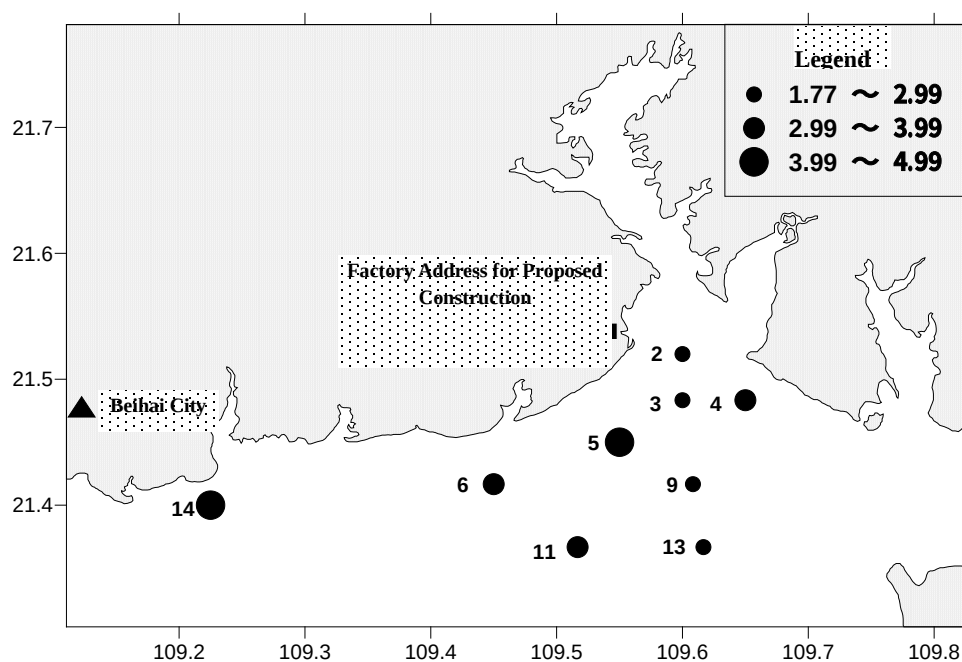


**Fig. 4.5-16** Distribution of diversity index of benthic organisms (ind/m<sup>2</sup>) (April 2005, by trawls)

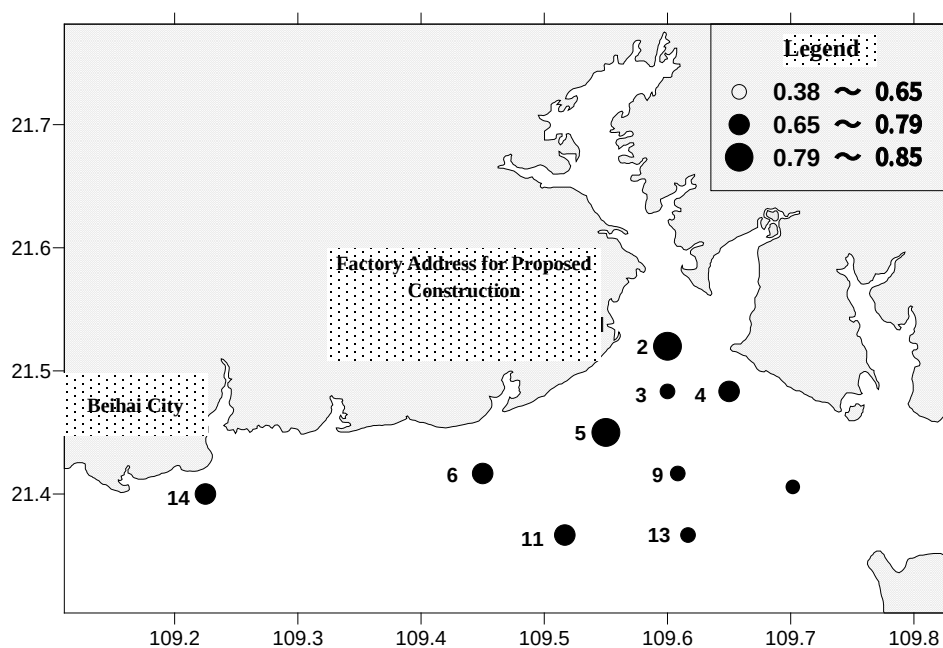


**Fig. 4.5-17** Uniformity distribution of benthic organisms (ind/m<sup>2</sup>) (April 2005, by trawls)

#### 4.5.7 Intertidal organisms

Data of April 2005 survey were cited for the investigation on intertidal organisms. The survey was done during the ebb tides from April 1st to April 2nd, 2005, with 2 sections for investigation, located in the vicinity of Tangxi Village and Zhuoluokou Village at Tieshan Port District. (Refer to Fig.4.6-1 for details.) At each of the section, there were 3 stations to be set up for investigation at high, medium and low tides zones respectively. The high tide belt was mainly fine sandy beach, with black sediments at the bottom layer, featuring gentle and slow slope as well. A quantities box of 25cm×25cm was used in collecting samples for quantities measurement of intertidal organisms, with 8 times of random collection at each of the tidal zones. Organisms adhering to the substrate in the box were picked up first, then came to the digging into the depth of 30cm. Samples were put into a bushing screen of 1mm in the mesh opening to be washed and irrigated in sea waters. After that, all samples were taken out, bottled in serial numbers, registered and fixed in the 5% neutral formalin liquid, to be taken back to the lab for further analysis (including the identification of species, biomass weighting, calculation of inhabiting density and etc. Qualitative sampling was carried out at the three qualitative sampling sites set up at high, medium and low tides zones, with efforts made for a complete collection of all animals and plants that appeared around the area. Samples collected were preserved through quick-freezing, to be taken back to the lab for identification of the species and counting the numbers.

##### 4.5.7.1 Composition of species

The quantitative and qualitative samples of intertidal organisms, in the primary identification, were named to be in 80 species (including genera of small quantities, the same below), among which the Mollusca came up with the largest number, which amounted to 30 species, taking up around 37.5% of total amount. Next were the Arthropoda and Annelida, with 19 and 13 species respectively, taking up approximately 23.75% and 16.25% of total amount; followed by the Echinodermata with 6 species, Phylum Chordata with 3 species, Zoobenthos with 4 species and Coelenterates with 3 species, taking up 7.5%, 3.75%, 5.0% and 3.75% of total amount respectively. Tunicata and Sipuncula were of the least numbers, both with 1 species only, taking up around 1.23% of total amount. Refer to Fig. 4.5-18 for the composition of organism groups and Annex V for organism species (name list of intertidal organisms).

The areas were dominated by eurythermic species, euryhaline species and eurytopic species; while endemic species of the temperate zones or of the tropical or subtropical zones, were also found. Major dominant species was the *Mictyris longicarpus* of Latreille.

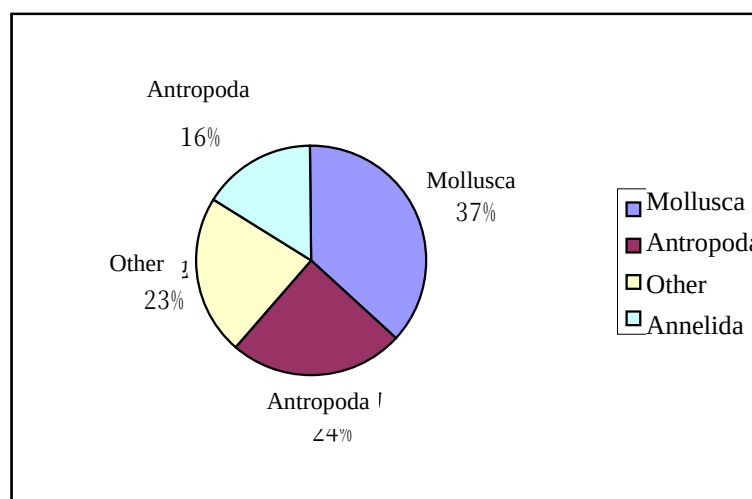


**Fig. 4.5-18 Composition of intertidal organism groups**

#### 4.5.7.2 Biomass and inhabiting density

Average numbers of inhabiting density and biomass of intertidal organisms with the specific area were 144.0inds/m<sup>2</sup> and 114.2g/m<sup>2</sup> respectively. Composition of inhabiting density mainly include the Mollusca, Arthropoda and Annelida, of 50.00 inds/m<sup>2</sup>, 44.00 inds/m<sup>2</sup> and 36.67 inds/m<sup>2</sup> respectively, taking up 34.72%, 30.56% and 25.46% of the total density. Composition of inhabiting density mainly included the Echinodermata and Mollusca, of 71.47g/m<sup>2</sup> and 28.43g/m<sup>2</sup> respectively, taking up 62.67% and 24.93% of the total density.

#### 4.5.7.3 Vertical distribution of intertidal organisms

##### (1) High tide belt

Altogether 12 intertidal organisms were collected of quantitative samples in the high tide belt, with 108.0 inds/m<sup>2</sup> of average inhabiting density and 21.84g/m<sup>2</sup> of average biomass. Arthropoda and Annelida were relatively in high inhabiting density, respectively 60.0 inds/m<sup>2</sup> and 46.0 inds/m<sup>2</sup>, taking up 55.56% and 42.59% in the average inhabiting density of the high tide belt. Maximum biomass was found in Arthropoda, which amounted to 15.5g/m<sup>2</sup>, taking up 70.97% of the average biomass in the high tide belt; followed by Annelida, with 5.74g/m<sup>2</sup> of biomass, taking up 26.28% of the average biomass in the high tide belt. Besides, another kind of Mollusca, the *Dosinia biscocta* (Reeve) was also found in this tide belt, with density 2.0 inds/m<sup>2</sup>, taking up 1.85% of the total density, whose biomass was 0.60g/m<sup>2</sup>, taking up 2.75% of the average biomass.

##### (2) Mid-tide belt

Altogether 14 intertidal organisms were collected as quantitative samples in the mid-tide belt, with average inhabiting density 214.0inds/m<sup>2</sup> and average biomass 161.0g/m<sup>2</sup>. Mollusca and Arthropoda were in relatively high inhabiting density, respectively 92.0 inds/m<sup>2</sup> and 80.0inds/m<sup>2</sup>, taking up 42.99% and 37.38% in the average inhabiting density of the mid-tide belt. Maximum biomass was found in Echinodermata, followed by Mollusca. Biomass of the Echinodermata amounted to 110.0g/m<sup>2</sup>, taking



up 68.31% of the average biomass in the mid-tide belt, with inhabiting density  $20.0 \text{ inds/m}^2$ , taking up 9.35% in the average inhabiting density of the mid-tide belt. And the biomass of the Mollusca was  $40.30 \text{ g/m}^2$ , taking up 25.02% of the average biomass in the mid-tide belt. Besides, some of the Annelida organisms were also found in this tide belt, such as the *Glycera* sp, with  $22.0 \text{ inds/m}^2$  inhabiting density taking up 10.28% of the total average density, whose biomass was  $2.24 \text{ g/m}^2$  of, taking up 1.39% of the average biomass.

### (3) Low tide belt

Altogether 17 intertidal organisms were collected as quantitative samples in the low tide belt, with average inhabiting density  $110.0 \text{ inds/m}^2$  and average biomass  $159.2 \text{ g/m}^2$ . Annelida was in relatively high inhabiting density, with inhabiting density  $64.00 \text{ inds/m}^2$  and biomass  $4.12 \text{ g/m}^2$ , taking up 58.18% of the average inhabiting density and 2.59% in the average biomass in the low tide belt. Maximum biomass was found in Echinodermata, followed by Mollusca. Biomass of the Echinodermata amounted to  $104.4 \text{ g/m}^2$ , taking up 65.57% of the average biomass in the low tide belt, with  $14.0 \text{ inds/m}^2$  of inhabiting density, taking up 12.73% in the average inhabiting density of the low tide belt. And the biomass of the Mollusca was  $44.40 \text{ g/m}^2$ , taking up 27.89% of the average biomass in the low tide belt, with inhabiting density  $16.00 \text{ inds/m}^2$  taking up 14.55% in the total average inhabiting density of the low tide belt. Besides, some of the Annelida organisms were also found in this tide belt, such as the *Alpheas hoplocheles* Coutiere, with inhabiting density  $10.0 \text{ inds/m}^2$ , taking up 9.09% of the average density and with biomass  $2.74 \text{ g/m}^2$ s, taking up 1.72% of the average biomass. Meanwhile, Coelenterates, Sipuncula and Phylum Chordata also came up with 1 species, each of whose inhabiting density was  $2.00 \text{ inds/m}^2$  of, taking up around 1.82% of the total average density and were recorded with  $1.90 \text{ g/m}^2$ ,  $1.50 \text{ g/m}^2$  and  $0.16 \text{ g/m}^2$  in the biomass respectively, taking up 1.19%, 0.94% and 0.10% of the average biomass.

Groups of intertidal organisms had been quite conspicuous in their distribution into vertical layers, as a result of the tidal flows, showing three separate organism belts at the high, middle and low tide belt. Vertical distribution of biomass and inhabiting density of the intertidal organisms in the area could both be summarized as: mid-tide belt > low tide belt > high tide belt; The numbers of organism species were: low tide belt > mid-tide belt > high tide belt, which was actually in consistence with the rules that organisms of high tide belt were small in their numbers of species and quantities and that those of the middle and low tide belt were larger in their numbers of species and quantities than in the high tide belt. However, the numbers of species and quantities middle and low tide belt also varied with different locations and bottom sediment types. Therefore, differences between the two tide belts can't be settled in one rule.

#### 4.5.7.4 Dominant species

Dominant species in the high tide belt was the *Mictyris longicarpus* Latreille, with inhabiting density  $60.00 \text{ inds/m}^2$ , taking up 55.56% of the total average inhabiting density, whose biomass is  $15.500 \text{ g/m}^2$ ,

taking up 70.97% of the average biomass in the high tide belt. Dominant species in the mid-tide belt were the *Mictyris longicarpus* Latreille, *Dosinia biscocta*(Reeve), *Laganum decagonale* (Blaiuville) and *Dosinia japonica*(Reeve), with inhabiting density 74.00 inds/m<sup>2</sup>, 70.00 inds/m<sup>2</sup>, 20.00 inds/m<sup>2</sup> and 18.00 inds/m<sup>2</sup>, taking up 34.58%, 32.71%, 9.35% and 8.41% of the total average inhabiting density; respective biomass 6.50g/m<sup>2</sup>, 21.00g/m<sup>2</sup>, 110.0g/m<sup>2</sup> and 17.40g/m<sup>2</sup> in the, taking up 4.04%, 13.04%, 68.31% and 10.80% of the average biomass respectively. The low-tide belt mainly contains *Haploscoloplos elongate* of Annelida and *Laganum decagonale* (Blaiuville) of Echinodermata. Inhabiting density of *Haploscoloplos elongate* was 34.0 inds/m<sup>2</sup>, taking up 30.91% of inhabiting density in this tide belt, while the biomass of *Laganum decagonale* (Blaiuville) was 104.2g/m<sup>2</sup>, taking up 65.57% of biomass in this tide belt.

On the whole, intertidal organisms were rich in the resource and diversified in species of shellfishes, with relatively large inhabiting density and biomass. Besides, ecological environment in the area was also quite good, with relatively diversifies species of organisms.

#### 4.5.8 Fishery resources and production situations

##### 4.5.8.1 Situation of Fishery resources

Investigation on the fishery resources was done by on-site trawling to estimate densities of nekton resources in the area. The report of environment evaluation referred to the works on fishery resources at Tieshan Port District done by Nanhai Monitoring center and Guangxi Marine Monitoring and Forecast Center with an joint effort in April 2005.

##### (1)Densities of nekton resources

Species caught by on-site bottom trawling for investigation included the *Evynnis cardinali* (crimson seabream), *Thrixa dussumiera*, *Harengula nymphaea* (Richardson), *Allanetta bleekeri* (Gunther), *Strongylura leiura leiura* (Bleeker), *Mugilcephalus*, *Sillago sihama*, *Navodon septentrionalis* (Gunther), *Trichiurus japonicus*(haritail), *Setipinna taty*, *Leiognathus ruconius*, *Caranx*(Atule) *kalla*, *Argyrosomus argentatus* (white croaker), *Lepidotrigla* (Triglidae), *Muraenesox cinereus*, *Chirocentrus dorab*, *Formio niger*, *Harpodon nehereus*, *Fugu santhopterus*, *Loligo japonica*, *Esculenta*(squid), *Portunus trituberculatus*, *Penaeus merguensis* and etc, among which the *Evynnis cardinali* was the dominant species, taking up 87.50% of all fishery catches. The fishery catch was mainly composed of fishes, which accounted for over 90%, while Cephalopoda and Crustacea both were in relatively low proportions. Average density of nekton resources at the bottom and near-bottom layer was 2.93 t/km<sup>2</sup>.

##### (2)Fish eggs and larvae-juveniles

Average number of fish eggs caught by level trawling was 1692 pieces/net, which included 9 species. Of all these species of fish eggs under investigation, most were from the genus *Leiognathidae*, followed by *Mullidae* and then gilt sardines. Average number of fish eggs caught by vertical trawling was 3.88 pieces/net, which included species, dominated by the gilt sardines and then followed by the genus

Leiognathidae and Mullidae in turn.

Average number of fish larvae-juveniles caught by level trawling was 2 tails per net, which included 5 species. Of all these species of fish larvae-juveniles, *Melanotaenia maccullochi* was in the largest quantity, followed by Sparidae fishes. Fish larvae-juveniles caught by vertical trawling included 3 species, with average number of quantity  $0.33 \text{ tail/m}^3$ . The gilt sardines were in the largest quantity of all species, followed by *Callionymus richardsoni* and the Gobiidae.

### (3) Migration and distribution laws of fishes

Fishes in the Beibu Gulf are mostly of tropical or subtropical offshore categories and the species there are basically classified into some unique fauna. Besides, fishes in the Beibu Gulf are also characterized with their abundance in the species, small groups and sizes, strong reproductive capacity and short life span. They were widely distributed and cross-inhibited in mixed groups, laid their eggs across dispersed spawning ground and basically migrated without longer distance beyond the Gulf. During the spring, the majority of them would swim to the offshore waters in east Beibu Gulf and alongside the coastlines of north Guangxi and west Guangdong area, to lay their eggs and nurture their juveniles and then migrate back to the middle and west part of the gulf. Therefore, the offshore waters in the east and north part of the gulf is dominated by small-scale fishes, while in the deep waters of the west and middle gulf, more medium and large-sized fishes will be found in the dominant position.

### (4) Situations of the spawning field

Major spawning and multiplying fields in Beibu Gulf are relatively scattered over dispersed areas and show no signs of any centralized spawning fields of major economic fishes in the evaluation waters.

#### 4.5.8.2 Situations of fishery resources

Being a coastal city located to the north-east of Beibu Gulf, Beihai enjoys the abundant and diversified fishery resources. According to the statistics of the survey, there are over 500 species of fishes, 200 species of shrimps, about 50 species of Cephalopod, over 20 species of crabs and many other kinds of shellfishes, sea products, the Algae and etc. The city had long been enjoy a reputation for its marine products treasures as the squids, cuttlefishes, groupers, prawns, the *Amussium japonicum formosum*, *Sipunculus*, abalones and the world-famous Hepu pearls, including many other species of sea products with high economic values, as the oysters, pearl oysters, clams, blood clams (*Tegillarca granosa*), ark shells (*Scapharca subcrenata*), abalones, cuttlefishes, Swimming Crab (*Portunus trituberculatus*), Samoan crabs (*Scylla serrata* Forsskal), Red rail prawn (*Penaeus penicillatus*), the *Penaeus japonicus* Bate, *Penaeus monodon*, Middle shrimps (*Metapenaeus intermedius* Kishinouye) and *Themetapenaeopsis barbata*. Of the Algae species, *Sargassum* is in large quantity of natural resources and *Gracilaria Greville* is the aquaculture variety. Medicinal marine organisms include 20 species of sea serpents, as well as the hippocampus, globefishes and Chinese horseshoe crab. Some rare animals, as the manatee, are also found. Besides, the organism resources with great potential for further development also include the *Lutraria maxima* Jonas and *Pinna (Atrina) pectinata* of

Mollusca(shellfishes), Nereid(Clamworm) of Polychaete, Sipunculus of Annelids, sea cucumbers(Holothurian) of Echinodermata, Branchiostoma lanceolatum of Acrania and etc.

Marine organisms in offshore waters of Guangxi coastlines (in the 20m depth contour) include 1760 species, with 172 marine plants and 1588 marine animals. Numbers of economic fishes that were commonly 122, over 30 of whom were found in large communities. Average volume of sea product resources in neritic sea areas in the 10m depth contour could amount to  $5t/km^2$ .

Mari culture in offshore waters of Guangxi coastlines is mainly composed of pearls, oysters, clams, prawns, Chinese ocellated gudgeon (*Bostrichthys sinensis*), Samoan crabs and groupers.

#### 4.5.8.3 Situations of fishery production

Refer to Table 4.5-28 for the situation of fishery at Beihai and Tieshan'agng of 2006, based on the statistics from the fishery management department of Guangxi.

**Table 4.5-28 Production of fishery ay Beihai and Tieshan'agng in 2006**

| Items                                | Beihai City | Tieshan Port District | Percentage (%) |
|--------------------------------------|-------------|-----------------------|----------------|
| Total volume of sea product(t)       | 965408      | 139545                | 14.45          |
| Marine catch(t)                      | 525984      | 86720                 | 16.49          |
| Marine culture(t)                    | 378478      | 47492                 | 12.55          |
| Inland catch(t)                      | 4057        | —                     | —              |
| Inland aquaculture(t)                | 56889       | 5333                  | 9.37           |
| Aquaculture(hm <sup>2</sup> )        | 38909       | 8832                  | 22.7           |
| Marine culture(hm <sup>2</sup> )     | 32338       | 7965                  | 24.63          |
| Inland aquaculture(hm <sup>2</sup> ) | 6571        | 867                   | 13.19          |
| Number of fishing boats(vessel)      | 7651        | 2444                  | 31.94          |
| Total tonnage(total ton)             | 211321      | 61981                 | 29.33          |
| Power(kw)                            | 533435      | 150468                | 28.21          |
| Muraenesox cinereus                  | 14335       | 1615                  | 11.27          |
| Chinese herring                      | 27366       | 16127                 | 58.93          |
| Groupers                             | 3510        | 12                    | 0.34           |
| Porgies                              | 21510       | 203                   | 0.94           |
| Ribbonfish                           | 17607       | 2700                  | 15.33          |
| Reddish fish                         | 36241       | 1922                  | 5.3            |
| Mullet                               | 12271       | 1210                  | 9.86           |
| Mackerel                             | 15873       | 4357                  | 27.45          |
| Spanish mackerel                     | 2629        | 262                   | 9.96           |
| Silvery pomfret                      | 9254        | 443                   | 4.79           |
| filefish (navodonmodestus)           | 31178       | 2014                  | 6.46           |
| Striped mullet (Mugil cephalus)      | 3715        | 74                    | 1.99           |
| white croaker (Argyrosomus)          | 52133       | 8425                  | 16.16          |

| Items                                | Beihai City | Tieshan Port District | Percentage (%) |
|--------------------------------------|-------------|-----------------------|----------------|
| argentatus Houத்துyn)                |             |                       |                |
| Acetes                               | 35703       | 7287                  | 20.41          |
| Pawns                                | 12427       | 2650                  | 21.32          |
| White-hair rough shrimp              | 5763        | 2538                  | 44.04          |
| Swimming crab                        | 24349       | 9264                  | 38.05          |
| Samoan crabs                         | 1795        | 120                   | 6.69           |
| Charybdis                            | 2101        | 2101                  | 100            |
| Shellfish                            | 38515       | 13485                 | 35.01          |
| Cuttlefish                           | 17813       | 3468                  | 19.47          |
| Squid                                | 18784       | 3472                  | 18.48          |
| Octopus                              | 5779        | 2971                  | 51.41          |
| Number of employee in marine fishery | 127929      | 44534                 | 34.81          |

#### (1) Situation of fishing vessels

Operational methods of fishing in the area include trawling, seining, gillnetting and hooking. There are 5007 vessels with trawls, 798 with purse seines, 501 with gill nets, 46 with stow nets, 177 with hooking equipments and 998 others.

#### (2) Situation of catching/fishing production

Marine fishing industry at Beibu Gulf is mainly conducted by means of trawling, which takes up approximately 50%. Major fishing fields for vessels of Tieshan Port District are scattered over the deep waters outside the gulf and the Beibu Gulf fishing field. Major methods for fishing operations in deep water areas are trawling and seining. Only seasonal fishing for pawns is done in the open sea areas of Shatian and Yingpan at the gulf mouth. Trawling is forbidden inside the gulf and permissions because fishing activities are only for small fishing vessels, such as those equipped with gill nets and long lines. Species caught by trawls at Beibu Gulf mainly include the *Priacanthus tayenus*, *Evynnis cardinalis*, *Arggrosomus argentatus*, *Decapterus maruadsi*, *Saurida*, *Nemipterus bathybius*, *Lutjanus sanguineus*, *Loligo edulis*, Squids, *Upeneus sulphurus*, *Upeneus bensai*, *Trichiurus haumela*, Mackerel, *Rastrelligerkanagurta*, *Pomadasy hasta*, *Abalistes stellaris*, *Apogonops*, *Pentaprion longimanus*, *Triacanthus Blochii* and etc. And the major economic species caught by fishing vessels at Beihai city include *Evynnis cardinalis*, sardines, *Scomberomorus commersoni*(Spanish mackerel), squids, groupers, cuttlefishes, *Sipunculus*, *Gracilaria*, *Amussium japonicum formosum*, pearls, clams, oysters, Samoan crabs, *Penaeus penicillatus*, *Penaeus japonicus* Bate, *Metapenaeopsis* and etc. Fishes take up the largest proportion of total fishing productivity, which amount to 75.46% of total volume, followed by shellfishes 13.01%.

Since 2002, there had been no major changes in the total number, power and fishing intensity of machine vessels for marine fishery at Beihai city as a whole. Total productivity of marine fishing of Beihai city amounted to 525984 t in the year 2006. Of the total fishing amount, fishes accounted for

67.6%, followed by crustaceans for 17.0% and the Cephalopoda for 7.8%, shell fishes for 7.2% and the rest species for 0.4%. The proportion of fishery productivity taken up by Tieshan Port District in the total volume of fishery productivity of Beihai City was about 15%.

### (3) Situations of marine culture

Plankton feed in sea waters at Beibu Gulf is rich and diversified. While the shallow sea and mudflat areas are mainly composed of sandy materials, the seafloor is flat and broad, perfect for developing the marine culture industry. 4 major types of marine culture include reclamation and pond culture, non-reclamation mudflat culture or bottom sowing culture in shallow sea, net cage culture and raft hanging culture. In 2006, total areas of marine culture at Beihai city had reached 32338 hm<sup>2</sup>, with total productivity 378478 t, among which the culturing on the sea accounted for 153348 t, mudflat culture for 145325 t and roadbed culture for 79805 t. The shellfishes takes up the largest proportion of productivity among all species cultured with 296260 t, followed by crustaceans with 78157 t, fishes for 3994 t, the other species for 3400 t and algae for 59 t. Major products of marine culture were *Lateolabrax japonicus*(perch), groupers, *Sciaenops ocellatus*(red fish), *Rachycentron canadum*(cobia fish), *Sphyrna*(barracuda), porgies, *Pseudosciaena crocea*, swellfishes (*Fugu* abe), lefteyed flounders, *Scophthalmus maximus*, *Penaeus Vannapiece* (white shrimp), *Penaeus monodon*(grass prawn), *Penaeus penicillatus* Alcock (Red tail prawn), *Penaeus japonicus* Bate, *Portunus trituberculatus*(swimming crabs), *Scylla serrata* (Samoan crab), oysters, abalones, *Limacina*(slug), ark shelles, *Mytilus edulis*(mussel), *Pinnidae*(pen shell), sea scallops, clams, razor clams, *Laminaria Japonica*(kelp), *Undaria pinnatifida*, laver, *Gracilaria*, *Eucheuma*, *Gelidiaceae*, *Sargassum fusiforme*(harv.)setchell, algae, octopus and etc. In 2006, total culture area in Tieshan Port was 7965 hm<sup>2</sup> and total productivity was 47500t. [Cultures in the sea areas of the evaluation are mainly mudflat cultures for shellfishes and Sipunculus. Refer to figure 13 for culture planning of Beihai city.](#)

### (4) Situations of aquatic products processing

According to the statistics of aquatic products processing in 2006, there were 34 companies for aquatic products processing with 222850 t of processing capacity and 34 refrigerators in Beihai city, with 889 t/d of refrigerating capacity 21210 t /time and 819612 t/d of freezing capacity and productivity, 2843 t/d and 169944 t of ice-making capacity and productivity. Total volume of aquatic products processing amounted to 76295 t, among which frozen aquatic products accounted to 60430t, minced fish products and cured products for 11565 t, canned products for 100 t, feed for 19 t and other kinds of processed aquatic products for 4200 t.

## 4.5.9 Situations of Mangrove

### 4.5.9.1 Distribution and species composition of mangroves in the evaluation area

Mangroves in the evaluation area are mainly distributed over the mudflats at Yingluo Bay, Dandou Bay,

Laoya'gang-E'jindun, in the vicinity of Hetangling and to the north of Wu Qi production division of Beimu Salt Pan. Mangroves at Yingluo Bay and Dandou Bay have biggest areas, with the best growth status and the richest species. (Refer to 4.8.1 Shankou Mangrove Natural Reserve) Areas of mangroves at other mudflats differ from several dozens of hectares to several hundred. According to the investigation, the mangrove near the cross-sea bridge at Tieshan Port is the only one being cut into areas under the gradual transformation to a shrimp pond. Other mangroves show very little changes in the total areas. There are 8 species of mangrove plants being recorded in the evaluation area: *Bruguiera gymnorhiza*, *Kandelia candel*, *Rhizophora. Stylos*, *Acanthu ilicifolius*, *Excoecaria agallocha*, *Aegiceras corniculatum*, *Avicennia marina*, *Acrostichum aureum*; Together with other 5 species of semi-mangroves: *Cerbera mangha*, *Hibicus tilisaceus*, *Thespeaisa populnea*, *Premna oblusifolia*, *Pongamia pinnata*.

#### 4.5.9.2 Types and areas of Mangrove communities

There are 8 types of mangrove communities in the evaluation area (Refer to Table 4.5-22), which are in zonal band-like distribution, roughly level to the coastline. Growth status is influenced by topography, soil matrix, nutrients and salinity. Typical succession orders of mangroves communities, from the de outer mudflat(low tide contour) to inner mudflat( high-tide contour); from sandy to loamy, clayey and muddy in the soil substrates; from high salinity to low salinity of soils, could be summarized as: *Avicennia marina*→*Kandelia candel*→*Rhizophora. Stylosa*→*Bruguiera gymnorhiza*→*Excoecaria agallocha*。

As shown by Table 4.5-29, the largest mangrove community of Tieshan Port Dandou Bay and Yingluo Bay is the *Avicennia marina*(1167.9 hm<sup>2</sup>), followed by *Rhizophora. Stylosa*(271.3 hm<sup>2</sup>)and *Bruguiera gymnorhiza*+*Kandelia candel*—*Aegiceras corniculatum* communities(203.6 hm<sup>2</sup>)。

The mangroves grown in the east-west direction from Shawei to the coastline of Beimu Salt Pan, were almost all *Avicennia marina* forests, most of which are manually planted.

**Table 4.5-29 Types and areas of mangrove communities in the evaluation area (hm<sup>2</sup>)**

| Name of Bay  | <i>Kandelia candel</i> | <i>Rhizophora . Stylosa</i> | <i>Aegiceras corniculatum</i> | <i>Avicennia marina</i> | <i>Kandelia candel</i> + <i>Avicennia marina</i> | <i>Avicennia marina</i> + <i>Aegiceras corniculatum</i> | <i>Bruguiera gymnorhiza</i> + <i>Kandelia candel</i> - <i>Aegiceras corniculatum</i> | Other community types | Total |
|--------------|------------------------|-----------------------------|-------------------------------|-------------------------|--------------------------------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|-----------------------|-------|
| Tieshan Port | 5                      | 0                           | 0                             | 988.6                   | 0                                                | 0                                                       | 0                                                                                    | 0                     | 993.6 |
| Dandou Bay   | 4.4                    | 74.9                        | 0                             | 170.6                   | 100.5                                            | 0.8                                                     | 203.6                                                                                | 3.8                   | 558.6 |
| Yingluo Bay  | 0                      | 196.4                       | 20.6                          | 8.7                     | 2.1                                              | 0                                                       | 0                                                                                    | 0                     | 227.8 |
| Total        | 9.4                    | 271.3                       | 20.6                          | 1167.9                  | 102.6                                            | 0.8                                                     | 203.6                                                                                | 3.8                   | 1780  |

**4.5.10 Situation of the sea grass bed**

## 4.5.10.1 Distribution of sea grass bed

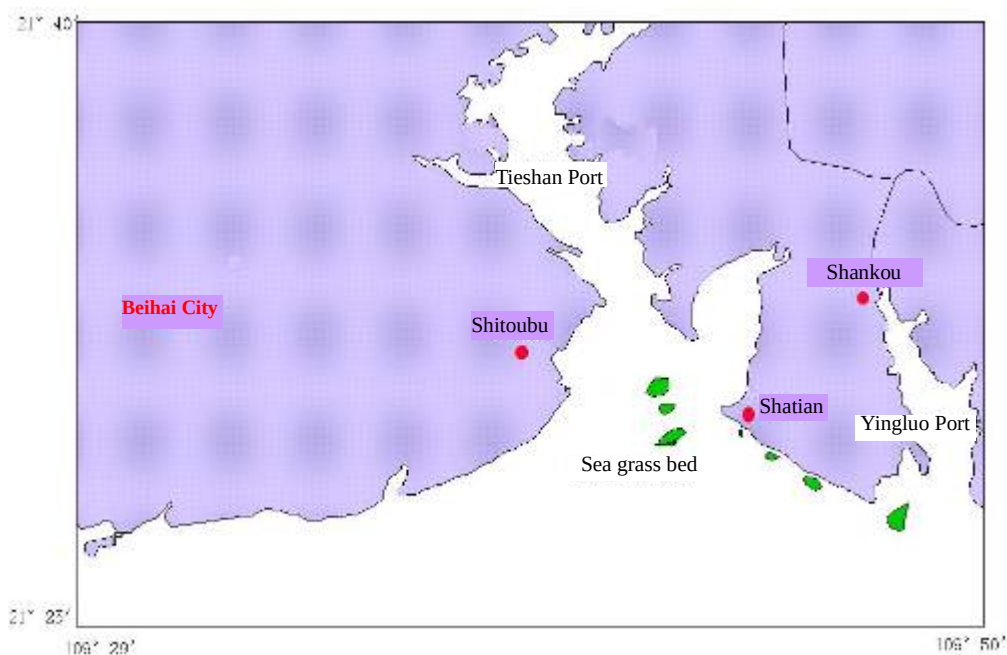
Survey of South China Sea Institute of Oceanology , Chinese Academy of Sciences in 2006 showed that sea grass beds in Hepu, Guangxi were distributed in patches, mainly concentrated at Dianzhousha, Xialongwei, Yingluo Bay, the fresh water gap of Shatian, the bottom of San Liao Jiu He well and at Gaoshaotou and the foot of Ronggenshan.(Refer to Fig. 4.5-19). Each patch differed with each other from 20 to 100 hm<sup>2</sup> in areas. (Refer to Table 4.5-30).

**Table 4.7—30 Areas of sea grass bed of Hepu in 2005 and 2006(hm<sup>2</sup>)**

| Name of the sea grass bed | Dec 2005 | Mar 2006 | June 2006 |
|---------------------------|----------|----------|-----------|
| Xialongwei                | 43.98    | 33.70    | 23.0      |
| Shabei                    | 54.82    | 41.80    | 31.40     |
| Yingluo                   | 16.10    | 19.10    | 28.50     |
| Ronggen Mountain          | 1.15     | 15.80    | 15.70     |
| Bottom well of Jiuhe      | —        | 25.4     | 12.0      |
| Total                     | 116.05   | 135.8    | 110.6     |

Note: “—” means uninvestigated areas of the sea grass bed.



**Fig 4.5-19 Distribution of sea grass bed in Guangxi**

#### 4.5.10.2 Dominant species

There are 4 species of sea grass distributed over the Tieshan Port sea area :*Halophila ovalis*, *Halodule univervis*, *Zostera japonica* and *Halophila beccarii*, among which the *Halophila ovalis* and *Zostera japonica* were the 2 dominant species, while *Halodule univervis* and *Halophila beccarii* were found in relatively small quantities.

#### 4.5.10.3 Biomass

Sea grass bed of Beihai is mainly distributed over Xialongwei of Dianzhousha and Wuni of Yinglong Bay; both were solely dominated by *Halophila ovalis*. Growth status of sea grass in Xialongwei is relatively better, with whole patched of green sea grass as a whole; while the situation at Wuni is worse, with scattered distribution of sea grass. Sea grass coverage at the two sites was 20% and 5% respectively, with 158ind/m<sup>2</sup> and 172ind/ m<sup>2</sup> of inhabiting density and 11.0g/m<sup>2</sup> and 3.6g/m<sup>2</sup> of sea grass biomass. Inhibiting densities of benthic animals in areas with sea grass distribution of the two sites were 54ind/ m<sup>2</sup> and 35ind/ m<sup>2</sup> respectively, and the numbers of biomass were 153.8g/m<sup>2</sup> and 115.3g/m<sup>2</sup> at these places.

Human activities with severe impact on the sea grass bed are mainly bottom towing, snail blowing, snail digging, sandworm (*Sipunculus nudus*) digging, piling for snail cultivation, channel dredging, sea piling, port construction and etc. Since these activities are reduced over the past years, growth status of sea grass bed is maintained stable.

#### 4.5.11 Conclusion

Investigation results and historical data indicate:

(1)Chlorophyll-a content and nutrient concentration in waters in the evaluation sea area have been kept far below the water eutrophication levels and primary productivities are also stable, indicating generally good environmental quality in waters in the evaluation sea area good;

(2)Species in the evaluation sea area are relatively rich and the species diversity indices are also relatively kept at high levels;

(3)Fishery resources in the evaluation sea area are relatively rich. However, due to over-fishing around offshore areas, fishery resources are declining over the years.

(4)Mangroves are generally in good status of growth; Sea grass bed is unevenly distributed. However, due to the strengthening of the protection measures, growth status of sea grass bed has become stable over the past few years.

Generally speaking, the current situation of marine ecological environment in the evaluation sea area is in good status, featuring rich and diversified organism species and fine community structures. In the area, eco-environmental functions are generally kept stable, only varied with changes of seasons and life traits of the various organisms. But the general situations in whole area have been kept stable, without big or significant changes.

## 4.6 Major Objectives for Marine Environmental Protection

See Table 1.7-2 for the main protection targets for offshore marine environment near the proposed project. This section mainly focuses on the basic information of Shankou mangrove protection zone, Hepu Dugong protection zone, Yingpan Mashi pearl oyster protection zone (to be applied) and state first-level protection zone for Chinese white dolphin.

### 4.6.1 Shankou State-level Mangrove Protection Zone

#### 4.6.1.1 Location & Profile

Shankou state-level mangrove protection zone was established as one of first five state-level protection zones approved by state council in Sept. 1990. It is located in east and west sides of Shatian Peninsular, Hepu Town, Guangxi and lies east to Yingluo Port and west to Dandou Port with the total area of 8000 hm<sup>2</sup> (Marine area: 4000 hm<sup>2</sup> and land area: 4000 hm<sup>2</sup>).

It mainly protects the ecological system of mangrove, whose forests is typical of continent offshore style, featuring the unique structure with continuous covering preserved well. There are 13 kinds of mangrove. (8 true mangrove plants including *bruguiera gymnorrhiza*, *kandelia candel*, *avicennia marina*, *aegiceras corniculatum*, *acrostichum aureum*, *excoecaria agallocha*, *heritiera littoralis*, *lumnizera racemosa*; 5 semi-mangroves including *acrostichaceae*, *cerbera manghas*, *cassytha filiformis*, *clerodendrum inerme*, *casuarina equisetifolia*). The forestry area is 800 hm<sup>2</sup>. There are 19 kinds of other usual high-level plants, 96 kinds of phytoplanktons, 158 kinds of benthonic diatom, 26 kinds of zooplankton, 82 kinds of fishes, 90 kinds of shells, 61 kinds of prawns and crabs, 106 kinds of birds, 258 kinds of insects and other 16 kinds of animals. There is no *Spartina alterniflora* near the protection, which can protect the bank and purify the environment, introduced by He-pu town in 1979.

The total volume of organism in this area is 75.64 t/hm<sup>2</sup>, among which the overground volume is 39.06 t/hm<sup>2</sup> and the under ground volume is 36.58 t/hm<sup>2</sup>. The production force for partially over ground in this area ranges from 1.48 to 15.37 t/hm<sup>2</sup>.a due to its type and development. The general average force for over-ground is 4.58 t/hm<sup>2</sup> in this area.

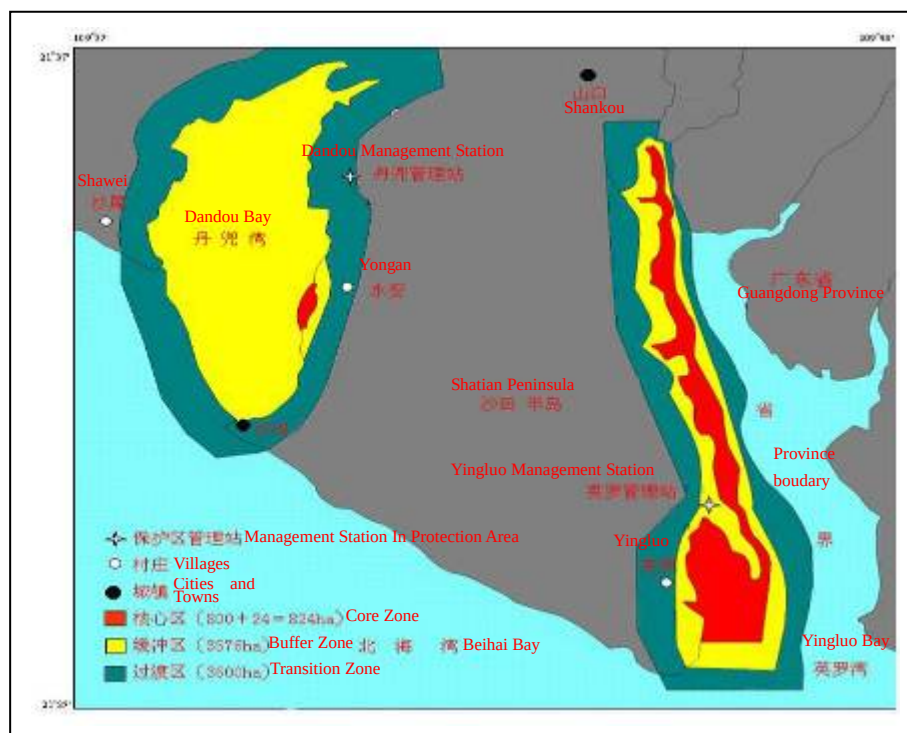
#### 4.6.1.2 Functional Division for Protection Zones

(1) Core area: mainly protecting extinct species of *Rhizophora stylosa* and *Bruguiera gymnorrhiza* that is very high and uniform with biological variety. It carries out closed management and forbids forest damage in the area. It is located in Yingluo Port with an area of 824 hm<sup>2</sup> (Dandou Port: 24hm<sup>2</sup>; Yingluo Port: 800 hm<sup>2</sup>).

(2) Buffer area: mainly protecting short *corniculatum* and *avicennia marina* with large area. It carries out forest planting, modelling second growth and setting up lab for ecological culture to explore sustainable development mode and methods for mangrove resources. The lab is located in Dandou Sea with an area of 3600 hm<sup>2</sup>.

(3) Transition area: the land and the mudflat around the forest higher than the coastline high tide line within 1 km is fishery and cultivation area for local villagers. It mainly prevents people from damaging the mangrove and the marine environment. The area is 3576 hm<sup>2</sup>.

See Picture 4.6-1 for distribution of protection zones.



Picture 4.6-1 State Natural Protection Zone for Mangrove in Guangxi

#### 4.6.1.3 Relation between Mangrove Protection Zone and the Project

There is 220 hm<sup>2</sup> mangrove in Yingluo Port and 510 hm<sup>2</sup> mangrove in Dandou Port. See Table 4.6-1 for the relation between the two protection zones with both the project site and the discharge outlets. According to the location and the tidal dynamics, Dandou Port shall be likely to be affected directly.

Table 4.6-1 Relation between Shankou Mangrove Protection Zone and Project Location

Unit: km

| Location                              | Dandou Port              |                    | Yingluo Port             |                    |
|---------------------------------------|--------------------------|--------------------|--------------------------|--------------------|
|                                       | Protection zone boundary | Core area boundary | Protection zone boundary | Core area boundary |
| Distance from the plant site          | 7.8                      | 12.2               | 23.1                     | 23.8               |
| Distance from the discharge outlet B3 | 4.7                      | 8.0                | 17.8                     | 18.8               |

#### 4.6.2 State-level Natural Hepu Dugong Protection Zone

It is located in Hepu Town, Beihai City, Guangxi, distributed at southeast marine area of Shatian. Early in Oct. 1992, the State Council approved to set up state-level Hepu Dugong protection zone, covering east from Yingluo Port, Shankou, Hepu, west to Shatian marine area, total coastline of 43 km. The concrete boundary is 109°38'30"~109°46'30" E, 21°30' N for north area and 109°34'30"~109°44' E, 21°18' N for south area with the total area of 350 hm<sup>2</sup>. Among them, the core area is 132 hm<sup>2</sup>, buffer area 110 hm<sup>2</sup> and the lab area 108 hm<sup>2</sup> (see Picture 4.6-2). It is the unique protection zone for Dugong in China.

Dugong mainly eats sea grass. The sea grass bed area is decreasing largely due to human damage since 1980s. At present, the sea grass bed in the area includes fresh water grass bed, Jiu-he-jing grass bed, Ronggenshan grass bed and Yingluo grass bed (the growth of grass bed can be seen at § 4.7.10). As fishery and protection management departments supervise the damage behaviors, the sea grass has grown steadily recently. However, there is no Dugong in protection area and nearby water area from the end of 1970s and the beginning of 1980s until now. Therefore, the ecological system for sea grass bed is the main protection target so far.

See Table 4.6-2 for the relation between Dugong protection zone with both project site and discharge outlet.

**Table 4.6-2 Relation between Hepu Dugong Protection Zone and Project Location**

| Unit: km                              |                          |                    |
|---------------------------------------|--------------------------|--------------------|
| Location<br>Relation                  | Protection zone boundary | Core area boundary |
| Distance from the plant site          | 10.6                     | 14.2               |
| Distance from the discharge outlet B3 | 5.0                      | 8.8                |



**Picture 4.6-2 State-level Hepu Dugong Natural Protection Zone**

### 4.6.3 Chinese White Dolphin

Chinese white dolphin is the first-level extinct marine mammal to be protected, the same as Dugong. It is scattered at the mix river mouth of salty fresh water in Donghai River and Nanhai River.

In the past, it was from south to north along Yangtze River. According to the recorded information, the north reaches the south of Xiangjiang River and the south extends to offshore of Fujian, Guangdong and Guangxi. However, at the end of 1980s, its distribution changed a lot. For example, it can be seldom seen at northern offshore in Fujian. Currently, it exists only at the mouth of Jiu-jiang water area in Xiamen, Zhujiang in Guangdong, northern area of Da-yu-shan, Long-gu area and Sha-zhou in Hongkong. It is used to living in marine area with short migratory lines.

From 2003 to 2004, Nanjin Normal University, together with the management station for Hepu Dugong natural protection zone, organized state-level Dugong natural protection zone in Hepu, Guangxi for investigation on Dugong resources in the area and the adjacent water area. Its results state that there are about 50 pieces to be protected discovered at Tiezhou, Fangcheng, Beihai and Shatian areas. According to the investigation, its migratory line is from Shatian, to Beihai, to Tiezhou and finally to Fangcheng. Its main living location is Sanliang Gulf area, Tiezhou, seldom seen in evaluated range.

## 4.7 Investigation and Evaluation on Current Land Ecological Environment

### 4.7.1 Current Situation of Land Use

#### 4.7.1.1 Regional Land Use

According to the investigation, the current situation of land use at the evaluation area of Xinggang Town is mainly composed of waters, farmland and forest land, of which the waters had taken up the largest area with 35.15% of the total, followed by farmland and forest land, with 26.24% and 24.46% respectively. See Table 4.7-1 for the current situation of land use at Xinggang Town and the Attached Drawing for the planning of land use.

**Table 4.7-1 Current Situation of Land Use at Xinggang Town**

| Item                         | Total area | Farmland    |          | Land for gardening use | Land for forestry use | Land for residents, factories and mines | Land for water conservancy facilities | Land for traffic use | Water area | Unused land |
|------------------------------|------------|-------------|----------|------------------------|-----------------------|-----------------------------------------|---------------------------------------|----------------------|------------|-------------|
|                              |            | Paddy field | Dry land |                        |                       |                                         |                                       |                      |            |             |
| Land area (hm <sup>2</sup> ) | 10970      | 765         | 2114     | 559                    | 2683                  | 123                                     | 53                                    | 49                   | 3856       | 768         |
| Proportion (%)               | 100        | 6.97        | 19.27    | 5.10                   | 24.46                 | 1.12                                    | 0.48                                  | 0.45                 | 35.15      | 7.00        |

#### 4.7.1.2 Current Situation of Project Land Occupation

Total areas of land occupation by project construction amounts to 236.30099 hm<sup>2</sup> (including the slag stockpile and the land for construction use). See Table 4.7-2 for details of the different types of land. The project occupies the area of basic farmland up to 45.25 hm<sup>2</sup>, accounting for 20.76% of the total area.

**Table 4.7-2 Land Occupation of Project Construction**

| Land Type         |                                          |                                             | Area (hm <sup>2</sup> ) | % of the total area of land use |
|-------------------|------------------------------------------|---------------------------------------------|-------------------------|---------------------------------|
| Agricultural land | Farmland                                 | Paddy filed                                 | 16.6974                 | 7.07                            |
|                   |                                          | Dry field                                   | 56.3514                 | 17.46                           |
|                   | Other Agricultural land                  | Forest land                                 | 39.8537                 | 18.28                           |
|                   |                                          | Cultivable waters                           | 47.6921                 | 21.88                           |
|                   |                                          | Others (water conservancy facilities, etc.) | 6.7543                  | 3.10                            |
|                   | Subtotal                                 |                                             | 149.0589                | 68.37                           |
| Construction land | Independent land for industry and mining |                                             | 23.1120                 | 10.60                           |
|                   | Land for traffic use                     |                                             | 0.4718                  | 0.22                            |
|                   | Land of special use                      |                                             | 2.9546                  | 1.36                            |
|                   | Residential center                       |                                             | 16.3737                 | 7.51                            |
|                   | Subtotal                                 |                                             | 22.9121                 | 10.51                           |

| Land Type   |                   | Area (hm <sup>2</sup> ) | % of the total area of land use |
|-------------|-------------------|-------------------------|---------------------------------|
| Unused land | Bare ground       | 1.2075                  | 0.55                            |
|             | Waste-grassland   | 1.6521                  | 0.76                            |
|             | Other unused land | 23.1803                 | 10.63                           |
|             | Subtotal          | 26.0399                 | 11.94                           |
| Total       |                   | 236.3009                | 100.00                          |

## 4.7.2 Vegetation Investigation

### 4.7.2.1 Vegetation

Vegetation shall be classified into the different categories in accordance with the three-level system of vegetation type, formation and association prescribed by *Chinese Vegetation*. According to the detailed classification systems and division standards for the various categories, the land vegetation in the evaluation area is divided into the 5 vegetation types, 10 formations and 12 associations (as in Table 4.7-3). For the area covered by the major vegetation type and its biomass statistics, see Table 4.7-3 and 4.7-4 respectively.

**Table 4.7-3 Current Situation of Vegetation in Evaluation Area**

| Vegetation type | Formation                                     | Association                                                         | Area (hm <sup>2</sup> ) | Percentage(%) |
|-----------------|-----------------------------------------------|---------------------------------------------------------------------|-------------------------|---------------|
| Timber forest   | Rubber woods                                  | Rubber tree—Chinaberry Tree—<br>Ageratum conyzoides Community       | 25.3                    | 0.31          |
|                 |                                               | Rubber tree—Lubianqing—<br>Ageratum conyzoides Community            |                         |               |
|                 | Eucalyptus forest                             | Eucalyptus tereticornis<br>Community                                | 6833.6                  | 84.76         |
|                 | Casuarina<br>equisetifolia forest             | Casuarina Equisetifolia<br>Community                                | 75.5                    | 0.94          |
|                 | Pinus massoniana<br>forest                    | Pinus massoniana—<br>Rhodomyrtus tomentosa—local<br>Scrub Community | 31.6                    | 0.39          |
|                 | Chinaberry Tree+<br>Mimosa sepiaria<br>Forest | Chinaberry Tree+Mimosa<br>sepiaria—Lubianqing Community             | 6.4                     | 0.08          |
|                 | Linden hibiscus<br>forest                     | linden hibiscus—pose mallow—<br>Ageratum conyzoides Community       | 8.7                     | 0.11          |
| Economic forest | Longan forest                                 | Longan Community                                                    | 321.2                   | 3.98          |
|                 | Lychee forest                                 | Lychee Community                                                    | 556.5                   | 6.90          |
| Bamboo forest   | Bamboo forest                                 | Bambusa pervariabilis McClure<br>Community                          | 5.6                     | 0.07          |
| Scrub-grassland | Scrubs-dominated<br>grassland                 | Lantana camara Community                                            | 198                     | 2.46          |
| Total           |                                               |                                                                     | 8062.4                  | 100.00        |



**Table 4.7-4 Biomass of Major Vegetation Community in Evaluation Area**

| Major vegetation type          | Area (hm <sup>2</sup> ) | Arbor layer                           |                   | Scrub layer                           |                   | Herb layer                            |                   | Total                                 |                   |
|--------------------------------|-------------------------|---------------------------------------|-------------------|---------------------------------------|-------------------|---------------------------------------|-------------------|---------------------------------------|-------------------|
|                                |                         | Biomass per unit (t/hm <sup>2</sup> ) | Total biomass (t) | Biomass per unit (t/hm <sup>2</sup> ) | Total biomass (t) | Biomass per unit (t/hm <sup>2</sup> ) | Total biomass (t) | Biomass per unit (t/hm <sup>2</sup> ) | Total biomass (t) |
| Rubber woods                   | 25.3                    | 65.20                                 | 1650              | 7.53                                  | 191               | 4.22                                  | 107               | 76.95                                 | 1947              |
| Eucalyptus forest              | 6833.6                  | 44.68                                 | 305325            |                                       | 0                 |                                       | 0                 | 52.18                                 | 305325            |
| Casuarina equisetifolia forest | 75.5                    | 82.40                                 | 6221              | 2.50                                  | 189               | 0.55                                  | 42                | 103.31                                | 6451              |
| Pinus massoniana forest        | 31.6                    | 72.50                                 | 2291              |                                       | 0                 |                                       | 0                 |                                       | 2291              |
| Economic forest                | 877.7                   |                                       | 0                 | 28.30                                 | 24839             |                                       | 0                 |                                       | 24839             |
| Spinney forest                 | 20.7                    | 35.82                                 | 741               | 10.36                                 | 214               | 5.56                                  | 115               | 51.74                                 | 1071              |
| Scrub-grass land               | 198.0                   |                                       | 0                 | 4.75                                  | 941               | 1.92                                  | 380               | 12.67                                 | 1321              |
| Total                          | 8062.4                  |                                       | 316228            |                                       | 26374             |                                       | 644               |                                       | 343245            |

The classification and structure of land vegetation in the evaluation area, dominated by artificial vegetation, is simple and non-diversified, and is small in both the quality and quantity of its local resources. There had been no sign of original vegetation in the evaluation area, with the present vegetation being secondary forests and artificial plantations, dominated by crops, eucalyptus and alike, which mainly include:

(1) Arbor: Protruding eucalyptus, Pinus massoniana, Rubber tree, Acacia cincinnata, Acacia mangium, Chinaberry tree, Casuarina equisetifolia, Hainan syzygium, Linden hibiscus, and Hibiscus abelmoschus;

(2) Scrubs: Mimosa sepia, Jade leaf and golden flower (vines), Striped Crotalaria Herb, Salanum torvum and Rose Mallow Root;

(3) Herbs: Dicranopteris dichotoma, Eupatorium odoratum Linn, Lantana camara and Chinese Eupatorium Root;

(4) Bamboo: Rhaps excelsa and Bambusa pervariabilis;

(5) Crops: paddy rice, cassava, sweet potatoes, corns, beans and peanuts. Biomass of vegetation in the evaluation area ranges from 20~78t/hm<sup>2</sup>. According to the survey, there had been no signs of any wild plant of national key protection. Vegetation types are mainly composed of 6 types as follows:

a. Eucalyptus forests: The forest plantations of eucalyptus cover an area of 6833.6 hm<sup>2</sup>, 84.76% of the major vegetation area in the evaluation area, with a total biomass of 305325 t. Eucalyptus forests in the evaluation area are characterized with an irregular distribution, interpenetration with the farmland and a few mature forests, while dominated by the coppice forests after being harvested down. The sample forests of eucalyptus in the investigation cover an area of 400 m<sup>2</sup>, with 0.4~0.6 of shade density and 1m×1.5 (2.0) m space between plants, while the number of sprouting branches for each plant ranges from 3~5, with 4.5~8.6cm in diameter and 6.5~13m in height.

b. Mature forests of rubber trees: Forests of rubber trees cover an area of 25.3 hm<sup>2</sup>, with a total biomass of 1497t, taking up 0.31% of the total area of major vegetation in the evaluation area. According to the investigation, the number of rubber trees in 100 m<sup>2</sup> forests shall be 13, all of which have been tapped of rubber and are 22.4cms in the diameter at breast height and 8.5 of height in average. Besides, canvasses are also planted below the forests of rubber trees. Understory scrubs are mainly composed of Lantana Camara, while the Rose Mallow Root, Indian String bush Root, Mallotus paniculatus, Lubianqing, Chineseberry Trees, Huoshaodou, Moghania philippinensis and canvasses is also located. Plantations at the herb layer are dominated by Ageratum conyzoides, with Hedyotis, Artemisia, Yekumai, Cockeyweed, Eupatorium odoratum, Sulfentrazone, Bermudagrass as well.

c. Casuarina equisetifolia forest: Casuarina equisetifolia, as a species of tree commonly used for dike consolidation and against the wind, is planted in communities alongside the coastline at the evaluation area, covering an area of 75.5hm<sup>2</sup>, with 12cm in diameter at breast height and 13m in height on average. Having been grown under such unfavorable environments, the trees are frequently drowned by the surging sea waters, devastating most of the understory scrubs.

d. Economic forests: The Economic forests of the evaluation area are mainly composed of longan, lychee, banana, Japanese banana, Chinese wampee, star fruit, etc. Given the favorable foundation of traditional agriculture, the area is abundant with major crops as paddy rice, sugarcane, canvass, sweet potato and beans.

e. Spinney forests: Spinney forests over the area are mainly composed of some weed trees grown in the front or at the back of villages, dominated by linden hibiscus, Acacia richii, Chineseberry trees, Mimosa sepiaria, etc.

f. Scrubs grasslands: Scrubs grasslands occupies a larger part of the evaluation area, covering an area of 198hm<sup>2</sup>, 2.46% of the total. The lantana camara communities are mainly grown over the wasted or non-reclaimed lands, of which the vegetation is found to be about 100cm in height and the coverage rate is 85%. Scrubs over the area include Lantana Camara, Guangyeqi, Mallotus paniculatus, wild peony, Downy Rosemyrtle, Berchemia Racemosa, Rose Mallow Root, Lubianqing, Emblic Leafflower Fruit, etc. The grasslands are dominated by communities of Eupatorium odoratum, mainly including the Eupatorium odoratum, Ageratum conyzoides, Rhizoma Imperatae, Bermudagrass, Eleusine indica, Coast Falsemallow, etc.

#### 4.7.2.2 Forest Distribution

Investigation on the forests distribution was conducted with Tieshan Port District as the pilot unit.

##### (1) Forests Area and Structure

For statistics of the forest area over the Tieshan Port District, see Table 4.7-5, which shows that the forests at Tieshan Port District is mainly composed of timber forests (66.12%), followed by protective forests and economic forests.

**Table 4.7-5 Statistics of Forest Areas in Tieshan Port District**

| Item                    | Forest area | Timber forest | Protective forest | Economic forest | Special forest | Open forest land | Scrubs forest | Nursery land | Logged land | Proposed plantation land | Unestablished forest |
|-------------------------|-------------|---------------|-------------------|-----------------|----------------|------------------|---------------|--------------|-------------|--------------------------|----------------------|
| Area (hm <sup>2</sup> ) | 9598.8      | 6346.3        | 1492.4            | 1266.9          | 1.4            | 8.6              | 198           | 4.2          | 124         | 90                       | 67                   |
| Proportion %            | 100.00      | 66.12         | 15.55             | 13.20           | 0.01           | 0.09             | 2.06          | 0.04         | 1.29        | 0.94                     | 0.70                 |

**(2) Forest stands structure**

Forest species structure: The timber forests cover an area of 6346.3 hm<sup>2</sup> and 123323m<sup>2</sup> for stock, taking up 69.69% and 95.9% of the total forest and plantation stock area respectively, while protective forests cover an area of 1492.4 hm<sup>2</sup> and 19912 hm<sup>2</sup> for stock, taking up 16.39% and 4.1% of the total forest and plantation stock area respectively. Areas covered by economic forests and special forests amount to 1266.9 hm<sup>2</sup> and 1.4 hm<sup>2</sup>, 13.91% and 0.01% of the total forest area respectively.

Tree species structure: The coverage of pines, broadleaved trees, and bamboo forests have been added up to 31.6 hm<sup>2</sup>, 7757.3 hm<sup>2</sup> (of which the eucalyptus accounts for 6833.6 hm<sup>2</sup>) and 5.6 hm<sup>2</sup>, 0.41%, 99.5% and 0.07% of the total forest area respectively.

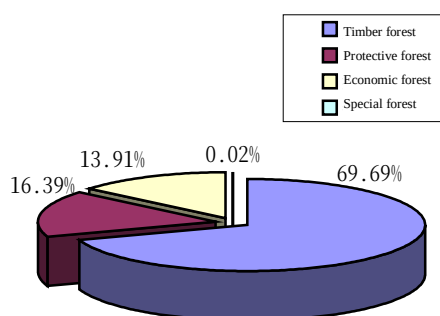


Diagram 4.7-1 Regional Forest Species Structure

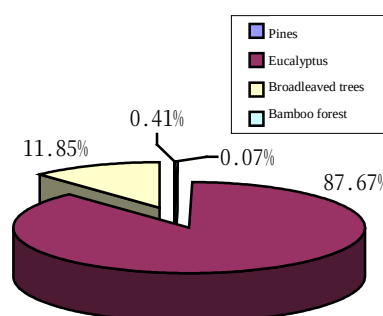


Diagram 4.7-2 Regional Tree Species Structure

**4.7.3 Investigation on Animal Resources**

According to statistics in relevant data and investigations conducted, in-land wild animal resources in the evaluation area are falling short both in the total volume and species. Wild animals under key protection of the state and the autonomous region are no more commonly seen, especially with the mammals that are scarcely found across the region. Wild animals now existing are mostly the common widely-dispersed species, which mainly include:

- Mammal: rats, bats, etc;
- Birds: long-tailed shrikes, great tits, sparrows, grackles, swallow, babbler, etc;
- Reptiles: Asian grass lizard, snakes, etc;

d. Insects: bees, black bees, dragon-flies, locusts, butterflies, cicadas, spiders, silkworms, crickets, etc; According to the investigation, there have been no signs of wild animals of national key protection within the evaluation area.

#### 4.7.4 Investigation and Evaluation on Soil Environment

In July 2005, entrusted by our institution, the Beihai Environment Protection Monitoring Station performed the monitoring on the current situation of soil environment over Tieshan Port District.

##### 4.7.4.1 Layout of Monitoring Sites

2 monitoring sites are distributed across the evaluation area. See Table 4.7-6 and the Attached Drawing 11 for details.

**Table 4.7-6 Positioning of Monitoring Sites for Soil Environment**

| No.            | Name of monitoring sites                          | Location                                  | Land type |
|----------------|---------------------------------------------------|-------------------------------------------|-----------|
| 1 <sup>#</sup> | The 11 <sup>th</sup> division of Qianwei Farmyard | NNW, about 1km away from the plant site   | Dry land  |
| 2 <sup>#</sup> | Great bamboo garden                               | SW, about 1.5 km away from the plant site | Farmland  |

##### 4.7.4.2 Sampling Methods

Collections of the soil samples shall be conducted in line with the requirement in the *Technical Specification for Soil Environmental Monitoring* (HJ/T 166-2004) issued by State Environmental Protection Administration. The mixed samples of soil shall be collected 0-20cm, 20-40cm and 40-60cm under the ground for monitoring.

##### 4.7.4.3 Monitoring Items and Analytical Methods

The monitoring includes the 6 items of pH, Cu, Pb, As, Cd and Hg.

Analytical methods of the monitoring shall be identified as the relevant requirements in the *Technical Specification for Soil Environmental Monitoring* (HJ/T 166-2004). See Table 4.7-7 for the analytical methods and detection limits.

**Table 4.7-7 Monitoring Items and Analytical Methods for Soils**

| Monitoring item | Analytical method                                                                                                                                 | Lower detectable limit (mg/kg) | Source of the method |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|----------------------|
| pH value        | Glass electrode (soil: water=1.0:2.5)                                                                                                             | 0.01                           | GB7859-87            |
| Copper          | Flame atomic absorption spectrophotometry after the dissolving of soil samples by hydrochloric acid-nitric acid-hydrofluoric acid-perchloric acid | 1.0                            | GB/T17138-1997       |
| Lead            | Flame atomic absorption spectrophotometry after the dissolving of soil samples by hydrochloric acid-nitric acid- hydrofluoric acid-perchloric     | 0.4                            | GB/T17141-1997       |

| Monitoring item | Analytical method                                                                                                                                  | Lower detectable limit (mg/kg) | Source of the method |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|----------------------|
|                 | acid                                                                                                                                               |                                |                      |
| Cadmium         | Flame atomic absorption spectrophotometry after the dissolving of soil samples by hydrochloric acid-nitric acid- hydrofluoric acid-perchloric acid | 0.025                          | GB/T17140-1997       |
| Arsenic         | Potassium borohydride-silver nitrate spectrophotometry                                                                                             | 0.0009                         | GB/T17135-1997       |
| Mercury         | Cold-vapor atomic absorption                                                                                                                       | 0.00009                        | GB/T17136-1997       |

#### 4.7.4.4 Evaluation Standards

Class II Standard as required in *Environmental Quality Standard for Soils* (GB15618-1995) shall be executed. (See Table 4.7-8.)

**Table 4.7-8 Evaluation Standards for Soil Environment Quality Unit:**

**mg/kg**

| Item          |                | Standard value (Class II in GB15618-1995) |         |      |
|---------------|----------------|-------------------------------------------|---------|------|
| pH value      |                | ≤6.5                                      | 6.5~7.5 | >7.5 |
| Total arsenic | Paddy filed    | 30                                        | 25      | 20   |
|               | Dry land       | 40                                        | 30      | 25   |
| Copper        | Farmland, etc. | 50                                        | 100     | 100  |
|               | Fruit yard     | 150                                       | 200     | 200  |
| Lead          |                | 250                                       | 300     | 350  |
| Cadmium       |                | 0.30                                      | 0.30    | 0.60 |
| Mercury       |                | 0.30                                      | 0.50    | 1.0  |

#### 4.7.4.5 Monitoring and Evaluation Results

See Table 4.7-9 for the results of soil analysis and Table 4.7-10 for the evaluation results, which shows that all single pollution index of monitoring items is less than 1 and meet the required Class II standard in the *Environmental Quality Standard for Soils* (GB15618-1995).

**Table 4.7-9 Results of Soil Analysis Unit: mg/kg (excluding pH**

**value)**

| Position | Soil depth | Monitoring results |        |      |         |         |          |
|----------|------------|--------------------|--------|------|---------|---------|----------|
|          |            | pH                 | Copper | Lead | Cadmium | Arsenic | Mercury  |
| 1#       | 0~-20cm    | 5.20               | 3.8    | 42.7 | 0.14    | 0.0009L | 0.00009L |
|          | -20~-40cm  | 4.73               | 5.5    | 39.5 | 0.08    | 0.0009L | 0.00009L |
|          | -40~-60cm  | 4.60               | 5.5    | 35.7 | 0.08    | 0.0009L | 0.00009L |
| 2#       | 0~-20cm    | 7.49               | 17.2   | 33.0 | 0.22    | 0.0009L | 0.00009L |
|          | -20~-40cm  | 7.35               | 16.8   | 26.7 | 0.20    | 0.0009L | 0.00009L |
|          | -40~-60cm  | 7.21               | 17.2   | 25.5 | 0.20    | 0.0009L | 0.00009L |

Notes: "L" stands for the analytical results being lower than the lowest detection limits of the specific method.

**Table 4.7-10 Evaluation Results of Single Index for Soil Quality**

| Position | Soil depth | Evaluation item |      |         |         |         |
|----------|------------|-----------------|------|---------|---------|---------|
|          |            | Copper          | Lead | Cadmium | Arsenic | Mercury |
| 1#       | 0~-20cm    | 0.08            | 0.17 | 0.47    | 0.00    | 0.00    |
|          | -20~-40cm  | 0.11            | 0.16 | 0.27    | 0.00    | 0.00    |
|          | -40~-60cm  | 0.11            | 0.14 | 0.27    | 0.00    | 0.00    |
| 2#       | 0~-20cm    | 0.17            | 0.11 | 0.73    | 0.00    | 0.00    |
|          | -20~-40cm  | 0.16            | 0.09 | 0.67    | 0.00    | 0.00    |
|          | -40~-60cm  | 0.17            | 0.09 | 0.67    | 0.00    | 0.00    |

#### 4.8 Investigation and Evaluation on Territorial Water Environment

The major surface river in the evaluation area is the Nankangjiang River, about 6km to the west of the plant site. As no water effluent (including wastewater and rain water) and water supply source for the proposed project is related to the River, the evaluation shall exclude investigations on the current environment situation of Nankangjiang River and only focus on the underground water quality within the impact of the projects.

##### 4.8.1 Layout of Monitoring Sites

For a better knowledge of the underground water quality within the plant site and around the slag stockpile, 9 monitoring sites were set up according to the flow direction of underground water within the area (from west to south) and its relative position to the plant site and the slag stockpile. See Table 4.8-1 and Attached Drawing 11 for details.

**Table 4.8-1 Positioning of Monitoring Sites**

| No. | Name of monitoring sites                      | Location                                                                                                                                                                                                                                    |
|-----|-----------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Nage Tang                                     | W to the plant site, natural village; 1.0km at the upper reach along the flow direction of underground water within the plant site.                                                                                                         |
| 2   | 11 <sup>th</sup> division of Qianwei Farmyard | NW to the plant site, natural village; 1.5km at the upper reach along the flow direction of underground water within the plant site.                                                                                                        |
| 3   | Xiejia                                        | NE to the plant site, natural village; 1.8km at the lower reach along the flow direction of underground water within the plant site, about 1.5km away from the coast.                                                                       |
| 4   | Beimu Salt Works                              | SE corner of the Works site, part of the salt field area; 0.85km at the lower reach of underground water running within the plant site, and the upper reach of underground water of Beimu slag stockpile; about 2.0 km away from the coast. |
| 5   | Anze                                          | SE to the plant site, natural village; about 0.8km at the lower reach of underground water running within the plant site, and 1.3km at the upper reach of underground water of Beimu slag stockpile; about 1.5 km away from the coast.      |
| 6   | Beimu slag stockpile                          | E to the Beimu slag stockpile, at the lower reach of underground water running within the slag stockpile area; about 1.5 km away from the coast.                                                                                            |
| 7   | Tiantouwu                                     | 1.5km to the west of Chijiang (for comparison and selection) slag stockpile; about 3km away from the coast; 1km at the upper reach of underground water running within the slag stockpile area.                                             |

| No. | Name of monitoring sites | Location                                                                                                                                                                                      |
|-----|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8   | Chijiang Primary School  | 1.0 km to the west of Chijiang (for comparison and selection) slag stockpile; about 3km away from the coast; at the lateral side of underground water within the slag stockpile area.         |
| 9   | Wolong Village           | 2.0km to the west of Chijiang (for comparison and selection) slag stockpile; about 0.5km away from the coast; at the lower reach of underground water running within the slag stockpile area. |

#### 4.8.2 Monitoring Factors

Taking the project pollution features and the water environment over the proposed site, the following 12 items of monitoring factors shall be covered: pH, total hardness, sulfate, volatile phenol, ammonia nitrogen ( $\text{NH}_3\text{-N}$ ), permanganate index ( $\text{COD}_{\text{Mn}}$ ), nitrates ( $\text{NO}^{-3}\text{-N}$  and  $\text{NO}^{-2}\text{-N}$ ), total dissolved solids, chlorides ( $\text{Cl}^-$ ), total coliform group, total bacteria, etc.

#### 4.8.3 Monitoring and Analytical Methods

See Table 4.8-2 for the monitoring & analytical methods and the detection lower limits of various items.

**Table 4.8-2 Monitoring Items, Analytical Methods and Sources and Detection Limits for Underground Water**

| No | Item                      | Analytical method                                | Minimum detection limit (mg/L) | Sources of the method                                                                           |
|----|---------------------------|--------------------------------------------------|--------------------------------|-------------------------------------------------------------------------------------------------|
| 1  | pH value                  | Glass electrode                                  | 0.1 (pH value)                 | GB6920—86                                                                                       |
| 2  | Total hardness            | EDTA titrimetry                                  | 0.05 (mmol/L)                  | GB7477—87                                                                                       |
| 3  | Sulfate                   | Luminosity-method of barium-chromate             | 1.0                            | <i>Monitoring and Analytical Methods for Water and Wastewater</i> (the 4 <sup>th</sup> Edition) |
| 4  | $\text{COD}_{\text{Mn}}$  | Acidic potassium permanganate process            | 0.5                            | GB11892—89                                                                                      |
| 5  | $\text{NO}^{-3}\text{-N}$ | Phenol disulfonic acid spectrophotometric method | 0.02                           | GB7480—87                                                                                       |
| 6  | $\text{NO}^{-2}\text{-N}$ | N-(1-Naphthyl)-Ethylenediamine spectrophotometry | 0.003                          | GB13580.7—92                                                                                    |
| 7  | $\text{NH}_3\text{-N}$    | Nessler's reagent colorimetry                    | 0.025                          | GB7479—87                                                                                       |
| 8  | $\text{Cl}^-$             | Silver nitrate titrimetry                        | 2.0                            | HJ/791-2002                                                                                     |
| 9  | Fluorides                 | Spectrophotometry with fluorinating agent        | 0.05                           | GB7483—87                                                                                       |
| 10 | Volatile phenol           | 4-Amino-antipyrine extraction photometer         | 0.002                          | GB7490—87                                                                                       |
| 11 | Total coliform group      |                                                  |                                | <i>Sanitary Standard for Drinking Water Quality</i> (2001)                                      |
| 12 | Total bacteria            |                                                  |                                | <i>Sanitary Standard for Drinking Water Quality</i> (2001)                                      |

#### 4.8.4 Monitoring Time and Frequency

The monitoring was conducted from Feb. 27<sup>th</sup> to March 1<sup>st</sup>, 2007, with the samples collected once every day and for three days in succession. Sampling methods had been identified with regard to the requirements prescribed in the *Technical Specification for Environmental Monitoring* (the 4<sup>th</sup> Edition) issued by the State Environment Protection Administration.

#### 4.8.5 Evaluation Standards and Methods

##### (1) Evaluation Standards

The evaluation was carried out in line with the Class III standard in the *Quality Standard for Ground Water* (GB/T14848-93).

##### (2) Evaluation Methods

Same as the surface water.

#### 4.8.6 Monitoring results and evaluation

See Table 4.8-3 to 4.8-11 for monitoring statistics and evaluation results of all monitoring sites.

As indicated by the monitoring and evaluation results, performance indicators at all monitoring sites had fulfilled the Class III standard as in the *Quality Standard for Ground Water* (GB/T14848-93), except for that of the pH value, which went higher than the required standards only out of the restrictions of geological features, in that the underground water of proposed project sites are diagnosed to be weak acidic to neutral, with the pH value ranging from 5.5 to 7 in most of the times.

**Table 4.8-3 Statistics and Evaluation of Monitoring Results at 1# Nage Tang**

Unit: mg/L (excluding pH and S<sub>i,j</sub>)

| N<br>o. | Item                   | Monitoring date       |                       |                       | Over-stand<br>ard rate<br>(%) | Maximum<br>over-stand<br>ard<br>multiple | S <sub>i,j</sub>    |
|---------|------------------------|-----------------------|-----------------------|-----------------------|-------------------------------|------------------------------------------|---------------------|
|         |                        | Feb. 27 <sup>th</sup> | Feb. 28 <sup>th</sup> | March 1 <sup>st</sup> |                               |                                          |                     |
| 1       | pH<br>value            | 6.3                   | 6.4                   | 6.4                   | 100                           | 0.40                                     | 1.200<br>~<br>1.400 |
| 2       | Total<br>hardne<br>ss  | 9.3                   | 8.9                   | 9.4                   | 0                             | 0                                        | 0.020<br>~<br>0.021 |
| 3       | CODM<br>n              | 0.6                   | 0.5                   | 0.5                   | 0                             | 0                                        | 0.167<br>~<br>0.200 |
| 4       | Volatil<br>e<br>phenol | 0.002L                | 0.002L                | 0.002L                | 0                             | 0                                        | 0.500               |
| 5       | NH <sub>3</sub> -N     | 0.025L                | 0.025L                | 0.025L                | 0                             | 0                                        | 0.125               |
| 6       | Cl <sup>-</sup>        | 14.3                  | 14.0                  | 15.0                  | 0                             | 0                                        | 0.056<br>~<br>0.060 |
| 7       | Sulfate                | 1.3                   | 1.3                   | 1.7                   | 0                             | 0                                        | 0.006<br>~<br>0.007 |
| 8       | NO <sup>-3</sup> -N    | 0.02L                 | 0.02L                 | 0.02L                 | 0                             | 0                                        | 0.001               |



| N<br>o. | Item                              | Monitoring date       |                       |                       | Over-stand<br>ard rate<br>(%) | Maximum<br>over-stand<br>ard<br>multiple | S <sub>i,j</sub>    |
|---------|-----------------------------------|-----------------------|-----------------------|-----------------------|-------------------------------|------------------------------------------|---------------------|
|         |                                   | Feb. 27 <sup>th</sup> | Feb. 28 <sup>th</sup> | March 1 <sup>st</sup> |                               |                                          |                     |
| 9       | NO <sup>-2</sup> -N               | 0.003L                | 0.003L                | 0.003L                | 0                             | 0                                        | 0.075               |
| 10      | Fluorides                         | 0.05L                 | 0.05L                 | 0.05L                 | 0                             | 0                                        | 0.025               |
| 11      | Total bacteria<br>(unit/ml)       | 25                    | 22                    | 17                    | 0                             | 0                                        | 0.170<br>~<br>0.250 |
| 12      | Total coliform group<br>(group/L) | Non-detectable        | Non-detectable        | Non-detectable        | 0                             | 0                                        | 0.500               |

Note: Monitoring results lower than the detection limits in the form are underlined with the “detection limit plus L”, except for the total coliform group (the same below).

**Table 4.8-4 Statistics and Evaluation of Monitoring Results at 2# 11th Division of Qianwei Farmyard**  
Unit: mg/L (excluding pH and S<sub>i,j</sub>)

| N<br>o. | Item                | Monitoring date       |                       |                       | Over-stand<br>ard rate<br>(%) | Maximum<br>over-stand<br>ard<br>multiple | S <sub>i,j</sub> |
|---------|---------------------|-----------------------|-----------------------|-----------------------|-------------------------------|------------------------------------------|------------------|
|         |                     | Feb. 27 <sup>th</sup> | Feb. 27 <sup>th</sup> | Feb. 27 <sup>th</sup> |                               |                                          |                  |
| 1       | pH value            | 5.0                   | 5.2                   | 5.6                   | 100                           | 3.0                                      | 2.800~4.000      |
| 2       | Total hardness      | 10.9                  | 9.7                   | 9.2                   | 0                             | 0                                        | 0.020~0.024      |
| 3       | COD Mn              | 0.6                   | 0.6                   | 0.5                   | 0                             | 0                                        | 0.167~0.200      |
| 4       | Volatile phenol     | 0.002L                | 0.002L                | 0.002L                | 0                             | 0                                        | 0.500            |
| 5       | NH <sub>3</sub> -N  | 0.025L                | 0.025L                | 0.027                 | 0                             | 0                                        | 0.125~0.135      |
| 6       | Cl <sup>-</sup>     | 28.6                  | 13.0                  | 13.0                  | 0                             | 0                                        | 0.052~0.114      |
| 7       | Sulfate             | 2.2                   | 1.7                   | 2.0                   | 0                             | 0                                        | 0.007~0.009      |
| 8       | NO <sup>-3</sup> -N | 2.40                  | 2.40                  | 2.50                  | 0                             | 0                                        | 0.120~0.125      |
| 9       | NO <sup>-2</sup> -N | 0.003L                | 0.003L                | 0.003L                | 0                             | 0                                        | 0.125            |
| 10      | Fluorides           | 0.05L                 | 0.05L                 | 0.05L                 | 0                             | 0                                        | 0.050            |

| N<br>o. | Item                                 | Monitoring date       |                       |                       | Over-stand<br>dard rate<br>(%) | Maximum<br>over-stand<br>dard<br>multiple | S <sub>i,j</sub> |
|---------|--------------------------------------|-----------------------|-----------------------|-----------------------|--------------------------------|-------------------------------------------|------------------|
|         |                                      | Feb. 27 <sup>th</sup> | Feb. 27 <sup>th</sup> | Feb. 27 <sup>th</sup> |                                |                                           |                  |
| 11      | Total bacteria<br>(unit/ml)          | 21                    | 27                    | 24                    | 0                              | 0                                         | 0.210~<br>0.270  |
| 12      | Total coliform<br>group<br>(group/L) | Non-detectable        | Non-detectable        | Non-detectable        | 0                              | 0                                         | 0.500            |

**Table 4.8-5 Statistics and Evaluation of Monitoring Results at 3# Xiejia****Unit: mg/L (excluding pH and S<sub>i,j</sub>)**

| No. | Item                                 | Monitoring date       |                       |                       | Over-standard<br>rate (%) | Maximum<br>over-standard<br>multiple | S <sub>i,j</sub> |
|-----|--------------------------------------|-----------------------|-----------------------|-----------------------|---------------------------|--------------------------------------|------------------|
|     |                                      | Feb. 27 <sup>th</sup> | Feb. 27 <sup>th</sup> | Feb. 27 <sup>th</sup> |                           |                                      |                  |
| 1   | pH value                             | 6.6                   | 6.5                   | 6.8                   | 0                         | 0                                    | 0.400~1.000      |
| 2   | Total hardness                       | 9.7                   | 10.5                  | 10.4                  | 0                         | 0                                    | 0.022~0.023      |
| 3   | CODMn                                | 0.6                   | 0.7                   | 0.5                   | 0                         | 0                                    | 0.167~0.233      |
| 4   | Volatile phenol                      | 0.002L                | 0.002L                | 0.002L                | 0                         | 0                                    | 0.500            |
| 5   | NH <sub>3</sub> -N                   | 0.030                 | 0.039                 | 0.050                 | 0                         | 0                                    | 0.150~0.250      |
| 6   | Cl <sup>-</sup>                      | 2.9                   | 6.0                   | 9.8                   | 0                         | 0                                    | 0.012~0.039      |
| 7   | Sulfate                              | 5.2                   | 1.3                   | 1.7                   | 0                         | 0                                    | 0.005~0.021      |
| 8   | NO <sup>-3</sup> -N                  | 0.20                  | 0.18                  | 0.20                  | 0                         | 0                                    | 0.009~0.010      |
| 9   | NO <sup>-2</sup> -N                  | 0.003L                | 0.003L                | 0.003L                | 0                         | 0                                    | 0.075            |
| 10  | Fluorides                            | 0.05L                 | 0.05L                 | 0.05L                 | 0                         | 0                                    | 0.025            |
| 11  | Total bacteria<br>(unit/ml)          | 25                    | 20                    | 19                    | 0                         | 0                                    | 0.190~0.250      |
| 12  | Total coliform<br>group<br>(group/L) | Non-detectable        | Non-detectable        | Non-detectable        | 0                         | 0                                    | 0.500            |

**Table 4.8-6 Statistics and Evaluation of Monitoring Results at 4# Beimu Salt Works****Unit: mg/L (excluding pH and  $S_{i,j}$ )**

| No. | Item                           | Monitoring date       |                       |                       | Over-standard rate (%) | Maximum over-standard multiple | $S_{i,j}$   |
|-----|--------------------------------|-----------------------|-----------------------|-----------------------|------------------------|--------------------------------|-------------|
|     |                                | Feb. 27 <sup>th</sup> | Feb. 27 <sup>th</sup> | Feb. 27 <sup>th</sup> |                        |                                |             |
| 1   | pH value                       | 5.0                   | 6.1                   | 6.6                   | 66.7                   | 3.0                            | 0.800~4.000 |
| 2   | Total hardness                 | 10.5                  | 8.0                   | 8.6                   | 0                      | 0                              | 0.018~0.023 |
| 3   | CODMn                          | 0.9                   | 0.9                   | 0.7                   | 0                      | 0                              | 0.023~0.300 |
| 4   | Volatile phenol                | 0.002L                | 0.002L                | 0.002L                | 0                      | 0                              | 0.500       |
| 5   | NH <sub>3</sub> -N             | 0.039                 | 0.025                 | 0.025                 | 0                      | 0                              | 0.125~0.195 |
| 6   | Cl <sup>-</sup>                | 59.9                  | 52.0                  | 50.9                  | 0                      | 0                              | 0.204~0.240 |
| 7   | Sulfate                        | 21.0                  | 22.3                  | 21.0                  | 0                      | 0                              | 0.084~0.089 |
| 8   | NO <sup>-3</sup> -N            | 0.30                  | 0.30                  | 0.32                  | 0                      | 0                              | 0.015~0.016 |
| 9   | NO <sup>-2</sup> -N            | 0.003L                | 0.003L                | 0.003L                | 0                      | 0                              | 0.075       |
| 10  | Fluorides                      | 0.05L                 | 0.05L                 | 0.05L                 | 0                      | 0                              | 0.025       |
| 11  | Total bacteria (unit/ml)       | 15                    | 17                    | 23                    | 0                      | 0                              | 0.150~0.230 |
| 12  | Total coliform group (group/L) | Non-detectable        | Non-detectable        | Non-detectable        | 0                      | 0                              | 0.500       |

**Table 4.8-7 Statistics and Evaluation of Monitoring Results at 5# Anze****Unit: mg/L (excluding for pH and  $S_{i,j}$ )**

| No. | Item               | Monitoring date      |                      |                      | Over-standard rate (%) | Maximum over-standard multiple | $S_{i,j}$    |
|-----|--------------------|----------------------|----------------------|----------------------|------------------------|--------------------------------|--------------|
|     |                    | May 23 <sup>rd</sup> | May 24 <sup>th</sup> | May 25 <sup>th</sup> |                        |                                |              |
| 1   | pH value           | 6.0                  | 5.9                  | 5.0                  | 100                    | 3.0                            | 2.000~4.000  |
| 2   | Total hardness     | 13.0                 | 12.5                 | 12.9                 | 0                      | 0                              | 0.028~0.029  |
| 3   | CODMn              | 0.6                  | 0.5L                 | 0.5L                 | 0                      | 0                              | 0.2000~0.083 |
| 4   | Volatile phenol    | 0.002L               | 0.002L               | 0.002L               | 0                      | 0                              | 0.500        |
| 5   | NH <sub>3</sub> -N | 0.038                | 0.043                | 0.015                | 0                      | 0                              | 0.075~0.22   |
| 6   | Cl <sup>-</sup>    | 21.8                 | 7.0                  | 5.2                  | 0                      | 0                              | 0.021~0.087  |
| 7   | Sulfate            | 3.8                  | 8.8                  | 2.0                  | 0                      | 0                              | 0.008~0.035  |

| No. | Item                           | Monitoring date      |                      |                      | Over-standard rate (%) | Maximum over-standard multiple | S <sub>i,j</sub> |
|-----|--------------------------------|----------------------|----------------------|----------------------|------------------------|--------------------------------|------------------|
|     |                                | May 23 <sup>rd</sup> | May 24 <sup>th</sup> | May 25 <sup>th</sup> |                        |                                |                  |
| 8   | NO <sup>-3</sup> -N            | 0.12                 | 0.12                 | 0.12                 | 0                      | 0                              | 0.006            |
| 9   | NO <sup>-2</sup> -N            | 0.015                | 0.012                | 0.012                | 0                      | 0                              | 0.60~<br>0.75    |
| 10  | Fluorides                      | 0.19                 | 0.17                 | 0.16                 | 0                      | 0                              | 0.16~<br>0.19    |
| 11  | Total bacteria (unit/ml)       | 30                   | 29                   | 37                   | 0                      | 0                              | 0.300~<br>0.370  |
| 12  | Total coliform group (group/L) | Non-detectable       | Non-detectable       | Non-detectable       | 0                      | 0                              | 0.500            |

**Table 4.8-8 Statistics and Evaluation of Monitoring Results at 6# Beimu Slag stockpile****Unit: mg/L (excluding pH and S<sub>i,j</sub>)**

| No. | Item                           | Monitoring date      |                      |                      | Over-standard rate (%) | Maximum over-standard multiple | S <sub>i,j</sub> |
|-----|--------------------------------|----------------------|----------------------|----------------------|------------------------|--------------------------------|------------------|
|     |                                | May 23 <sup>rd</sup> | May 24 <sup>th</sup> | May 25 <sup>th</sup> |                        |                                |                  |
| 1   | pH value                       | 4.7                  | 4.8                  | 5.0                  | 100                    | 3.6                            | 4.000~<br>4.600  |
| 2   | Total hardness                 | 9.7                  | 10.3                 | 10.5                 | 0                      | 0                              | 0.022~<br>0.023  |
| 3   | CODMn                          | 0.7                  | 1.1                  | 0.5L                 | 0                      | 0                              | 0.083~<br>0.367  |
| 4   | Volatile phenol                | 0.002L               | 0.002L               | 0.002L               | 0                      | 0                              | 0.500            |
| 5   | NH <sub>3</sub> -N             | 0.028                | 0.110                | 0.048                | 0                      | 0                              | 0.140~<br>0.550  |
| 6   | Cl <sup>-</sup>                | 6.7                  | 9.8                  | 4.9                  | 0                      | 0                              | 0.020~<br>0.040  |
| 7   | Sulfate                        | 2.5                  | 8.8                  | 4.1                  | 0                      | 0                              | 0.010~<br>0.035  |
| 8   | NO <sup>-3</sup> -N            | 0.02L                | 0.02L                | 0.02L                | 0                      | 0                              | 0.001            |
| 9   | NO <sup>-2</sup> -N            | 0.003L               | 0.003L               | 0.003L               | 0                      | 0                              | 0.075            |
| 10  | Fluorides                      | 0.005                | 0.005                | 0.007                | 0                      | 0                              | 0.005~<br>0.007  |
| 11  | Total bacteria (unit/ml)       | 20                   | 19                   | 25                   | 0                      | 0                              | 0.200~<br>0.250  |
| 12  | Total coliform group (group/L) | Non-detectable       | Non-detectable       | Non-detectable       | 0                      | 0                              | 0.500            |

**Table 4.8-9 Statistics and Evaluation of Monitoring Results at 7# Tiantouwu****Unit: mg/L (excluding pH and S<sub>i,j</sub>)**

| N<br>o. | Item                                            | Monitoring date      |                      |                      | Over-stand<br>ard rate<br>(%) | Maximum<br>over-stand<br>ard<br>multiple | S <sub>i,j</sub>    |
|---------|-------------------------------------------------|----------------------|----------------------|----------------------|-------------------------------|------------------------------------------|---------------------|
|         |                                                 | May 23 <sup>rd</sup> | May 24 <sup>th</sup> | May 25 <sup>th</sup> |                               |                                          |                     |
| 1       | pH<br>value                                     | 5.3                  | 5.0                  | 4.7                  | 100                           | 3.6                                      | 3.400<br>~<br>4.600 |
| 2       | Total<br>hardne<br>ss                           | 11.7                 | 8.1                  | 11.3                 | 0                             | 0                                        | 0.010<br>~<br>0.026 |
| 3       | CODM<br>n                                       | 0.5                  | 0.5L                 | 0.5L                 | 0                             | 0                                        | 0.083<br>~<br>0.166 |
| 4       | Volatil<br>e<br>phenol                          | 0.002L               | 0.002L               | 0.002L               | 0                             | 0                                        | 0.500               |
| 5       | NH <sub>3</sub> -N                              | 0.043                | 0.054                | 0.026                | 0                             | 0                                        | 0.130<br>~<br>0.270 |
| 6       | Cl <sup>-</sup>                                 | 19.8                 | 2.9                  | 6.0                  | 0                             | 0                                        | 0.012<br>~<br>0.079 |
| 7       | Sulfate                                         | 8.8                  | 7.9                  | 3.3                  | 0                             | 0                                        | 0.013<br>~<br>0.035 |
| 8       | NO <sup>-3</sup> -N                             | 0.08                 | 0.12                 | 0.10                 | 0                             | 0                                        | 0.004<br>~<br>0.006 |
| 9       | NO <sup>-2</sup> -N                             | 0.003L               | 0.003L               | 0.003L               | 0                             | 0                                        | 0.075               |
| 10      | Fluorid<br>es                                   | 0.05                 | 0.19                 | 0.05                 | 0                             | 0                                        | 0.05<br>~<br>0.19   |
| 11      | Total<br>bacteri<br>a<br>(unit/m<br>l)          | 21                   | 15                   | 23                   | 0                             | 0                                        | 0.15<br>~<br>0.23   |
| 12      | Total<br>colifor<br>m<br>group<br>(group/<br>L) | Non-detect<br>able   | Non-detect<br>able   | Non-detect<br>able   | 0                             | 0                                        | 0.500               |

**Table 4.8-10 Statistics and Evaluation of Monitoring Results at 8# Chijiang Primary School**  
Unit: mg/L (excluding pH and  $S_{ij}$ )

| No. | Item                           | Monitoring date      |                      |                      | Over-standard rate (%) | Maximum over-standard multiple | $S_{ij}$    |
|-----|--------------------------------|----------------------|----------------------|----------------------|------------------------|--------------------------------|-------------|
|     |                                | May 23 <sup>rd</sup> | May 24 <sup>th</sup> | May 25 <sup>th</sup> |                        |                                |             |
| 1   | pH value                       | 4.4                  | 4.5                  | 4.8                  | 100                    | 4.2                            | 4.40~5.20   |
| 2   | Total hardness                 | 8.5                  | 11.1                 | 7.6                  | 0                      | 0                              | 0.017~0.019 |
| 3   | CODMn                          | 0.5L                 | 0.5L                 | 0.5L                 | 0                      | 0                              | 0.083~0.166 |
| 4   | Volatile phenol                | 0.002L               | 0.002L               | 0.002L               | 0                      | 0                              | 0.500       |
| 5   | NH <sub>3</sub> -N             | 0.032                | 0.038                | 0.043                | 0                      | 0                              | 0.160~0.215 |
| 6   | Cl <sup>-</sup>                | 8.8                  | 5.0                  | 4.2                  | 0                      | 0                              | 0.017~0.035 |
| 7   | Sulfate                        | 2.6                  | 10.0                 | 3.8                  | 0                      | 0                              | 0.010~0.040 |
| 8   | NO <sup>-3</sup> -N            | 0.10                 | 0.10                 | 0.08                 | 0                      | 0                              | 0.400~0.500 |
| 9   | NO <sup>-2</sup> -N            | 0.003L               | 0.003L               | 0.003L               | 0                      | 0                              | 0.075       |
| 10  | Fluorides                      | 0.05                 | 0.13                 | 0.05                 | 0                      | 0                              | 0.050~0.130 |
| 11  | Total bacteria (unit/ml)       | 17                   | 22                   | 16                   | 0                      | 0                              | 0.160~0.22  |
| 12  | Total coliform group (group/L) | Non-detectable       | Non-detectable       | Non-detectable       | 0                      | 0                              | 0.500       |

**Table 4.8-11 Statistics and Evaluation of Monitoring Results at 9# Wolong Village**

Unit: mg/L (excluding pH and  $S_{ij}$ )

| No. | Item                | Monitoring date      |                      |                      | Over-standard rate (%) | Maximum over-standard multiple | $S_{ij}$    |
|-----|---------------------|----------------------|----------------------|----------------------|------------------------|--------------------------------|-------------|
|     |                     | May 23 <sup>rd</sup> | May 24 <sup>th</sup> | May 25 <sup>th</sup> |                        |                                |             |
| 1   | pH value            | 4.7                  | 4.7                  | 4.9                  | 100                    | 3.6                            | 4.200~4.600 |
| 2   | Total hardness      | 9.7                  | 10.1                 | 10.5                 | 0                      | 0                              | 0.022~0.023 |
| 3   | CODMn               | 0.8                  | 1.1                  | 0.5L                 | 0                      | 0                              | 0.083~0.367 |
| 4   | Volatile phenol     | 0.002L               | 0.002L               | 0.002L               | 0                      | 0                              | 0.500       |
| 5   | NH <sub>3</sub> -N  | 0.026                | 0.110                | 0.038                | 0                      | 0                              | 0.130~0.550 |
| 6   | Cl <sup>-</sup>     | 6.8                  | 10.0                 | 4.9                  | 0                      | 0                              | 0.020~0.040 |
| 7   | Sulfate             | 2.4                  | 8.8                  | 3.8                  | 0                      | 0                              | 0.010~0.035 |
| 8   | NO <sup>-3</sup> -N | 0.02L                | 0.02L                | 0.02L                | 0                      | 0                              | 0.001       |

| No. | Item                           | Monitoring date      |                      |                      | Over-standard rate (%) | Maximum over-standard multiple | S <sub>i,j</sub> |
|-----|--------------------------------|----------------------|----------------------|----------------------|------------------------|--------------------------------|------------------|
|     |                                | May 23 <sup>rd</sup> | May 24 <sup>th</sup> | May 25 <sup>th</sup> |                        |                                |                  |
| 9   | NO <sup>-2</sup> -N            | 0.003L               | 0.003L               | 0.003L               | 0                      | 0                              | 0.075            |
| 10  | Fluorides                      | 0.005                | 0.005                | 0.006                | 0                      | 0                              | 0.005~0.006      |
| 11  | Total bacteria (unit/ml)       | 18                   | 19                   | 23                   | 0                      | 0                              | 0.180~0.230      |
| 12  | Total coliform group (group/L) | Non-detectable       | Non-detectable       | Non-detectable       | 0                      | 0                              | 0.500            |

#### 4.8.7 Amendment result of expert opinion

According to the review comments advanced by the project experts in the technical evaluation meeting on March 2008, in terms of the hydrogeological condition, the proposed plant site, the landfill site, the route of discharge pipe line, this evaluation re-optimizes the layout of the underground water monitoring site and gives clear indication of the relative orientation, distance, water level (head) depth, monitoring horizons of the monitoring wells. And verify the total hardness results of the underground water's current status monitoring.

##### (1) Layout of the monitoring site

According to the hydrogeological condition, the proposed plant site, the landfill site, the route of discharge pipe line, optimizes the layout of the underground water monitoring site, six monitoring site are laid, see table 4.8-12 and attached drawing 11 for the details.

**Table 4.8-12 Positioning of Monitoring Sites**

| No. | Name of monitoring sites | Location                                                                                                                            | Well depth and depth to water table        | Remark                |
|-----|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|-----------------------|
| 1   | Haishan Dam              | N to the plant site, natural village. 0.2km at the upper reach along the flow direction of underground water within the plant site. | Well depth 22m, depth to water table 12.5m | Inhabitant drink well |
| 2   | Anze                     | S to the plant site, natural village. 0.6km at the lower reach along the flow direction of underground water within the plant site. | Well depth 22m, depth to water table 8.8m  | Inhabitant drink well |

| No. | Name of monitoring sites                    | Location                                                                                                                                       | Well depth and depth to water table        | Remark                       |
|-----|---------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|------------------------------|
| 3   | First production division of Beimu Salt Pan | S to the plant site. The lower reach along the flow direction of underground water within the plant site, by the waste pipe of land-side area. | Well depth 50m, depth to water table 4.2m  | Inhabitant drink well        |
| 4   | Ecological prawn nursery area               | S to the plant site. 1.5km at the lower reach along the flow direction of underground water within the plant site.                             | Well depth 60m, depth to water table 3.2m  | Inhabitant drink well        |
| 5   | Xinpu village                               | N to the Beimu slag stockpile, 0.5km at the upper reach of underground water running within the slag stockpile area.                           | Well depth 9.5m, depth to water table 6.8m | Inhabitant drink well        |
| 6   | recharge well of shrimp pond                | S to the Beimu slag stockpile, 0.8km at the lower reach of underground water running within the slag stockpile area.                           | Well depth 21m, depth to water table 3.5m  | recharge well of shrimp pond |

## (2) Monitoring factors

Taking the project pollution features and the water environment over the proposed site, the following 12 items of monitoring factors selected in this evaluation are: pH, total hardness, sulfate, volatile phenol, ammonia nitrogen ( $\text{NH}_3\text{-N}$ ), permanganate index ( $\text{COD}_{\text{Mn}}$ ), nitrates ( $\text{NO}^{-3}\text{-N}$  and  $\text{NO}^{-2}\text{-N}$ ), total dissolved solids, chlorides ( $\text{Cl}^-$ ), total coliform group, total bacteria, etc.

## (3) Monitoring and Analytical Methods

See Table 4.8-13 for the monitoring & analytical methods and the detection lower limits of various items.

Table 4.8-13 Monitoring Items, Analytical Methods and Sources and Detection Limits for Underground Water

| No | Item                      | Analytical method                                | Minimum detection limit (mg/L) | Sources of the method                                                                           |
|----|---------------------------|--------------------------------------------------|--------------------------------|-------------------------------------------------------------------------------------------------|
| 1  | pH value                  | Glass electrode                                  | 0.1 (pH value)                 | GB6920—86                                                                                       |
| 2  | Total hardness            | EDTA titrimetry                                  | 0.05 (mmol/L)                  | GB7477—87                                                                                       |
| 3  | Sulfate                   | Luminosity-method of barium-chromate             | 1.0                            | <i>Monitoring and Analytical Methods for Water and Wastewater</i> (the 4 <sup>th</sup> Edition) |
| 4  | $\text{COD}_{\text{Mn}}$  | Acidic potassium permanganate process            | 0.5                            | GB11892—89                                                                                      |
| 5  | $\text{NO}^{-3}\text{-N}$ | Phenol disulfonic acid spectrophotometric method | 0.02                           | GB7480—87                                                                                       |



| No | Item                 | Analytical method                                | Minimum detection limit (mg/L) | Sources of the method                                      |
|----|----------------------|--------------------------------------------------|--------------------------------|------------------------------------------------------------|
| 6  | NO <sup>-2</sup> -N  | N-(1-Naphthyl)-Ethylenediamine spectrophotometry | 0.003                          | GB13580.7—92                                               |
| 7  | NH <sub>3</sub> -N   | Nessler's reagent colorimetry                    | 0.025                          | GB7479—87                                                  |
| 8  | Cl <sup>-</sup>      | Silver nitrate titrimetry                        | 2.0                            | HJ/791-2002                                                |
| 9  | Fluorides            | Spectrophotometry with fluorinating agent        | 0.05                           | GB7483—87                                                  |
| 10 | Volatile phenol      | 4-Amino-antipyrine extraction photometer         | 0.002                          | GB7490—87                                                  |
| 11 | Total coliform group |                                                  |                                | <i>Sanitary Standard for Drinking Water Quality (2001)</i> |
| 12 | Total bacteria       |                                                  |                                | <i>Sanitary Standard for Drinking Water Quality (2001)</i> |

#### (4) Monitoring time and frequency

The monitoring was conducted from Apr. 2nd to Apr. 4th, 2008, with the samples collected once every day and for three days in succession. Sampling methods had been identified with regard to the requirements prescribed in the *Technical Specification for Environmental Monitoring* (the 4<sup>th</sup> Edition) issued by the State Environment Protection Administration.

#### (5) Evaluation standards and methods

##### 1) Evaluation Standards

The evaluation was carried out in line with the Class III standard in the *Quality Standard for Ground Water* (GB/T14848-93).

##### 2) Evaluation Methods

All monitoring factors shall be evaluated by using the standard index method prescribed in the *Technical Guidelines for Environmental Impact Assessment*, of which the formula shall be:

$$S_{i,j} = C_{i,j} / C_{si}$$

Wherein:

$S_{i,j}$ —standard index of pollutant “i” at the monitoring site “j”;

$C_{i,j}$ —concentration level of pollutant “i” at the monitoring site “j”;

$C_{si}$ —criteria for underground water of water quality parameter “i”.

Standard index of pH value shall be:

$$S_{pH,j} = \frac{pH_j - 7.0}{pH_{su} - 7.0} \quad pH_j > 7.0$$

$$S_{pH,j} = \frac{7.0 - pH_j}{7.0 - pH_{sd}} \quad pH_j \leq 7.0$$

Wherein:  $pH_j$ —pH value at the monitoring site “j”;

$pH_{sd}$ —lower limit for pH value as in the required criteria for sea water quality;

$\text{pH}_{\text{SU}}$ —upper limit for pH value as in the required criteria for sea water quality.

Standard index of water quality parameter  $>1$  indicates the water quality parameter has exceeded the limit prescribed in the criteria for sea water quality; the bigger the standard index of water quality parameter goes, the further it goes beyond the prescribed limits in the criteria.

#### (6) Monitoring results and evaluation

See Table 4.8-14 to 4.8-19 for monitoring statistics and evaluation results of all monitoring sites.

As indicated by the monitoring and evaluation results, all performance indicators at No. 5<sup>th</sup> monitoring site of Xinpu Village had fulfilled the Class III standard as in the *Quality Standard for Underground Water* (GB/T14848-93). Performance indicators at other monitoring sites had fulfilled the Class III standard as in the *Quality Standard for Underground Water* (GB/T14848-93), except for that of the pH value. The underground water of proposed project sites are diagnosed to be weak acidic to neutral, with the pH value ranging from 4.1 to 6.9 in most of the times, which went higher than the required standards because of the restrictions of geological features.

**Table 4.8-14 Statistics and Evaluation of Monitoring Results at 1# Haishan Dam**

Unit: mg/L (excluding pH, total hardness and  $\text{S}_{\text{ij}}$ )

| No. | Item                     | Monitoring date |          |          | Over standard rate (%) | Maximum over-standard multiple | $\text{S}_{\text{ij}}$ |
|-----|--------------------------|-----------------|----------|----------|------------------------|--------------------------------|------------------------|
|     |                          | Apr. 2nd        | Apr. 3rd | Apr. 4th |                        |                                |                        |
| 1   | pH value                 | 6.6             | 6.4      | 6.3      | 66                     | 0.40                           | 0.800<br>~<br>1.400    |
| 2   | Total hardness           | 63.35           | 63.50    | 63.20    | 0                      | 0                              | 0.140<br>~<br>0.141    |
| 3   | CODMn                    | 0.5L            | 0.5      | 0.5L     | 0                      | 0                              | 0.833<br>~<br>0.167    |
| 4   | Volatile phenol          | 0.002L          | 0.002L   | 0.002L   | 0                      | 0                              | 0.500                  |
| 5   | $\text{NH}_3\text{-N}$   | 0.151           | 0.141    | 0.140    | 0                      | 0                              | 0.700<br>~<br>0.750    |
| 6   | $\text{Cl}^-$            | 4.10            | 6.5      | 8.0      | 0                      | 0                              | 0.016<br>~<br>0.032    |
| 7   | Sulfate                  | 21.0            | 22.0     | 23.2     | 0                      | 0                              | 0.084<br>~<br>0.092    |
| 8   | $\text{NO}_3^-\text{-N}$ | 0.755           | 0.780    | 0.766    | 0                      | 0                              | 0.038<br>~<br>0.039    |
| 9   | $\text{NO}_2^-\text{-N}$ | 0.003L          | 0.003L   | 0.003L   | 0                      | 0                              | 0.075                  |

| No. | Item                           | Monitoring date |          |          | Over standard rate (%) | Maximum over-standard multiple | S <sub>i,j</sub>    |
|-----|--------------------------------|-----------------|----------|----------|------------------------|--------------------------------|---------------------|
|     |                                | Apr. 2nd        | Apr. 3rd | Apr. 4th |                        |                                |                     |
| 10  | Fluorides                      | 0.06            | 0.06     | 0.06     | 0                      | 0                              | 0.025               |
| 11  | Total bacteria (unit/ml)       | 32              | 30       | 34       | 0                      | 0                              | 0.300<br>~<br>0.340 |
| 12  | Total coliform group (group/L) | <3              | <3       | <3       | 0                      | 0                              | 0.500               |

Note: the monitoring results that is lower than the detection limit in the table represents as “detection limit plus L”, except for the total coliform group. The same below .

**Table 4.8-15 Statistics and Evaluation of Monitoring Results at 2# Anze**

**Unit: mg/L (excluding pH, total hardness and S<sub>i,j</sub>)**

| No. | Item                           | Monitoring date |          |          | Over-standard rate (%) | Maximum over-standard multiple | S <sub>i,j</sub> |
|-----|--------------------------------|-----------------|----------|----------|------------------------|--------------------------------|------------------|
|     |                                | Apr. 2nd        | Apr. 3rd | Apr. 4th |                        |                                |                  |
| 1   | pH value                       | 5.0             | 5.2      | 5.5      | 100                    | 3.0                            | 3.000~4.000      |
| 2   | Total hardness (mmol/L)        | 53.5            | 53.6     | 53.4     | 0                      | 0                              | 0.119            |
| 3   | CODMn                          | 0.5             | 0.5      | 0.5      | 0                      | 0                              | 0.167            |
| 4   | Volatile phenol                | 0.002L          | 0.002L   | 0.002L   | 0                      | 0                              | 0.500            |
| 5   | NH <sub>3</sub> -N             | 0.151           | 0.151    | 0.150    | 0                      | 0                              | 0.750~<br>0.755  |
| 6   | Cl <sup>-</sup>                | 90.3            | 91.8     | 93.0     | 0                      | 0                              | 0.361~<br>0.372  |
| 7   | Sulfate                        | 14.6            | 18.7     | 16.2     | 0                      | 0                              | 0.058~<br>0.075  |
| 8   | NO <sup>-3</sup> -N            | 1.688           | 1.538    | 1.466    | 0                      | 0                              | 0.073~<br>0.084  |
| 9   | NO <sup>-2</sup> -N            | 0.003L          | 0.003L   | 0.003L   | 0                      | 0                              | 0.125            |
| 10  | Fluorides                      | 0.17            | 0.17     | 0.17     | 0                      | 0                              | 0.170            |
| 11  | Total bacteria (unit/ml)       | 27              | 30       | 28       | 0                      | 0                              | 0.270~<br>0.300  |
| 12  | Total coliform group (group/L) | <3              | <3       | <3       | 0                      | 0                              | 0.500            |

**Table 4.8-16 Statistics and Evaluation of Monitoring Results at 3# First production division of Beimu Salt Pan** Unit: mg/L (excluding pH, total hardness and  $S_{i,j}$ )

| No. | Item                           | Monitoring date |          |          | Over-standard rate (%) | Maximum over-standard multiple | $S_{i,j}$   |
|-----|--------------------------------|-----------------|----------|----------|------------------------|--------------------------------|-------------|
|     |                                | Apr. 2nd        | Apr. 3rd | Apr. 4th |                        |                                |             |
| 1   | pH value                       | 4.7             | 5.0      | 5.2      | 100                    | 0.6                            | 3.600~4.600 |
| 2   | Total hardness (mmol/L)        | 14.4            | 14.6     | 14.6     | 0                      | 0                              | 0.032       |
| 3   | CODMn                          | 0.5L            | 0.5L     | 0.5L     | 0                      | 0                              | 0.167       |
| 4   | Volatile phenol                | 0.002L          | 0.002L   | 0.002L   | 0                      | 0                              | 0.500       |
| 5   | NH <sub>3</sub> -N             | 0.141           | 0.140    | 0.141    | 0                      | 0                              | 0.700~0.705 |
| 6   | Cl <sup>-</sup>                | 3.5             | 3.8      | 4.0      | 0                      | 0                              | 0.014~0.016 |
| 7   | Sulfate                        | 1.78            | 1.80     | 1.92     | 0                      | 0                              | 0.007~0.008 |
| 8   | NO <sup>-3</sup> -N            | 0.705           | 0.710    | 0.688    | 0                      | 0                              | 0.034~0.036 |
| 9   | NO <sup>-2</sup> -N            | 0.003L          | 0.003L   | 0.003L   | 0                      | 0                              | 0.075       |
| 10  | Fluorides                      | 0.07            | 0.07     | 0.07     | 0                      | 0                              | 0.07        |
| 11  | Total bacteria (unit/ml)       | 38              | 32       | 36       | 0                      | 0                              | 0.320~0.380 |
| 12  | Total coliform group (group/L) | <3              | <3       | <3       | 0                      | 0                              | 0.500       |

**Table 4.8-17 Statistics and Evaluation of Monitoring Results at 4# Ecological prawn nursery area** Unit: mg/L (excluding pH, total hardness and  $S_{i,j}$ )

| No. | Item                    | Monitoring date |          |          | Over-standard rate (%) | Maximum over-standard multiple | $S_{i,j}$      |
|-----|-------------------------|-----------------|----------|----------|------------------------|--------------------------------|----------------|
|     |                         | Apr. 2nd        | Apr. 3rd | Apr. 4th |                        |                                |                |
| 1   | pH value                | 5.2             | 5.1      | 5.0      | 100                    | 3.0                            | 3.600 ~4.000   |
| 2   | Total hardness (mmol/L) | 6.15            | 6.12     | 6.15     | 0                      | 0                              | 0.0136 ~0.0137 |
| 3   | CODMn                   | 0.9             | 0.9      | 0.9      | 0                      | 0                              | 0.300          |
| 4   | Volatile phenol         | 0.002L          | 0.002L   | 0.002L   | 0                      | 0                              | 0.500          |
| 5   | NH <sub>3</sub> -N      | 0.196           | 0.187    | 0.190    | 0                      | 0                              | 0.94~0.98      |
| 6   | Cl <sup>-</sup>         | 2.9             | 3.0      | 2.0      | 0                      | 0                              | 0.008~0.012    |
| 7   | Sulfate                 | 23.2            | 23.2     | 23.0     | 0                      | 0                              | 0.067~0.093    |
| 8   | NO <sup>-3</sup> -N     | 0.029           | 0.029    | 0.029    | 0                      | 0                              | 0.001          |
| 9   | NO <sup>-2</sup> -N     | 0.003L          | 0.003L   | 0.003L   | 0                      | 0                              | 0.075          |
| 10  | Fluorides               | 0.05L           | 0.05L    | 0.05L    | 0                      | 0                              | 0.025          |

| No. | Item                           | Monitoring date |          |          | Over-standard rate (%) | Maximum over-standard multiple | S <sub>i,j</sub> |
|-----|--------------------------------|-----------------|----------|----------|------------------------|--------------------------------|------------------|
|     |                                | Apr. 2nd        | Apr. 3rd | Apr. 4th |                        |                                |                  |
| 11  | Total bacteria (unit/ml)       | 24              | 20       | 28       | 0                      | 0                              | 0.200~0.280      |
| 12  | Total coliform group (group/L) | <3              | <3       | <3       | 0                      | 0                              | 0.500            |

**Table 4.8-18 Statistics and Evaluation of Monitoring Results at 5# Xinpu village****Unit: mg/L (excluding pH, total hardness and S<sub>i,j</sub>)**

| No. | Item                           | Monitoring date |          |          | Over-standard rate (%) | Maximum over-standard multiple | S <sub>i,j</sub> |
|-----|--------------------------------|-----------------|----------|----------|------------------------|--------------------------------|------------------|
|     |                                | Apr. 2nd        | Apr. 3rd | Apr. 4th |                        |                                |                  |
| 1   | pH value                       | 6.5             | 6.7      | 6.9      | 0                      | 0                              | 0.200~1.000      |
| 2   | Total hardness (mmol/L)        | 82.2            | 82.9     | 81.8     | 0                      | 0                              | 0.181~0.184      |
| 3   | CODMn                          | 0.7             | 0.7      | 0.7      | 0                      | 0                              | 0.023            |
| 4   | Volatile phenol                | 0.002L          | 0.002L   | 0.002L   | 0                      | 0                              | 0.500            |
| 5   | NH <sub>3</sub> -N             | 0.156           | 0.158    | 0.153    | 0                      | 0                              | 0.765~0.790      |
| 6   | Cl <sup>-</sup>                | 31.7            | 32.0     | 33.0     | 0                      | 0                              | 0.127~0.132      |
| 7   | Sulfate                        | 1.62            | 1.89     | 1.88     | 0                      | 0                              | 0.006~0.007      |
| 8   | NO <sup>-3</sup> -N            | 1.864           | 1.870    | 1.806    | 0                      | 0                              | 0.093~0.094      |
| 9   | NO <sup>-2</sup> -N            | 0.007           | 0.003L   | 0.003L   | 0                      | 0                              | 0.075            |
| 10  | Fluorides                      | 0.07            | 0.07     | 0.07     | 0                      | 0                              | 0.07             |
| 11  | Total bacteria (unit/ml)       | 43              | 42       | 44       | 0                      | 0                              | 0.420~0.440      |
| 12  | Total coliform group (group/L) | <3              | <3       | <3       | 0                      | 0                              | 0.500            |

**Table 4.8-19 Statistics and Evaluation of Monitoring Results at 6# recharge well of shrimp pond**  
**Unit: mg/L (excluding pH, total hardness and S<sub>i,j</sub>)**

| No. | Item                            | Monitoring date |          |          | Over-standard rate (%) | Maximum over-standard multiple | S <sub>i,j</sub> |
|-----|---------------------------------|-----------------|----------|----------|------------------------|--------------------------------|------------------|
|     |                                 | Apr. 2nd        | Apr. 3rd | Apr. 4th |                        |                                |                  |
| 1   | pH value                        | 4.1             | 4.3      | 4.3      | 100                    | 4.8                            | 5.400 ~5.800     |
| 2   | Total hardness (mmol/L)         | 63.3            | 63.6     | 62.8     | 0                      | 0                              | 0.140~0.141      |
| 3   | CODMn                           | 0.8             | 0.8      | 0.8      | 0                      | 0                              | 0.267            |
| 4   | Volatile phenol                 | 0.002L          | 0.002L   | 0.002L   | 0                      | 0                              | 0.500            |
| 5   | NH <sub>3</sub> -N              | 0.188           | 0.190    | 0.188    | 0                      | 0                              | 0.94~0.95        |
| 6   | Cl <sup>-</sup>                 | 220.8           | 220.0    | 220.0    | 0                      | 0                              | 0.880~0.883      |
| 7   | Sulfate                         | 16.8            | 17.8     | 18.0     | 0                      | 0                              | 0.067~0.072      |
| 8   | NO <sub>3</sub> <sup>-</sup> -N | 0.020           | 0.020    | 0.020    | 0                      | 0                              | 0.001            |
| 9   | NO <sub>2</sub> <sup>-</sup> -N | 0.003L          | 0.003L   | 0.003L   | 0                      | 0                              | 0.075            |
| 10  | Fluorides                       | 0.18            | 0.18     | 0.17     | 0                      | 0                              | 0.170~0.180      |
| 11  | Total bacteria (unit/ml)        | 21              | 28       | 26       | 0                      | 0                              | 0.210~0.280      |
| 12  | Total coliform group (group/L)  | <3              | <3       | <3       | 0                      | 0                              | 0.500            |

After verification, the unit of the total hardness in the underground status monitoring is mmol/L. The unit mg/L of the total hardness in the environmental evaluation report (draft) is a slip of the pen.

#### 4.9 Investigation and Evaluation on Current Sound Environment

##### 4.9.1 Investigation Content

Noises within the proposed plant boundary as well as in the ambient environment

##### 4.9.2 Layout of Monitoring Sites and Methods

###### (1) Layout of Monitoring Sites

8 monitoring sites were altogether set up for the investigation on noises within the plant boundary and 5 more for monitoring on ambient noises. For the layout of monitoring sites, see Table 4.9-1 and Attached Drawing 11 for details.

Table 4.9-1

Layout of Monitoring Sites

| Category        | Site No.          | Name                                                                                                         | Environmental features |
|-----------------|-------------------|--------------------------------------------------------------------------------------------------------------|------------------------|
| Plant boundary  | 1#                | 1m to the west of plant boundary                                                                             | Farmland, forest land  |
|                 | 2#                | 1m to the west of plant boundary                                                                             | Farmland, forest land  |
|                 | 3#                | 1m to the north of plant boundary                                                                            | Farmland               |
|                 | 4#                | 1m to the north of plant boundary                                                                            | Farmland               |
|                 | 5#                | 1m to the east of plant boundary                                                                             | Farmland               |
|                 | 6#                | 1m to the east of plant boundary                                                                             | Farmland               |
|                 | 7#                | 1m to the south of plant boundary                                                                            | Salt field             |
|                 | 8#                | 1m to the south of plant boundary                                                                            | Salt field             |
| Sensitive point | 9# Pokou Tang     | 200m to the west of plant boundary, 1m in front of the first row of civil blocks facing the plant boundary   | Residential centre     |
|                 | 10# Xinwupo       | 40 m to the west of plant boundary, 1m in front of the first row of civil blocks facing the plant boundary   | Residential centre     |
|                 | 11# Yaxi Village  | 100 m to the north of plant boundary, 1m in front of the first row of civil blocks facing the plant boundary | Residential centre     |
|                 | 12# Haishan Dam   | 80 m to the north of plant boundary, 1m in front of the first row of civil blocks facing the plant boundary  | Residential centre     |
|                 | 13# Beimu Village | 20 m to the south of plant boundary, 1m in front of the first row of civil blocks facing the plant boundary  | Residential centre     |

## (2) Monitoring Time and Frequency

The monitoring was conducted from Feb. 27<sup>th</sup> to 28<sup>th</sup>, 2007, once every day and night for two days in succession.

## (3) Monitoring Methods

a. Monitoring on noises within the plant boundary was carried out in line with the *Method of Measuring Noise at Boundary of Industrial Enterprises* (GB12349-1990). HS-6288 sound level meter was used as the major monitoring instrument, which had all been calibrated to the reference sound sources. The monitoring was timed at 6:00~22:00 during daytime (once) and 22:00~6:00 during night time (once), free from rain and with the wind velocity under 55m/s.

b. Monitoring on noises in sensitive points was carried out in line with the *Measuring Method of Environmental Noise of Urban Area* (GB/T 14623-93), timed under weather conditions free from rain or snow and with the wind velocity under 5.5m/s. Besides, the microphones were covered with air hoods during the monitoring. Monitoring sites were set up outside the residential or office buildings, at least 1m away from any of them, while the microphones were set at least 1.2m to the ground vertically. The monitoring was timed at 6:00~22:00 during daytime (once) and 22:00~6:00 during night time (once).

### 4.9.3 Evaluation Standard

$L_{Aeq}$ , the equivalent sound level, was cited as the evaluation measurement, while monitoring on noises within the plant boundary was carried out in line with the Class III standard in the *Method of Measuring Noise at Boundary of Industrial Enterprises* (GB12349-1990) and monitoring on noises in sensitive points was carried out according to the Class III standard in *Measuring Method of Environmental Noise of Urban Area* (GB/T 14623-93).

### 4.9.4 Monitoring and Evaluation Results

See Table 4.9-3 for monitoring and evaluation results on the current situation of sound environment.

**Table 4.9-3 Monitoring and Evaluation Results on Noises within the Plant Boundary**

**(Unit: Leq [dB(A)])**

| Name of monitoring sites       | Day time              |                       |                    | Night time            |                       |                    |
|--------------------------------|-----------------------|-----------------------|--------------------|-----------------------|-----------------------|--------------------|
|                                | Monitoring value      |                       | Evaluation         | Monitoring value      |                       | Evaluation         |
|                                | Feb. 27 <sup>th</sup> | Feb. 28 <sup>th</sup> |                    | Feb. 27 <sup>th</sup> | Feb. 28 <sup>th</sup> |                    |
| 1# west to the plant boundary  | 38.2                  | 39.2                  | Reach the standard | 39.5                  | 39.7                  | Reach the standard |
| 2# west to the plant boundary  | 42.8                  | 43.0                  | Reach the standard | 42.0                  | 42.7                  | Reach the standard |
| 3# north to the plant boundary | 40.5                  | 40.8                  | Reach the standard | 38.2                  | 40.1                  | Reach the standard |
| 4# north to the plant boundary | 44.9                  | 45.8                  | Reach the standard | 43.1                  | 43.6                  | Reach the standard |
| 5# east to the plant boundary  | 39.4                  | 40.3                  | Reach the standard | 38.6                  | 39.3                  | Reach the standard |
| 6# east to the plant boundary  | 43.7                  | 45.1                  | Reach the standard | 42.3                  | 43.3                  | Reach the standard |
| 7# south to the plant boundary | 40.3                  | 41.6                  | Reach the standard | 39.1                  | 37.9                  | Reach the standard |
| 8# south to the plant boundary | 44.2                  | 46.0                  | Reach the standard | 42.7                  | 43.5                  | Reach the standard |
| 9# Pokou Tang                  | 51.6                  | 52.3                  | Reach the standard | 46.5                  | 47.0                  | Reach the standard |
| 10# Xinwupo                    | 52.7                  | 52.1                  | Reach the standard | 47.4                  | 47.9                  | Reach the standard |
| 11# Yaxi Village               | 49.5                  | 42.6                  | Reach the standard | 48.7                  | 43.1                  | Reach the standard |
| 12# Haishan Dam                | 53.8                  | 53.0                  | Reach the standard | 44.7                  | 43.9                  | Reach the standard |
| 13#Beimu Village               | 50.2                  | 49.8                  | Reach the standard | 45.8                  | 45.5                  | Reach the standard |

As indicated from Table 4.9-3, values of noises recorded within the plant boundary at all monitoring sites during the daytime and night time have all reached the Class III standard in the *Method of Measuring Noise at Boundary of Industrial Enterprises* (GB12349-1990) and results of noises recorded in sensitive points at all monitoring sites during the daytime and night time have also come up to the Class III standard in *Measuring Method of Environmental Noise of Urban Area* (GB/T 14623-93).





## Appendices

### Appendix I

### List of Phytoplankton Species

| Chinese Name | Latin                                                             | May, 2007 | Dec., 2006 |
|--------------|-------------------------------------------------------------------|-----------|------------|
| 藍藻           | <b>Cyanophyceae</b>                                               |           |            |
| 紅海束毛藻        | <i>Trichodesmium erythraeum</i>                                   |           | +          |
| 硅藻           | <b>Bacillariophcea</b>                                            |           |            |
| 翼蜚形藻         | <i>Amphiprora alata</i>                                           |           | +          |
| 派格棍形藻        | <i>Bacillaria paxillifera</i>                                     |           | +          |
| 丛毛輻杆藻        | <i>Bacteriastrum comosum</i>                                      | +         | +          |
| 优美輻杆藻        | <i>Bacteriastrum delicatulum</i>                                  | +         | +          |
| 长輻杆藻         | <i>Bacteriastrum elongatum</i>                                    | +         |            |
| 透明輻杆藻        | <i>Bacteriastrum hyalinum</i>                                     | +         | +          |
| 主型透明輻杆藻      | <i>Bacteriastrum hyalinum</i> var.<br><i>princes</i> (Castracane) | +         |            |
| 地中海輻杆藻       | <i>Bacteriastrum mediterraneum</i>                                | +         |            |
| 小輻杆藻         | <i>Bacteriastrum minus</i>                                        | +         |            |
| 变异輻杆藻        | <i>Bacteriastrum varians</i>                                      | +         | +          |
| 高盒形藻         | <i>Biddulphia regi</i>                                            |           | +          |
| 中华盒形藻        | <i>Biddulphia sinensis</i>                                        |           | +          |
| 柏氏角管藻        | <i>Cerataulina bergonii</i>                                       | +         | +          |
| 海洋角管藻        | <i>Cerataulina pelagica</i>                                       | +         |            |
| 角毛藻          | <i>Chaetocero Sp</i>                                              |           | +          |
| 异常角毛藻        | <i>Chaetoceros abnormis</i>                                       | +         |            |
| 均等角毛藻        | <i>Chaetoceros aequatoriale</i>                                   | +         |            |
| 窄隙角毛藻        | <i>Chaetoceros affinis</i>                                        | +         | +          |
| 窄隙角毛藻等角变种    | <i>Chaetoceros affinis</i> v. <i>willei</i>                       | +         | +          |
| 桥联角毛藻        | <i>Chaetoceros anastomosans</i>                                   | +         |            |
| 短孢角毛藻        | <i>Chaetoceros brevis</i>                                         |           | +          |
| 北方角毛藻        | <i>Chaetoceros borealis</i>                                       |           | +          |
| 卡氏角毛藻        | <i>Chaetoceros castracanei</i>                                    | +         |            |

|       |                                |   |   |
|-------|--------------------------------|---|---|
| 绕抱角毛藻 | <i>Chaetoceros cinctus</i>     | + |   |
| 扁面角毛藻 | <i>Chaetoceros compressus</i>  | + | + |
| 缢缩角毛藻 | <i>Chaetoceros constrictus</i> | + |   |
| 扭角毛藻  | <i>Chaetoceros convolutus</i>  | + |   |
| 中肋角毛藻 | <i>Chaetoceros costatus</i>    | + |   |

| Chinese Name | Latin                                      | May, 2007 | Dec., 2006 |
|--------------|--------------------------------------------|-----------|------------|
| 旋链角毛藻        | <i>Chaetoceros curvisetus</i>              | +         | +          |
| 丹麦角毛藻        | <i>Chaetoceros danicus</i>                 | +         |            |
| 柔弱角毛藻        | <i>Chaetoceros debilis</i>                 | +         |            |
| 并基角毛藻        | <i>Chaetoceros decipiens</i>               | +         |            |
| 并基角毛藻单胞变型    | <i>Chaetoceros decipiens f. singularis</i> | +         |            |
| 密联角毛藻        | <i>Chaetoceros densus</i>                  | +         | +          |
| 齿角毛藻         | <i>Chaetoceros denticulatus</i>            | +         |            |
| 双突角毛藻        | <i>Chaetoceros didymus</i>                 | +         |            |
| 异角角毛藻        | <i>Chaetoceros diversus</i>                | +         |            |
| 艾氏角毛藻        | <i>Chaetoceros eibenii</i>                 | +         | +          |
| 印度角毛藻        | <i>Chaetoceros indicum</i>                 | +         | +          |
| 垂缘角毛藻        | <i>Chaetoceros lacinosus</i>               | +         |            |
| 平滑角毛藻        | <i>Chaetoceros laevis</i>                  |           | +          |
| 罗氏角毛藻        | <i>Chaetoceros lauderi</i>                 | +         |            |
| 洛氏角毛藻        | <i>Chaetoceros lorenzianus</i>             | +         | +          |
| 新紧密角毛藻       | <i>Chaetoceros neocompactum</i>            |           | +          |
| 日本角毛藻        | <i>Chaetoceros nipponica</i>               | +         |            |
| 奇异角毛藻        | <i>Chaetoceros paradox</i>                 | +         |            |
| 海洋角毛藻        | <i>Chaetoceros pelagicus</i>               | +         |            |
| 秘鲁角毛藻        | <i>Chaetoceros peruvianus</i>              | +         | +          |
| 拟弯角毛藻        | <i>Chaetoceros pseudocurvisetus</i>        | +         | +          |
| 放射角毛藻        | <i>Chaetoceros radians</i>                 | +         |            |
| 根状角毛藻        | <i>Chaetoceros radicans</i>                | +         |            |
| 嘴状角毛藻        | <i>Chaetoceros rostratus</i>               | +         |            |

|           |                                                   |   |   |
|-----------|---------------------------------------------------|---|---|
| 嘴状角毛藻格氏变种 | <i>Chaetoceros rostratus</i> Var. <i>glandazi</i> |   | + |
| 暹罗角毛藻     | <i>Chaetoceros siamense</i>                       | + | + |
| 相似角毛藻     | <i>Chaetoceros smilis</i>                         | + |   |
| 聚生角毛藻     | <i>Chaetoceros socialis</i> Lauder                |   | + |
| 冕孢角毛藻     | <i>Chaetoceros subsecundus</i>                    | + | + |
| 细弱角毛藻     | <i>Chaetoceros subtilis</i>                       | + |   |
| 圆柱角毛藻     | <i>Chaetoceros teres</i>                          | + |   |
| 扭链角毛藻     | <i>Chaetoceros tortissimus</i>                    | + | + |
| 范氏角毛藻     | <i>Chaetoceros vanheurcki</i>                     | + | + |
| 威氏角毛藻     | <i>Chaetoceros weissflogii</i>                    | + |   |
| 中心圆筛藻     | <i>Coscinodiscus centralis</i>                    |   | + |

| Chinese Name | Latin                                   | May, 2007 | Dec., 2006 |
|--------------|-----------------------------------------|-----------|------------|
| 整齐圆筛藻        | <i>Coscinodiscus concinnus</i>          |           | +          |
| 海南圆筛藻        | <i>Coscinodiscus hainanensis</i>        |           | +          |
| 琼氏圆筛藻        | <i>Coscinodiscus jonesianus</i>         |           | +          |
| 细束纹圆筛藻       | <i>Coscinodiscus minutifasciculatus</i> |           | +          |
| 虹彩圆筛藻        | <i>Coscinodiscus oculus-iridis</i>      |           | +          |
| 平壳圆筛藻        | <i>Coscinodiscus planithecus</i>        |           | +          |
| 布氏双尾藻        | <i>Ditylum brightwelli</i>              |           | +          |
| 短角弯角藻        | <i>Eucampia zoodiacus</i>               | +         |            |
| 菱软几内亚藻       | <i>Guinardia flaccida</i>               | +         | +          |
| 霍氏半管藻        | <i>Hemiaulus hauckii</i>                |           | +          |
| 印度半管藻        | <i>Hemiaulus indicus</i>                | +         |            |
| 中华半管藻        | <i>Hemiaulus sinensis</i>               |           | +          |
| 哈氏半盘藻        | <i>Hemidiscus hardmannianus</i>         |           | +          |
| 环纹劳德藻        | <i>Lauderia annulata</i>                |           | +          |
| 丹麦细柱藻        | <i>Leptocylindrus danicus</i>           | +         | +          |
| 细柱藻          | <i>Leptocylindrus Sp.</i>               |           | +          |
| 具槽直链藻        | <i>Melosira sulcata</i>                 | +         |            |
| 舟形藻          | <i>Navicula sp.</i>                     |           | +          |
| 披针菱形藻        | <i>Nitzschia lanceolata</i>             | +         |            |
| 洛氏菱形藻        | <i>Nitzschia loenziana</i>              |           | +          |
| 长菱形藻         | <i>Nitzschia longissima</i>             | +         | +          |
| 长菱形藻弯端变种     | <i>Nitzschia longissima v. reversa</i>  | +         |            |
| 洛伦菱形藻        | <i>Nitzschia lorenziana</i>             | +         |            |
| 尖刺菱形藻        | <i>Nitzschia pungens</i>                | +         |            |
| 弯菱形藻         | <i>Nitzschia sigma</i>                  | +         |            |
| 弯菱形藻中型变种     | <i>Nitzschia sigma v. intercedens</i>   | +         |            |
| 奇异菱形藻        | <i>Nitzschia paradoxa</i>               | +         |            |
| 太阳漂流藻        | <i>Planktoniella sol</i>                |           | +          |
| 近缘斜纹藻        | <i>Pleurosigma affine</i> Grunow        |           | +          |
| 艾希斜纹藻        | <i>Pleurosigma aestuarii</i>            | +         |            |
| 美丽斜纹藻        | <i>Pleurosigma formosum</i>             |           | +          |

|       |                                    |   |   |
|-------|------------------------------------|---|---|
| 镰刀斜纹藻 | <i>Pleurosigma falx</i>            | + |   |
| 中型斜纹藻 | <i>Pleurosigma intermedium</i>     | + |   |
| 诺氏斜纹藻 | <i>Pleurosigma normanii</i>        |   | + |
| 海洋斜纹藻 | <i>Pleurosigma pelagicum</i> Perag |   | + |

| Chinese Name | Latin                                                       | May, 2007 | Dec., 2006 |
|--------------|-------------------------------------------------------------|-----------|------------|
| 斜纹藻          | <i>Pleurosigma sp.</i>                                      |           | +          |
| 尖刺拟菱形藻       | <i>Pseudo-nitzschia pungens</i>                             |           | +          |
| 成列拟菱形藻       | <i>Pseudo-nitzschia seriata</i>                             |           | +          |
| 近小头羽纹藻       | <i>Pinnularia subcapitata</i>                               | +         |            |
| 模式型翼根管藻      | <i>Rhizosolenia alata f. genuine</i>                        |           | +          |
| 翼根管藻纤细变型     | <i>Rhizosolenia alata f. gracillima</i>                     | +         | +          |
| 印度翼根管藻       | <i>Rhizosolenia alata f. indica</i><br>(Peragallo)Ostenfeld |           | +          |
| 培氏根管藻        | <i>Rhizosolenia bergonii</i>                                |           | +          |
| 距端根管藻        | <i>Rhizosolenia calcar-avis</i>                             | +         | +          |
| 螺端根管藻        | <i>Rhizosolenia cochlea</i>                                 |           | +          |
| 厚刺根管藻        | <i>Rhizosolenia crassispina</i>                             |           | +          |
| 半棘钝根管藻       | <i>Rhizosolenia hebetata f. semispina</i>                   |           | +          |
| 粗根管藻         | <i>Rhizosolenia robusta</i> Norman                          |           | +          |
| 覆瓦根管藻        | <i>Rhizosolenia imbricata</i>                               | +         | +          |
| 刚毛根管藻        | <i>Rhizosolenia setigera</i>                                |           | +          |
| 斯氏根管藻        | <i>Rhizosolenia stolterforthii</i>                          | +         |            |
| 笔尖形根管藻       | <i>Rhizosolenia styliformis</i>                             |           | +          |
| 笔尖形根管藻粗径变种   | <i>Rhizosolenia styliformis v. latissima</i>                | +         | +          |
| 优美旭氏藻        | <i>Schroederella delicatula</i>                             |           | +          |
| 中肋骨条藻        | <i>Skeletonema costatum</i>                                 |           | +          |
| 掌状冠盖藻        | <i>Stephanopyxis palmeriana</i>                             | +         | +          |
| 华丽针杆藻        | <i>Synedra formosa</i>                                      | +         |            |
| 菱形海线藻        | <i>Thalassionema nitzschioides</i>                          | +         | +          |
| 细弱海链藻        | <i>Thalassiosira subtilis</i> (Ostenfeld)Gran               |           | +          |
| 佛氏海毛藻        | <i>Thalassiothrix frauenfeldii</i>                          |           | +          |
| 长海毛藻         | <i>Thalassiothrix longissima</i>                            |           | +          |
| 甲藻           | <b>Dinophyceae</b>                                          |           |            |
| 纺锤角藻         | <i>Ceratium fusus</i>                                       | +         | +          |

|          |                                     |   |   |
|----------|-------------------------------------|---|---|
| 短角角藻平行变种 | <i>Ceratium breve v. parallelum</i> | + |   |
| 歧散原多甲藻   | <i>Protoperdinium divergens</i>     |   | + |
| 钟扁甲藻     | <i>pyrophacus horologicum</i>       | + |   |



## Appendix II

## List of Zooplankton Species

| Chinese Name | Latin                                   | May, 2007 | Dec., 2006 |
|--------------|-----------------------------------------|-----------|------------|
| <b>水母类</b>   | <b>Medusae</b>                          |           |            |
| 黑球真唇水母       | <i>Eucosmion menoni</i>                 | +         |            |
| 薏枝水母         | <i>Obelia</i> spp.                      | +         |            |
| 印度拟杯水母       | <i>Octophialucium indicum</i>           | +         |            |
| 拟杯水母         | <i>Phialucium carolinae</i>             | +         |            |
| <b>栉水母类</b>  | <b>Ctenophora</b>                       |           |            |
| 球型侧腕水母       | <i>Pleuobranchia globosa</i>            | +         |            |
| <b>枝角类</b>   | <b>Cladocera</b>                        |           |            |
| 肥胖三角蚤        | <i>Pseudevadne tergestina</i>           | +         | +          |
| <b>桡足类</b>   | <b>Copepoda</b>                         |           |            |
| 红纺锤水蚤        | <i>Acartia erythraea</i>                | +         |            |
| 刺尾纺锤水蚤       | <i>Acartia spinicauda</i>               | +         |            |
| 驼背隆哲水蚤       | <i>Acrocalanus gibber</i>               | +         |            |
| 微驼隆哲水蚤       | <i>Acrocalanus gracilis</i>             | +         |            |
| 汤氏长足水蚤       | <i>Calanopia thompsis</i>               | +         |            |
| 椭圆形长足水蚤      | <i>Calanopia elliptica</i>              | +         | +          |
| 微刺哲水蚤        | <i>Canthocalanus pauper</i>             | +         | +          |
| 瘦尾胸水蚤        | <i>Centropages tenuiremis</i>           |           | +          |
| 东亚大眼剑水蚤      | <i>Corycaeus asiaticus</i>              | +         |            |
| 平大眼剑水蚤       | <i>Corycaeus dahl</i>                   | +         |            |
| 美丽大眼剑水蚤      | <i>Corycaeus speciosus</i>              | +         | +          |
| 亚强真哲水蚤       | <i>Eucalanus subcrassus</i> Giesbrecht  |           | +          |
| 尖额真猛水蚤       | <i>Euterpia acutifrons</i>              | +         |            |
| 后截唇角水蚤       | <i>Labidocera detruncata</i>            | +         |            |
| 双刺唇角水蚤       | <i>Labidocera bipinnata</i>             | +         |            |
| 小哲水蚤         | <i>Nannocalanus minor</i>               | +         |            |
| 短角长腹剑水蚤      | <i>Oithona brevicornis</i>              | +         |            |
| 针刺拟哲水蚤       | <i>Paracalanus aculeatus</i> Giesbrecht |           | +          |
| 小拟哲水蚤        | <i>Paracalanus parvus</i>               | +         |            |
| 强额孔雀哲水蚤      | <i>Pavocalanus crassirostris</i>        | +         |            |
| 钝筒角水蚤        | <i>Pontellopsis yamadae</i>             | +         |            |
| 筒角水蚤         | <i>Pontellopsis</i> sp.                 | +         |            |
| 海洋伪镖水蚤       | <i>Pseudodiaptomus marinus</i>          | +         | +          |
| 亚强次真哲水蚤      | <i>Subeucalanus subcrassus</i>          | +         |            |
| 锥形宽水蚤        | <i>Temora turbinata</i>                 | +         | +          |
| 钳形歪水蚤        | <i>Tortanus forcipatus</i>              | +         | +          |
| <b>十足类</b>   | <b>Decapoda</b>                         |           |            |
| 钩虾           | Gammaridea                              |           | +          |

| Chinese Name | Latin                                | May, 2007 | Dec., 2006 |
|--------------|--------------------------------------|-----------|------------|
| 中型莹虾         | <i>Lucifer intermedius</i>           | +         |            |
| 享生莹虾         | <i>Lucifer hansenii</i>              |           | +          |
| <b>介形类</b>   | <b>Ostracoda</b>                     |           |            |
| 针刺真浮萤        | <i>Euconchoecia aculeate</i> (Scott) |           | +          |
| <b>毛颚类</b>   | <b>Chaetognatha</b>                  |           |            |
| 百陶箭虫         | <i>Sagitta bedoti</i>                | +         |            |
| 弱箭虫          | <i>Sagitta delicata</i>              | +         |            |
| 肥胖箭虫         | <i>Sagitta enflata</i>               | +         | +          |
| 圆囊箭虫         | <i>Sagitta johorensis</i>            | +         |            |
| 小箭虫          | <i>Sagitta neglecta</i>              | +         | +          |
| <b>被囊类</b>   | <b>Tunicata</b>                      |           |            |
| 异体住囊虫        | <i>Oikopleura dioica</i>             | +         |            |
| 长尾住囊虫        | <i>Oikopleura longicauda</i>         | +         |            |
| 住囊虫属         | <i>Oikopleura sp.</i>                |           | +          |
| <b>浮游幼虫</b>  | <b>Larvae</b>                        |           |            |
| 歪尾类幼虫        | <i>Anomura larva</i>                 | +         |            |
| 海星羽腕幼虫       | <i>Bipinnaria larva</i>              | +         |            |
| 短尾类溞状幼虫      | <i>Brachyura zoaea larva</i>         | +         | +          |
| 短尾类大眼幼虫      | <i>Brachyura megalopa larva</i>      |           | +          |
| 蔓足类无节幼虫      | <i>Cirripedia nauplius</i>           | +         |            |
| 腺介幼虫         | <i>Cypris larva</i>                  | +         | +          |
| 碟状幼体         | <i>Ephyra larva</i>                  | +         |            |
| 鱼卵           | Fish egg                             | +         | +          |
| 仔鱼           | Fish larva                           | +         | +          |
| 腹足类后期幼虫      | <i>Gastropoda veliger</i>            | +         |            |
| 瓣鳃类幼虫        | <i>Lamellibranchia larva</i>         |           | +          |
| 长尾类幼虫        | <i>Macrura larva</i>                 | +         | +          |
| 大眼幼虫         | <i>Megalopa larva</i>                | +         |            |
| 无节幼虫         | <i>Nauplius larva</i>                | +         |            |
| 蛇尾长腕幼虫       | <i>Ophiopluteus larva</i>            | +         | +          |
| 多毛类幼虫        | <i>Polychaeta larva</i>              | +         | +          |
| 磁蟹幼虫         | <i>Porcellana larva</i>              | +         | +          |
| 口足类幼虫        | <i>Stomatopoda larva</i>             | +         |            |
| 担轮幼虫         | <i>Trochopore larva</i>              | +         |            |

## Appendix III

## List of Bottom Creatures

| Chinese Name | Latin                                        | May, 2007 | April, 2005 |
|--------------|----------------------------------------------|-----------|-------------|
| <b>环节动物</b>  | <b>Annelida</b>                              |           |             |
| 菱内卷齿蚕        | <i>Aglaophamus vietnamensis</i>              | +         |             |
| 中华内卷齿蚕       | <i>Aglaophamus sinensis</i> Fauvel           |           | +           |
| 角海蛭          | <i>Ophelia acuminata</i>                     | +         |             |
| 杂色巢沙蚕        | <i>Diopatra variabilis</i>                   | +         |             |
| 欧文虫          | <i>Owenia fusiformis</i>                     | +         |             |
| 异足索沙蚕        | <i>Lumbrineris heteropoda</i>                | +         |             |
| 斑角吻沙蚕        | <i>Goniada maculata</i>                      | +         |             |
| 锥唇吻沙蚕        | <i>Glycera onomichiensis</i> Izuka           |           | +           |
| 双形拟单指虫       | <i>Cossurella dimorpha</i>                   | +         |             |
| 不倒翁虫         | <i>Sternaspis scutata</i>                    | +         |             |
| 热带杂毛虫        | <i>Poecilochaetus tropicus</i>               | +         |             |
| 纳加索沙蚕        | <i>Lumbrineris nagaee</i>                    | +         | +           |
| 长锥虫          | <i>Haploscoloplos elongatus</i>              | +         |             |
| 尖锥虫          | <i>Scoloplos</i> sp.                         |           | +           |
| 多丝独毛虫        | <i>Tharyx multifilis</i> Moore               |           | +           |
| 背毛背蚓虫        | <i>Notomastus cf. aberans</i>                | +         |             |
| 背蚓虫          | <i>Notomastus latericeus</i> Sars            |           | +           |
| 梳鳃虫          | <i>Terebellides stroemii</i> Sars            |           | +           |
| 梯斑海毛虫        | <i>Chloeia parva</i> Baird                   |           | +           |
| 梯额虫          | <i>Scalibregma inflatum</i> Rathke           |           | +           |
| 岩虫           | <i>Marphysa sanguinea</i> (Montagu)          |           | +           |
| 似蛭虫          | <i>Amaeana trilobata</i> (Sars)              |           | +           |
| 欧努菲虫         | <i>Onuphis eremita</i> Audouin et M. Edwards |           | +           |
| 太平洋树蛭虫       | <i>Pista pacifica</i> Berkeley               |           | +           |
| 原管虫          | <i>Protula tubularia</i> (Montagu)           |           | +           |
| 拟节虫          | <i>Praxillella praetermissa</i>              | +         |             |
| <b>软体动物</b>  | <b>Mollusca</b>                              |           |             |
| 配景轮螺         | <i>Architectonica perspectiva</i>            |           | +           |
| 方斑东风螺        | <i>Babylonia areolata</i> (Link)             |           | +           |
| 短壳肠蛤         | <i>Botula silicula</i> (Lamarck)             |           | +           |
| 鸟嘴尖帽螺        | <i>Capulus dilatatus</i>                     | +         |             |
| 甲虫螺          | <i>Cantharus cecillei</i> (Philippi)         |           | +           |
| 粒帆螺          | <i>Calyptraea morbida</i> (Reeve)            |           | +           |

| Chinese Name | Latin                                                            | May, 2007 | April, 2005 |
|--------------|------------------------------------------------------------------|-----------|-------------|
| 美叶雪蛤         | <i>Clausinella calophylla</i> (Philippi)                         |           | +           |
| 美女蛤          | <i>Circe scripta</i> (Linnaeus)                                  |           | +           |
| 假主棒螺         | <i>Crassispira pseudoprincipilis</i> (Yokoyama)                  |           | +           |
| 粗糙真蹄螺        | <i>Euchelus scaber</i> (Linne)                                   |           | +           |
| 泡状薄壳鸟蛤       | <i>Fulvia bullata</i> (Linnaeus)                                 |           | +           |
| 澳洲薄壳鸟蛤       | <i>Fulvia australis</i> (Sowerby)                                |           | +           |
| 细肋蕾螺         | <i>Gemmula deshayesii</i> (Doumel)                               |           | +           |
| 镶边鸟蛤         | <i>Vepricardium coronatum</i> (Spengler)                         |           | +           |
| 橡子织纹螺        | <i>Nassarius glans</i> (Linnaeus)                                |           | +           |
| 黄短口螺         | <i>Inquistor flavidula</i> (Lamarck)                             |           | +           |
| 节织纹螺         | <i>Nassarius hepaticus</i> (Pulteney)                            |           | +           |
| 蓝斑背肛海兔       | <i>Notarchus (Bursatella) leachii cirrosus</i><br>Stimpson       |           | +           |
| 宽壳胡桃蛤        | <i>Nucula convexa</i> (Sowerby)                                  |           | +           |
| 真曲巴非蛤        | <i>Paphia (Paphia) euglypta</i>                                  | +         |             |
| 经氏壳蛞蝓        | <i>Philine kinglipini</i> Tchang                                 |           | +           |
| 襞蛤           | <i>Plicatula plicata</i> (Linnaeus)                              |           | +           |
| 棕带仙女蛤        | <i>Callista erycina</i>                                          | +         |             |
| 彩榧螺          | <i>Oliva ispidula</i>                                            | +         |             |
| 中华牡蛎         | <i>Parahyotissa sinensis</i> (Gmelin) [ <i>Ostrea sinensis</i> ] |           | +           |
| 肥小塔螺         | <i>Pyramidella ventricosa</i> Guerin                             |           | +           |
| 伶鼬榧螺         | <i>Oliva mustellina</i> Lamarck                                  |           | +           |
| 团聚牡蛎         | <i>Ostrea glomerata</i>                                          |           | +           |
| 朱红菖蒲螺        | <i>Vexillum ornatum coccineum</i>                                | +         |             |
| 美女白樱蛤        | <i>Macoma (Psammacoma) candida</i> (Lamarck)                     |           | +           |
| 马氏瓷光螺        | <i>Melanella martinii</i> A. Adamw                               |           | +           |
| 江户明樱蛤        | <i>Moerella jedoensis</i>                                        | +         |             |
| 中国小铃螺        | <i>Minolia chinensis</i>                                         | +         |             |
| 马氏瓷光螺        | <i>Melanella martinii</i>                                        | +         |             |
| 中华莫利加螺       | <i>Merica sinensis</i> (Reeve)                                   |           | +           |
| 浅缝骨螺         | <i>Murex trapa</i> Roding                                        |           |             |
| 不等壳毛蚶        | <i>Scapharca inaequalvis</i> (Bruguere)                          |           | +           |
| 双缘耳乌贼        | <i>Sepiola birostrata</i> Sasaki                                 |           | +           |
| 针乌贼          | <i>Sepia andreana</i> Steenstrup                                 |           | +           |

| Chinese Name | Latin                                    | May, 2007 | April, 2005 |
|--------------|------------------------------------------|-----------|-------------|
| 大竹蛭          | <i>Solen grandis</i> Dunker              |           | +           |
| 直线竹蛭         | <i>Solen linearis</i>                    | +         |             |
| 衣硬篮蛤         | <i>Solidicorbula tunicata</i> (Hinds)    |           | +           |
| 可变荔枝螺        | <i>Thais mustabilis</i> (Link)           |           | +           |
| 白带笋螺         | <i>Terebra (Noditerebra) dussumieri</i>  |           | +           |
| 白带三角口螺       | <i>Trigonaphera bocageana</i>            |           | +           |
| 棒锥螺          | <i>Turritella bacillum</i>               | +         |             |
| 假奈拟塔螺        | <i>Turricula nelliae spurius</i>         |           | +           |
| <b>棘皮动物</b>  | <b>Echinodermata</b>                     |           |             |
| 小棘真蛇尾        | <i>Ophiura micracantha</i>               | +         |             |
| 长腕双鳞蛇尾       | <i>Amphipholis loripes</i>               | +         |             |
| 多棘槭海星        | <i>Astropecten polyacanthus</i>          |           | +           |
| 星刺蛇尾         | <i>Ophiothrix stelligera</i>             | +         |             |
| 二色桌片参        | <i>Mensamaria intercedens</i>            | +         |             |
| 瘤五角瓜参        | <i>Pentacta anceps</i>                   | +         |             |
| 洼颚倍棘蛇尾       | <i>Amphioplus depressus</i>              | +         |             |
| 光滑倍棘蛇尾       | <i>Amphioplus laevis</i>                 | +         |             |
| 光亮背棘蛇尾       | <i>Amphioplus lucidus</i> Koehler        |           | +           |
| 异常盘棘蛇尾       | <i>Ophiocentrus anomalus</i>             | +         |             |
| 斑瘤蛇尾         | <i>Opiocnemis marmorata</i>              |           | +           |
| 伪指刺锚参        | <i>Protankyra pseudo-digitata</i>        |           | +           |
| 细雕刻肋海胆       | <i>Temnopleurus toreumaticus</i>         |           | +           |
| 二角赛瓜参        | <i>Thyone bicornis</i> Ohshima           |           | +           |
| 瘤五角瓜参        | <i>Pentacta anceps</i> (Selenka)         |           | +           |
| 黑乳参          | <i>Holothuria nobilis</i> (Selenka)      |           | +           |
| <b>节肢动物</b>  | <b>Arthropoda</b>                        |           |             |
| 网纹藤壶         | <i>Balanus reticulatus</i>               | +         |             |
| 日本沙钩虾        | <i>Byblis japonicus</i> Dahl             |           | +           |
| 镰形叶钩虾        | <i>Jassa falcata</i> (Montagu)           |           | +           |
| 口虾蛄          | <i>Oratosquilla oratoria</i> (de Haan)   |           | +           |
| 长眼对虾         | <i>Miyadiella podophthalmus</i>          |           | +           |
| 沙栖新对虾        | <i>Metapenaeus moyebi</i> (Kishinouye)   |           | +           |
| 鹰爪虾          | <i>Trachypenaeus curvirostris</i>        |           | +           |
| 扁足异对虾        | <i>Atypopenaeus stenodactylus</i>        |           | +           |
| 细巧仿对虾        | <i>Parapenaeopsis tenella</i> (Bate)     |           | +           |
| 中华仿对虾        | <i>Parapenaeopsis sinica</i> Liu et Wang |           | +           |

| Chinese Name | Latin                                       | May, 2007 | April, 2005 |
|--------------|---------------------------------------------|-----------|-------------|
| 须赤虾          | <i>Metapenaeopsis barbata</i> (de Haan)     |           | +           |
| 尖尾细螯虾        | <i>Leptochela aculeocaudata</i> Paulson     |           | +           |
| 鲜明鼓虾         | <i>Alpheus distinguendus</i> de Man         |           | +           |
| 高峰星藤壶        | <i>Chirona amaryllis</i> (Darwin)           |           | +           |
| 绒毛细足蟹        | <i>Raphidopus ciliatus</i> Stimpson         |           | +           |
| 仿瓷蟹          | <i>Porcellanella picta</i> Stimpson         |           | +           |
| 刺猬栗壳蟹        | <i>Arcania erinaceus</i> (Fabricius)        |           | +           |
| 红斑玉蟹         | <i>Leucosia haematosticta</i>               |           | +           |
| 带纹玉蟹         | <i>Leucosia vittata</i> Stimpson            |           | +           |
| 强壮菱蟹         | <i>Parthenopw validus</i> de Haan           |           | +           |
| 锐刺长踦蟹        | <i>Phalangipus hystrix</i> (Miers)          |           | +           |
| 慈母互敬蟹        | <i>Hyastenus pleione</i> (Herbst)           |           | +           |
| 环状隐足蟹        | <i>Cryptopodia fronicata</i> (Fabricius)    |           | +           |
| 颗粒关公蟹        | <i>Dorippe (Paradorippe) granulata</i>      |           | +           |
| 关公蟹          | <i>Dorippe</i> sp.                          |           | +           |
| 远海梭子蟹        | <i>Portunus pelagicus</i>                   |           | +           |
| 矛形梭子蟹        | <i>Portunus hastatoides</i>                 |           | +           |
| 拥剑梭子蟹        | <i>Portunus haanii</i>                      |           | +           |
| 直额蜉          | <i>Charybdis truncata</i>                   |           | +           |
| 双额短桨蟹        | <i>Thalamita sima</i>                       |           | +           |
| 扇蟹           | Xanthidae                                   |           | +           |
| 火红皱蟹         | <i>Leptodius exaratus</i>                   |           | +           |
| 五角暴蟹         | <i>Halimede ochtodes</i>                    |           | +           |
| 短眼蟹          | <i>Xenophthalmus pinnotheroides</i>         |           | +           |
| 隆背蟹          | <i>Carcinoplax</i> sp.                      |           | +           |
| 模糊新短眼蟹       | <i>Neoxenophthalmus obscurus</i>            | +         |             |
| <b>螯虫动物</b>  | <b>Sipuncula</b>                            |           |             |
| 短吻铲荚螯        | <i>Listriolobus brevirostris</i>            | +         |             |
| <b>脊索动物</b>  | <b>Chordata</b>                             |           |             |
| 白氏银汉鱼        | <i>Allanetta bleekeri</i> (Gunther)         |           | +           |
| 中线天竺鲷        | <i>Apogon kiensis</i> Jordan et Snyder      |           | +           |
| 纤羊舌鲷         | <i>Arnoglossus tenuis</i> Gunther           |           | +           |
| 厦门文昌鱼        | <i>Branchiostoma belcheri</i>               | +         |             |
| 丝棘鱼衍         | <i>Callionymus flagris</i> Jordon et Fowler |           | +           |
| 基岛鱼衍         | <i>Callionymus kaianus</i> Gunther          |           | +           |
| 长丝鰕虎鱼        | <i>Cryptocentrus filifer</i>                |           | +           |

| Chinese Name | Latin                                                   | May, 2007 | April, 2005 |
|--------------|---------------------------------------------------------|-----------|-------------|
|              | (Cuvier et Valenciennes)                                |           |             |
| 云斑栉鰕虎鱼       | <i>Ctenogobius criniger</i><br>(Cuvier et Valenciennes) |           | +           |
| 斑头舌鳎         | <i>Cynoglossus puncticeps</i> (Richardson)              |           | +           |
| 少鳞舌鳎         | <i>Cynoglossus oligolepis</i> (Bleeker)                 |           | +           |
| 幼鱼           | <i>Fish larve</i>                                       |           | +           |
| 大鳞鳞头鲷        | <i>Sebastapistes megalepis</i> (Fowler)                 |           | +           |
| 卵鲷           | <i>Solea ovata</i> Richardson                           |           | +           |
| 红鱼衍          | <i>Synchirops altivelis</i><br>(Temminck et Schlegel)   |           | +           |
| 条纹三叉鰕虎鱼      | <i>Tridentiger trigonocephalus</i>                      |           | +           |
| 长体银鲈         | <i>Gerres macrosoma</i> Bleeker                         |           | +           |
| 裸胸红娘鱼        | <i>Lepidotrigla kanagashira</i>                         |           | +           |
| 裸鳍虫鳗         | <i>Muraenichthys gymnopterus</i>                        |           | +           |
| 斑点拟鲈         | <i>Parapercis punctata</i>                              |           | +           |
| 印度拟棘须鲷       | <i>Paracentropogon indicus</i>                          |           | +           |
| 丝指鲷          | <i>Psettina filimanus</i>                               |           | +           |
| 少牙斑鲷         | <i>Pseudorhombus oligodon</i>                           |           | +           |
| 大鳞鳞鲷         | <i>Onigocia macrolepis</i>                              |           | +           |
| 触角沟鰕虎鱼       | <i>Oxyurichthys tentacularis</i>                        |           | +           |
| 小鳞尖尾鱼        | <i>Oxyurichthys microlepis</i>                          |           | +           |
| <b>腔肠动物</b>  | <b>Coelenterata</b>                                     |           |             |
| 海笔           | <i>Virgularia spl.</i>                                  |           | +           |
| 近丽海葵         | <i>Paracalliactis sp.</i>                               |           | +           |
| 美丽海葵         | <i>Calliactis sp.</i>                                   |           | +           |
| <b>星虫动物</b>  | <b>Sipuncula</b>                                        |           |             |
| 泥蒜 (可口革囊星虫)  | <i>Phascosoma esculenta</i>                             |           | +           |
| <b>尾索动物</b>  | <b>Urochordata</b>                                      |           |             |
| 海鞘           | <i>Asciadiacea</i>                                      |           | +           |
| <b>海绵动物</b>  | <b>Porifera</b>                                         |           |             |
| 海绵动物         | <i>Spongia</i>                                          |           | +           |
| <b>褐藻</b>    |                                                         |           |             |
| 水云           | <i>Ectocarpus sp.</i>                                   |           | +           |

## Appendix IV

## List of Fish Eggs and Juveniles Fish

| Chinese Name | Latin                           | May, 2007 | Dec., 2006 |
|--------------|---------------------------------|-----------|------------|
| <b>鱼卵</b>    | <b>Fish Egg</b>                 |           |            |
| 鲷属           | <i>Leiognathus</i> sp.          | +         |            |
| 小沙丁鱼         | <i>Sardinella</i> sp.           | +         |            |
| 多鳞鲈          | <i>Sillago sihama</i>           | +         |            |
| 小公鱼          | <i>Stolephorus</i> sp.          | +         |            |
| 舌鲷科          | Synoglossidae                   | +         |            |
| 细鳞刺鱼         | <i>Therapon jarbus</i> (Forsk.) |           | +          |
| 中颌棱鲷         | <i>Thrissa mystax</i>           | +         |            |
| <b>子稚鱼</b>   | <b>Fish larvae</b>              |           |            |
| 鰕虎鱼科         | Gobiidae                        | +         | +          |
| 鲷属           | <i>Leiognathus</i> sp.          | +         |            |
| 鲷科           | Mugilidae                       | +         |            |
| 小沙丁鱼         | <i>Sardinella</i> sp.           | +         |            |
| 石首鱼科         | Sciaenidae                      | +         |            |
| 多鳞鲈          | <i>Sillago sihama</i> (Forsk.)  |           | +          |
| 鲷            | Soleidae                        |           | +          |
| 舌鲷科          | Synoglossidae                   | +         |            |
| 日本金线鱼        | <i>Nemipterus japonicus</i>     | +         |            |



## Appendix V List of Tide Region Creatures

| Chinese Name | Latin                                               | May, 2007 | April, 2005 |
|--------------|-----------------------------------------------------|-----------|-------------|
| <b>环节动物</b>  | <b>Annelida</b>                                     |           |             |
| 围沙蚕          | <i>Perinereis sp.</i>                               |           | +           |
| 多齿围沙蚕        | <i>Perinereis nuntia</i> (Savigny)                  |           | +           |
| 软疣沙蚕         | <i>Tylonereis bogoyawleskyi</i> Fauvel              |           | +           |
| 双齿围沙蚕        | <i>Perinereis aibuhitensis</i> Grube                |           | +           |
| 海蛹           | <i>Opheliidae spp.</i>                              |           |             |
| 粘海蛹          | <i>Ophelia cf. limacina</i> (Rathke)                |           | +           |
| 白色吻沙蚕        | <i>Glycera alba</i> (Muller)                        |           | +           |
| 吻沙蚕          | <i>Glycera sp.</i>                                  |           | +           |
| 刺沙蚕          | <i>Neanthes sp.</i>                                 |           | +           |
| 长锥虫          | <i>Haploscoloplos elongatus</i> (Johnson)           |           | +           |
| 索沙蚕          | <i>Lumbrineris sp</i>                               |           | +           |
| 多毛类          | <i>Poluchaeta sp.</i>                               |           | +           |
| 稚齿虫          | <i>Prionospio sp.</i>                               |           | +           |
| <b>软体动物</b>  | <b>Mollusca</b>                                     |           |             |
| 丽文蛤          | <i>Meretrix lusoria</i> (Rumphius)                  |           | +           |
| 大开腹蛤         | <i>Eufistulana grandis</i> (Deshayes)               |           | +           |
| 繸缘锦蛤         | <i>Taprs aspersa</i> (Gmelin)                       |           | +           |
| 岐脊加夫蛤        | <i>Gafrarium divaricatum</i> (Gmelin)               |           | +           |
| 日本镜蛤         | <i>Dosinia</i> (Phacosoma) <i>japonica</i> (Reeve)  |           | +           |
| 饼干镜蛤         | <i>Dosinia</i> (Phacosoma) <i>biscocta</i> (Reeve)  |           | +           |
| 帆镜蛤          | <i>Dosinia</i> (Bonartemis) <i>histrio</i> (Gmelin) |           | +           |
| 九州斧蛤         | <i>Tentidonax kiusiuensis</i> (Pilsbry)             |           | +           |
| 团聚牡蛎         | <i>Ostrea</i> (Pycnodonta) <i>glornerata</i> Gould  |           | +           |
| 中华牡蛎         | <i>Parahyotissa sinensis</i> (Gmelin)               |           | +           |
| 不等壳毛蚶        | <i>Scapharca inaequivalvis</i> (Bruguere)           |           | +           |
| 合浦珍珠贝        | <i>Pinctada martensi</i> (Dunker)                   |           | +           |
| 贻贝           | <i>Mytilus edulis</i> Linnaeus                      |           |             |
| 旋纹细带螺        | <i>Fasciolaria filamentosa</i> (Roding)             |           | +           |
| 扁平寶螺         | <i>Sinum planulatum</i> (Recluz)                    |           | +           |
| 浅缝骨螺         | <i>Murex trapa</i> Roding                           |           | +           |
| 斑马蹄螺         | <i>Trochus</i> (Trochus) <i>maculatus</i> Linnaeus  |           | +           |
| 疣荔枝螺         | <i>Thais clavigera</i> Kuster                       |           | +           |
| 可变荔枝螺        | <i>Thais mustabilis</i> (Link)                      |           |             |

| Chinese Name | Latin                                                       | May, 2007 | April, 2005 |
|--------------|-------------------------------------------------------------|-----------|-------------|
| 粒花冠小月螺       | <i>Lunella coronata granulata</i> (Gmelin)                  |           | +           |
| 福氏乳玉螺        | <i>Polynices fortunerii</i>                                 |           | +           |
| 古氏摊栖螺        | <i>Batillaria cumingi</i> (Crosse)                          |           | +           |
| 习见织纹螺        | <i>N.dealbatus</i> (A.Adams)                                |           | +           |
| 胆织纹螺         | <i>Nassarius dealbatus</i>                                  |           | +           |
| 胆形织纹螺        | <i>Nassarius thersitcs</i> (Bruguiera)                      |           | +           |
| 焦棘螺          | <i>Chicoreus torrefactus</i> (Sowerby)                      |           | +           |
| 旋纹细带螺        | <i>Fasciolaria filamentosa</i> (Roding)                     |           | +           |
| 粒神螺          | <i>Apollon olivator rubustus</i> (Fulton)                   |           |             |
| 网纹海兔         | <i>Aplysia</i> (Varria) <i>pulmonica</i> Gould              |           | +           |
| 蓝无壳侧鳃        | <i>Pleurobranchaea novaezealandiae</i><br>Cheeseman         |           | +           |
| <b>节肢动物门</b> | <b>ARTHROPODA</b>                                           |           |             |
| 善泳螳          | <i>Charybdis natator</i> (Herbst)                           |           | +           |
| 长腕和尚蟹        | <i>Mictyris longicarpus</i> Latreille                       |           | +           |
| 细足梭子蟹        | <i>Portunus tenuipes</i> (de Haan)                          |           | +           |
| 短桨蟹          | <i>Thalamita</i> sp.                                        |           | +           |
| 少刺短桨蟹        | <i>Thalamita danae</i> Stimpson                             |           | +           |
| 纯齿短桨蟹        | <i>Thalamita martensii</i>                                  |           |             |
| 钝齿短桨蟹        | <i>Thalamita crenata</i> (Latreille)                        |           | +           |
| 寄居蟹          | <i>Paguridae</i> sp.                                        |           | +           |
| 大眼蟹          | <i>Macrophthalmus</i> sp.                                   |           | +           |
| 毛粒蟹          | <i>Polumnopeus</i> sp.                                      |           | +           |
| 疙瘩拳蟹         | <i>Philyra tuberculosa</i> Stimpson                         |           | +           |
| 小相手蟹         | <i>Nanosesarma</i> (Nanosesarma) <i>minutum</i><br>(de Man) |           | +           |
| 皱蟹           | <i>Leptodius</i> sp.                                        |           | +           |
| 沙蟹           | <i>Ocypode</i> sp.                                          |           | +           |
| 鼓虾           | <i>Alpheas</i> sp.                                          |           |             |
| 刺螯鼓虾         | <i>Alpheus hoplocheles</i> Coutiere                         |           | +           |
| 周氏新对虾        | <i>Metapenaeus joyneri</i> (Miers)                          |           | +           |
| 新对虾          | <i>Metapenaeus</i> sp.                                      |           | +           |
| 网纹藤壶         | <i>Balanus reticulatus</i> Utinomi                          |           | +           |
| <b>棘皮动物</b>  | <b>EOHINODERMATA</b>                                        |           |             |
| 花刺参          | <i>Stichopus variegatus</i> Semper                          |           | +           |
| 马氏海参         | <i>Holothuria martensi</i> Semper                           |           | +           |

| Chinese Name | Latin                                             | May, 2007 | April, 2005 |
|--------------|---------------------------------------------------|-----------|-------------|
| 棘刺锚参         | <i>Protankyra bidentata</i> (Woodward et Barrett) |           | +           |
| 锚参           | <i>Synaptidae spp.</i>                            |           |             |
| 十角饼干海胆       | <i>Laganum decagonale</i> (de Blainville)         |           | +           |
| 飞白凤海星        | <i>Archaster typicus</i> Muller et Troschel       |           | +           |
| <b>脊索动物</b>  | <b>Chordata</b>                                   |           |             |
| 弹涂鱼          | <i>Periophthalmus sp.</i>                         |           | +           |
| 弹涂鱼幼体        | <i>Periophthalmidae spp.</i>                      |           | +           |
| 褐菖鲉          | <i>Sebastiscus marmoratus</i>                     |           | +           |
| <b>腔肠动物</b>  | <b>Coelenterata</b>                               |           |             |
| 海葵           | <i>Actinaria</i>                                  |           | +           |
| 螳形美丽海葵       | <i>Calliactis polypus</i> (Forsk.)                |           | +           |
| 纵条肌海葵        | <i>Haliplanella luciae</i> Hand                   |           | +           |
| 肌海葵          | <i>Haliplanella sp.</i>                           |           | +           |
| 淡水棒螳         | <i>Cordylophora lacustris</i>                     |           | +           |
| <b>星虫动物</b>  | <b>Sipuncula</b>                                  |           |             |
| 裸体方格星虫       | <i>Sipunculus nudus</i> Linnaeus                  |           | +           |
| <b>尾索动物</b>  | <b>Urochordata</b>                                |           |             |
| 柄海鞘          | <i>Styela clava</i> Herdman                       |           | +           |
| <b>底栖植物</b>  | <b>Plantae</b>                                    |           |             |
| 石莼           | <i>Ulva lactuca</i> L.                            |           | +           |
| 绿藻           | <i>Chlorophyta</i>                                |           | +           |
| 褐藻           | <i>Phaeophyta</i>                                 |           | +           |
| 浒苔           | <i>Enteromorpha prolifera</i> (Muell.) J. Ag.     |           | +           |

Project No.: GXHBS- 2006-01-001

**The 900,000 Ton Pulp and 900,000 Ton Paper and  
Cardboard Project of Stora Enso (Guangxi) Pulp & Paper  
Co., Ltd**

# **Environmental Impact Report**

## **Volume II**

Compiler: Research Institute of Environmental Protection of Guangxi Zhuang  
Autonomous Region

Certificate No.: GHPZJZ NO. 2902

Time of Compilation: October 2008

Note; The document is a translation of the Chinese EIA report submitted for application for the environmental approval for the project according to Chinese regulations. The approval process took place in 2008.

The translated report has been edited by Stora Enso for the purpose of public disclosure. Certain financial information and technical details of the planned investment have been removed from the text.



Project Name: The 900,000 Ton Pulp and 900,000 Ton Paper and  
Cardboard Project of Stora Enso (Guangxi) Pulp & Paper Co., Ltd.  
Industry Type: Light industry  
Document Type: Environment Impact Report  
Entrusting Unit: Stora Enso (Guangxi) Pulp & Paper Co., Ltd.  
Evaluation Unit: Research Institute of Environmental Protection of Guangxi  
Zhuang Autonomous Region

Legal Representative: Li Min

Approved by:

Audited by:

Checked by:

Project leaders: (Senior engineer Certificate No. of Environmental Impact Assessment  
Engineer A29020020300)

(Senior engineer Certificate No. of Environmental Impact Assessment  
Engineer A29020041000)

(Senior engineer Certificate No. of Environmental Impact Assessment  
Engineer A29020030300)

Cooperative Unit: Tianjin Research Institute for Water Transport  
Engineering of Ministry of Communications

Legal Representative:

Cooperative Unit: Guangxi Beihai Environment Monitoring Station

Legal Representative:

# Table of Contents

|                                                                                                              |            |
|--------------------------------------------------------------------------------------------------------------|------------|
| <b>5 Summary of Environment Impact Report for Forest Base in the Project</b>                                 | <b>1</b>   |
| 5.1 Brief introduction to the raw material forest base construction                                          | 1          |
| 5.2 Analysis of engineering of raw material forest bases                                                     | 4          |
| 5.3 Status quo evaluation of the environment                                                                 | 11         |
| 5.4 Analysis of impact on biological diversity and ecological sensitive objects                              | 12         |
| 5.5 Analysis of impact on soil fertility                                                                     | 17         |
| 5.6 Analysis of impact of soil erosion                                                                       | 18         |
| 5.7 Impact on the water conservation areas                                                                   | 20         |
| 5.8 Analysis of impact on ecological landscape                                                               | 23         |
| 5.9 Analysis on effect of farm chemicals and chemical fertilizer application on environment                  | 24         |
| 5.10 Analysis of environmental effect of other forest management activities                                  | 26         |
| 5.11 Protective measures concerning effects on ecological environment                                        | 27         |
| 5.12 Conclusions and suggestions                                                                             | 33         |
| <b>6 Analysis on Environmental Effect During Construction</b>                                                | <b>40</b>  |
| 6.1 Brief Introduction of Construction                                                                       | 40         |
| 6.2 Analysis on the Effect of Air Environment During Construction                                            | 41         |
| 6.3 Analysis on Sound Environment Impact During Construction                                                 | 42         |
| 6.4 Analysis on Water Environment During Construction                                                        | 45         |
| 6.5 Analysis on Water and Soil Loss Effect During Construction                                               | 46         |
| 6.6 Analysis on Environmental Influence of Solid Waste During Construction                                   | 46         |
| 6.7 Analysis on Health Effect of Population in Construction                                                  | 47         |
| 6.8 Analysis on Influence of Offshore Swage Pipe Construction                                                | 48         |
| <b>7 Prediction and Evaluation of Impact on Aquatic Environment in Sea Area</b>                              | <b>52</b>  |
| 7.1 Hydrological Survey                                                                                      | 52         |
| 7.2 Numerical Simulation of Tidal Current and Analysis on Hydrodynamic Conditions                            | 51         |
| 7.3 Overview of Discharge Outlet                                                                             | 68         |
| 7.4 Forecast of environmental impacts by discharge outlet in the case of Implementation of planned coastline | 75         |
| 7.5 Environmental Impacts of Discharge Outlet of the Project without Implementation of Coastline Plan        | 123        |
| 7.6 Summary                                                                                                  | 163        |
| <b>8 Prediction and Evaluation of Atmospheric Environmental Effects</b>                                      | <b>164</b> |
| 8.1 Analysis of Meteorological Conditions for Pollution                                                      | 164        |
| 8.2 Prediction and Evaluation of Effect on Air Environment                                                   | 180        |

|                                                                     |            |
|---------------------------------------------------------------------|------------|
| 8.3 Summary .....                                                   | 202        |
| <b>9 Ecological and Environmental Impact Analysis.....</b>          | <b>203</b> |
| 9.1 Marine ecological and environmental Impact .....                | 203        |
| 9.2 Analysis of Ecological environmental Impact in Land Area .....  | 211        |
| <b>10 Analysis on Regional Social &amp; Economic Impact.....</b>    | <b>215</b> |
| 10.1 Direct Social Impact of the Project .....                      | 215        |
| 10.2 Analysis on Regional Social & Economic Impact .....            | 226        |
| 10.3 Summary.....                                                   | 230        |
| <b>11 Other Environmental Impact Prediction and Evaluation.....</b> | <b>231</b> |
| 11.1 Sound Environment Impact Prediction and Evaluation .....       | 231        |
| 11.2 Disposal and Impact Analysis of Solid Wastes .....             | 241        |
| 11.3 Impact Analysis of Transportation and Logistics .....          | 255        |
| <b>12. Analysis on Environmental Risk .....</b>                     | <b>261</b> |
| 12.1 Outline of Environmental Risk Evaluation .....                 | 261        |
| 12.2 Risk Identification .....                                      | 264        |
| 12.3 Sources Term Analysis.....                                     | 272        |
| 12.4 Consequence Calculation .....                                  | 275        |
| 12.5 Quantitative Risk Assessment .....                             | 281        |
| 12.6 Qualitative Risk Assessment .....                              | 282        |
| 12.7 Risk Precautions .....                                         | 287        |
| 12.8 Summary.....                                                   | 294        |
| 12.9 Emergency Rescue Plan .....                                    | 294        |

Attached Drawings: [not included]

16. Slag Stockpile Site Selection Scheme (I) Geological Hazard Comprehensive Evaluation Drawing
17. Slag Stockpile Site Selection Scheme (II) Geological Hazard Comprehensive Evaluation Drawing
18. Type and Distribution of Regional Underground Water



## 5. Summary of Environment Impact Report for Forest Base in the Project

The proprietor commissions the China Environmental Science Research Institute to complete the environment impact evaluation of the raw material forest base construction with extra review, and this report will only extract the main evaluation conclusion.

### 5.1 Brief introduction to the raw material forest base construction

#### 5.1.1 Brief introduction to construction

Project name: The 160,000 hectares Raw Material Forest Base construction project of the 900,000 Ton Pulp and 900,000 Ton Paper and Cardboard Project of Stora Enso (Guangxi) Pulp & Paper Co., Ltd

The total area of the construction: construct a raw material forest base of 160,000 hectares (2,400,000 mu) by 2011.

The distribution of the raw material base: construct a raw material forest base of 160000.0hm<sup>2</sup> (2,400,000 mu) at 8 national forestry farms belonged to the Guangxi Gaofeng Group and 15 county (city, prefecture) of 4 cities of Beihai, Fangchenggang, Yulin, Chongzuo, ect. in the south area of the Guangxi province.

The designed rotation: 6 to 7 years.

Outturn percentage: 6-year eucalyptus 82.86%, 7-year eucalyptus 83.99%, acacia 75%.



#### 5.1.2 Contents of construction

- (1) Tending and management of the existing forest;
- (2) Construct 123056.0hm<sup>2</sup> of raw material forest (including the forestation by the forestry company, commissioning forestation and purchasing the social forest stand) from 2006 to 2011; tree species are all eucalyptus; the construction contents include planting, tending, fertilization and management;
- (3) Construct and maintain the forest road. Construct 940.0km of forest road for support, and maintain 258.0km of the existing forest road in the forest land.

#### 5.1.3 The distribution layout and fulfillment of raw material forest bases

At present, the total area of the selected forest land in this project that is allocated to the small classes is 139,820.14hm<sup>2</sup>, accounting for 87.4% of the area (160,000hm<sup>2</sup>) of the planned raw material forest base, of which:

97342.3hm<sup>2</sup> of forest land is raised from 8 national forestry farms belonged to the Guangxi Gaofeng Group, accounting for 60.8% of the area of the planned raw material forest base. 2478.84hm<sup>2</sup> of forest land is requisitioned by means of renting from Fangchenggang, Yulin, Qinzhou and part of forestry farms, accounting for 1.5% of the area of the planned raw material forest base. 39999hm<sup>2</sup> of land is rented from Beihai

city, accounting for 25% of the area of the planned raw material forest base.

#### 5.1.4 Forestation scheme

##### 5.1.4.1 Selection of tree species

The primary tree species of the base forestation of this project is eucalyptus. The good species of eucalyptus are: fine clone of hybrid eucalyptus urophylla × E. grandis from Dongmen, fine clone of eucalyptus urophylla × E. grandis from Brazil, clone of hybrid eucalyptus urophylla × E. grandis from Dongmen, clone of hybrid eucalyptus urophylla × E. tereticornis from Dongmen, clone of hybrid eucalyptus urophylla × E. camaldulensis, fine species from the see orchard of eucalyptus urophulla clone of Dongmen Forestry Farm, fine species of eucalyptus urophulla seedling orchard from Dongmen Forestry Farm, seed from eucalyptus urophulla seed stand of Dongmen, No. 5 eucalyptus urophulla from Guanglin, No. 9 eucalyptus urophulla from Guanglin, No. 4 eucalyptus urophulla from Guanglin.

##### 5.1.4.2 Forestation technology

###### (1)Forestation technology

See the model of forestation technology in Table 5.1-3

**Table 5.1-3 Model of forestation technology**

| Tree species                   |                      | Eucalyptus (New plantation, tending)         |                                                                                                                 |
|--------------------------------|----------------------|----------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| Cultivation objectives         |                      | Pulp wood                                    |                                                                                                                 |
| Site index or site type        |                      | Middle level or above                        |                                                                                                                 |
| Tree seedling                  |                      | Source                                       | Nursery                                                                                                         |
|                                |                      | Seedling grade                               | Qualified cutting seedlings                                                                                     |
| Forestation measure            | Forest land cleaning | Cleaning mode                                | Manually chop and clean weeds in strips or blocks                                                               |
|                                | Soil preparation     | Gradient $\geq 16^{\circ}$                   | Manually dig holes; manually cultivate in strips, mechanically dig holes, specification of the hole: 50×50×50cm |
|                                |                      | Gradient is from $6^{\circ} \sim 15^{\circ}$ | Mechanical cultivate in strips, plough channel using ripper along contour of the forest land, depth 60~90cm     |
|                                |                      | Gradient is from $0^{\circ} \sim 5^{\circ}$  | Mechanical entirely cultivate, parallely plough to loosen, depth 30~50cm                                        |
| Application of base fertilizer | 250g/hole            | Eucalyptus specified fertilizer              | 100g/hole                                                                                                       |
|                                |                      | Calcium Magnesium and Phosphorfertilizer     | 150g/hole                                                                                                       |
| Initial planting density       |                      | Low hill and mesa terrace with gentle slope  | 1250 plants/hectare, row spacing 2x4m                                                                           |

|                          |                                          |                                                                                                                                                |                                                              |
|--------------------------|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
|                          |                                          | Mountain with larger slope                                                                                                                     | 1390~1667 plants/hectare<br>row spacing 4x1.8m, 4x1.5m, 3x2m |
| Additional fertilization | Eucalyptus specified compound fertilizer | First additional fertilization                                                                                                                 | 1~2 months after forestation, 300g/plant                     |
|                          |                                          | Second additional fertilization                                                                                                                | 7~8 months after forestation, 500g/plant                     |
|                          |                                          | 3 years after forestation, determine whether additional fertilization is needed according to the soil diagnosis and fertilization test results |                                                              |
|                          | Fertilization mode                       | Mainly adopt the channel fertilization, and part of area with mechanical fertilization                                                         |                                                              |
| Forest stand tending     | Controlling weed                         | Weed manually or using chemical herbicides                                                                                                     |                                                              |
|                          | Loosening soil                           | Loosen soil with expansion threshold and in strips once in the first year, strip width 1.2~1.5m                                                |                                                              |

## (2) Prevention and cure of diseases and pests

The diseases and pests endangering eucalyptus mainly include eucalyptus bacterial wilt, termite, cricket, *Buzura suppressaria* Guenee, and so on. The prevention of eucalyptus bacterial wilt is fulfilled mainly by breeding good species and clone with disease resistance. For termite and cricket, dig the root of the seedling in Silafluofen before the seedling is taken out of the nursery. The effect is good. Chafer can be trapped and killed with poison bait prepared with Trichlofon and stir-fried fire bran. In addition, eucalyptus is also easy to have physiological diseases, mainly due to lack of certain nutrient or microelement. Such diseases can be prevented and cured by fertilization and applying microelements.

### 5.1.4.3 Construction scheme of forestry roads

According to the current traffic status of the project forest land and the construction requirement of the raw material forest base, the part of new forestation will be planned as per 8m of forest road every hectare, and the planned constructing forest road is 940km. The forest road specification is: road surface width 2.0~3.0m; road base width 3.0~4.0m; the maximum vertical slope 13%; and the soil road surface will be improved. The forest road of existing forest part is sound basically. No new construction of forest road is planned, and only maintenance of the existing forest road will be carried out. Calculated according to 6m of forest road every hectare of forest land, 285km of forest road needs to be maintained.

## 5.2 Analysis of engineering of raw material forest bases

### 5.2.1 Analysis of rationality of selection of raw material forest bases

#### 5.2.1.1 Consistency with planning of the forest-paper integration industry

##### (1) Consistency analysis with *Fast-Growing and High-Yielding Timber Base Construction Program in Key Areas*

The plan advanced that the natural condition in Guangdong, Guangxi, Hainan and Fujian region is superior. The annual precipitation is more than 1000mm, and annual average temperature is more than 16°C. The natural conditions can meet the growth requirement of the fast-growing and high-yielding tree species. "The coastal hilly mesa terrace area is suitable for development of pulp raw material forest base with eucalyptus and acacia. The low mountain area is suitable for development of pulp or man-made cardboard raw material forest base with Chinese red pine, Caribbean pine, Pinuselliottii and base for valuable timber of large-diameter like Teak, Mahogany, and Chinese cherry."

The engineering construction scope table in the plan also lists 73 districts, counties and forestry farms that are suitable for development of fast-growing and high-yielding timber forest base in Guangxi. The construction site of raw material forest base in this project is located in 15 counties (cities, prefectures) in 4 cities of Beihai, Fangchenggang, Yulin and Chongzuo in Southern Guangxi and 8 national forestry farms belonging to Gaofeng Group. And the selected sites are basically located within the planned engineering construction scope. In terms of layout, the development of pulp raw material forest base with eucalyptus complies with the requirements of the fast-growing and high-yielding timber forest base construction project plan.

##### (2) Consistency analysis with *The National Special Plan of the Forest-paper Integration Project Construction in 'the Tenth Five-Year' and 2010*

In 2003, the National Development and Reform Commission issued *The National Special Plan of the Forest-paper Integration Project Construction in 'the Tenth Five-Year' and 2010*. The layout in the "Special Plan" focuses on the development of the southeast coastal areas, mainly including Guangdong, Guangxi, Hainan and Fujian. These areas have tropical and subtropical humid climate, with sufficient light and heat resources, and are areas with the largest rainfall and abundant water resources in our nation. The raw material forest base in this project is located in southern Guangxi, with typical tropical / subtropical climate and an annual average precipitation of 1500mm. The water resource is abundant and water environment capacity is large, thus the water and heat condition both comply with the requirements of development of the pulp integration project.

##### (3) Relation to the Guangxi forest-paper integration industry plan

On April 2002, the Planning Commission, the Finance Department, the Forestry Bureau of Guangxi Zhuangzu Autonomous Region issued *Circulation on the People's Government*

of Guangxi Zhuang Autonomous Region Approving and Forwarding Opinions of the Planning Commission, the Finance Department and Forestry Bureau of the Autonomous Region on Expediting Development of Fast-growing and High-yielding Forest in Our Region, and this Circulation determined that “the industrial raw material timber forest mainly with fast-growing eucalyptus, fast-growing acacia and good species of pine is developed in eastern and southern Guangxi”.

In 2004, Guangxi Development and Reform Commission issued *An Overall Plan for the Development of Forestry-pulp-paper Integration Industry of Guangxi from 2005 to 2015*. Scale of the raw material forest base of this project is within the scope of the *Plan*. The construction sites are basically located within the Beihai, Yulin, Fangchenggang and Chongzuo city, in conformity with the layout plan. And eucalyptus is selected as the tree species for the forest, in conformity with development of the fast-growing raw material forest.

(4) Consistency with the *Guangxi Development Plan of Fast-growing and High-yielding forest in ‘the Eleventh Five-year’ and 2020*

See the layout of four raw material forest bases planned in *Guangxi Development Plan of Fast-growing and High-yielding forest in ‘the Eleventh Five-Year’ and 2020* in table 5.2-1. According to this table, the prefectures and counties involved in the raw material forest bases of this project all are located within the scope of the planned coastal pulp raw material base, and comply with the planned layout requirements.

**Table 5.2-1 The construction layout scope list of *Guangxi Development Plan of Fast-growing and High-yielding forest in ‘the Eleventh Five-Year’ and 2020***

| No. | Base name                             | Layout scope                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Counties(prefectures, cities, forestry) | Construction focus                                                                                       |
|-----|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|----------------------------------------------------------------------------------------------------------|
| 1   | Coastal pulp raw material forest base | Qinnan, Qinbei, Pubei, Lingshan, Hepu, Tieshan Port, Yinhai, Gangkou, Fangcheng, Shangsi, Dongxin, Yuzhou, Fumian, Beiliu, Xingye, Bobai, Luchuan, Rong county, Gangnan, Gangbei, Tantang, Guiping, Pingnan, Long'an, Mashan, Bingyang, Shanglin, Heng county, Wuming, Yining, Liangqin, Jiangnan, Xingning, Xixiangtang, Qingxiu, Jiangzhou, Ningming, Fusui and Qinlian Forestry Farm, Liuwan forestry farm, Bobai Forestry Farm, Dongmen Forestry Farm, Paiyangshan Forestry Farm, Qipo forestry farm, Gaofeng Forestry Farm, Nanning Liangfengjiang Forestry Park | 46                                      | Focus on development of the short-circulation-period pulp raw material forest with eucalyptus and acacia |

| No | Base name                                                                                             | Layout scope                                                                                                                                                                                                                                                                                       | Counties(prefectures, cities, forestry) | Construction focus                                                                                                                                                                                                                                                                                                                                                                                                        |
|----|-------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2  | Cardboard and pulp industry raw material forest base in eastern Guangxi                               | Cenxi, Teng county, Cangwu, Mengshan, Babu, Zhaoping, Zhongshan, Fuchuan, Lipu, Pingling, Gongcheng, Yangsu and Daguishan Forestry Farm                                                                                                                                                            | 13                                      | Focus on development of the short-circulation-period man-made board and pulp raw material forest with <i>Castanopsis fissa</i> , Chinese red pine, eucalyptus, and give consideration to construct the large-diameter timber forest with Chinese red pine and <i>Castanopsis hickelii</i>                                                                                                                                 |
| 3  | Large-diameter timber forest and cardboard, pulp industry raw material forest base in western Guangxi | Zuojiang, Jinxi, Debao, Napo, Pingguo, Tiandong, Tianyang, Tinglin, Lingyun, Leye, Longlin, Xilin, Dahua, Du'an, Bama, Donglan, Fengshan, Yizhou, Hechi, Nandan, Tian'e, Tiandeng, Daxin, Longzhou, Pinxiang and Yachang Forestry Farm                                                             | 26                                      | Focus on development of the large-diameter timber forest with Chinese red pine, Chinese fir, West-south birch, <i>Zenia insignis</i> , Chinese mahogany, and give consideration to construct the short-circulation-period industry raw material forest with Chinese red pine, eucalyptus, clumping bamboo.                                                                                                                |
| 4  | Wood and bamboo pulp industry raw material forest base in northern and central Guangxi                | Yongfu, Lingui, Yanshan, Lingchuan, Guanyang, Xing'an, Quanzhou, Longsheng, Ziyuan, Rongshui, Rong'an, Sanjiang, Liujiang, Liucheng, Luzhai, Luocheng, Huanjiang, Xingbing, Heshan, Yicheng, Wuxuan, Xiangzhou, Jinxiu and Weidu Forestry Farm, Huangmian Forestry Farm, Sanmenjiang Forestry Farm | 26                                      | Focus on development of pulp industry raw material forest with clumping bamboo (hybrid bamboo, <i>D. minor</i> (McClure) Chia et H.L.Fung, <i>Bambusa pervariabilis</i> McClure, etc.), giant hairy sheath edible bamboo, Chinese red pine, Eucalyptus, and give consideration to breed large-diameter timber forest with pine, West-south birch, <i>Schima</i> , sweetgum, <i>Zenia insignis</i> , and Chinese mahogany. |

Note: the counties with underline in the table are the prefectures and counties involved in raw material forest bases of this project.

#### (5) Coordination with *Outline of Ecological Guangxi Construction Plan*

The raw material forest bases in this project include four cities of Yulin, Beihai, Fangcheng Port and Chongzuo as well as eight Gaofeng forestry farms. These cities are respectively located in the hilly ecological region of East South Guangxi, hilly mesa ecological region of South Guangxi and karst hill ecological region of South Guangxi in *Outline of Ecological Guangxi Construction Plan*.

Yulin and Liuwang Forestry Farm as well as Bobai Forestry Farm involved in the raw material forest bases of this project belong to the hilly ecological region of East South Guangxi. Creating the eucalyptus man-made forest within the existing man-made woodland, complies with the direction of focus on development of this ecological region –

“compound farming, forestry and animal husbandry”. The selection of woodland avoids natural forests and important ecological function protective region and the forestation measures adopted by this project produce little water and fertilizer loss impact, so it will not worsen the ecological problems in this ecological region, complying with the ecological protection and construction focus in this region.

Beihai, Fangchenggang, Gaofeng Forestry Farm, Liangfengshan Forestry Farm, Qipo Forestry Farm and Qinlian Forestry Farm involved in the raw material forest bases of this project belong to the hilly mesa ecological region of South Guangxi, complying with the direction of focus on development of “fast-growing and high-yielding forest” in this ecological region. The selected woodland involves no ecological forests such as the natural conservation and protective forest, avoids the highlighted regions of water and soil loss, and is compatible the ecological conservation and construction focus of this region. The area rate of man-made pure forest in this region is larger, which is a ubiquitous problem in this region, and there is a historical reason. In 1950's and 1960's, in order to construct the wind-breaking and sand-fixation forest in this region, other tree species also have been planted, but all can not survive or the growth condition is worse. Later the eucalyptus man-made forest is introduced, and the growth condition of eucalyptus is well under conditions of taking forestation management measures such as fertilizer. This project only reconstructs the existing man-made forest, thus can not worsen the problems of large man-made pure forest in this ecological region.

Chongzuo and Dongmen Forestry Farm involved in the raw material forest bases of this project are located in the karst hill ecological region of West Southern Guangxi, which fall into the direction of focus on development of “fast-growing and high-yielding forest” in this region. The environment evaluation has suggested eliminating the partial woodland that exists inlaid with White-Head Langur Nature reserve and the partial woodland within the scope of 1km from the conservation boundary and at both sides of rivers, and no rocky desert area is involved. The ecological conservation and construction focus of “protecting natural ecological system and important species habitat” in this region is met. Whistle the eucalyptus is tree species that has been introduced to Guangxi region for many years, there exists the influence of alien species invasion.

Generally, construction of the raw material forest bases of this project complies with the requirements of the Outline. The adopted appropriate forestation measures will not worsen the main ecological environment problems confronted by the ecology.

#### **5.2.1.2 The relative relation to peripheral existing pulp raw material forest bases**

At present, the existing pulp raw material forest bases surrounding this project are mainly the forestry-pulp-paper integration project of “Sino-foreign joint Jingui Pulp & Paper Co. Ltd.”

*According to Several Suggestions about Expediting Construction of Pulp and Paper Raw*

*Material Forest Bases in Coastal Regions Issued by the People's Government of Guangxi Zhuang Autonomous Region*, "in order to orderly develop the woodland resource, according to the layout of two pulp and paper factories, 38 counties (cities, prefectures) of Beihai, Qinzhou, Fangchenggang, Yulin, Guigang, Nanning and Chongzuo are divided into two project regions of Qinzhou and Beihai, respectively corresponding to the two pulp and paper factories of Qinzhou and Beihai. " The suggestion delimits the scope of the location of the raw material forest bases of this project, and provides the optional woodland, without land contest problem with other corporations.

### **5.2.1.3 Analysis of rationality of the woodland selection**

According to the subcompartment information of woodlands, woodlands are filtered in term of the following environment protection requirements:

- (1) In conformity with the requirements of timber stands of the commercial woodland
- (2) The gradient of the woodland is less than 35 °
- (3) More than 1km far away from the ecological sensitive objects such as natural conservation.

The filtering results of the irrational woodland are as follows:

The areas of the selected woodland whose properties does not comply with timber stands of the commercial woodland are 4396hm<sup>2</sup>, distributed over the Yinhai and Hepu county of Beihai city. The areas of the selected woodland whose gradient is more than 35 ° are 195.7hm<sup>2</sup>, distributed over Hepu county. The areas of the selected woodland which is close to or beset the nature reserves are 2860hm<sup>2</sup>, distributed over Bobai County, Dongmen Forestry Farm, Gaofeng Forestry Farm and Paiyangshan Forestry Farm. The areas of the selected woodland which can not meet the requirements of environmental protection are 7452hm<sup>2</sup>. In the fulfilled woodland, the areas of the woodland which comply with the requirements are 132,400 hm<sup>2</sup>, accounting for 82.7% of the planned forestation areas.

## **5.2.2 Analysis of balance of supply and demand in raw material wood for the pulp and paper factory**

### **5.2.2.1 Demand for the raw material wood of pulp and paper factory**

Annual production capacity of the pulp and paper factory constructed to support this project is 900,000 ton chemical pulp. It is intended to put into production from 2009. The production load of 2009 is 80%, and it will reach the production target in 2010. According to the requirements of production technology of the pulp and paper factory, eucalyptus wood is adopted as the raw material wood (a small amount of acacia wood is used in the year of putting into production), Each ton of chemical pulp needs 4.01546m<sup>3</sup> of eucalyptus / acacia wood (with bark, in which the bark rate is 6%, converted into net weight is



3.77453m<sup>3</sup>). Upon calculation, the pulp and paper factory needs 2,717,700m<sup>3</sup> of raw material wood in 2009 (without bark, the below is the same), and needs 3,397,100m<sup>3</sup> of raw material wood every year after 2010.

#### **5.2.2.2 Analysis of balance of wood supply and demand**

In *The Guangxi Development Plan of Fast-growing and High-yielding Forest in 'the Eleventh Five-Year' and 2020*, it is planned to layout and construct four bases of coastal forestry-pulp-paper raw material forest base, forestry-cardboard and forestry-pulp-paper industrial raw material forest base in Eastern Guangxi, large-diameter timber forest and forestry-cardboard and forestry-pulp-paper industrial raw material forest base in Western Guangxi, wood and bamboo pulp industrial raw material forest base in Northern and Central Guangxi, defines the layout scope, tree species of plantation and supply industry type of various fast-growing and high-yielding forest bases. This project falls into the category of the coastal forestry-pulp-paper raw material forest base. The selection of woodland complies with the planned site selection requirements, and has no competitive relation to other cardboard and woodland processing industry in the project region.

Upon calculation, the pulp and paper factory needs 2717700m<sup>3</sup> of raw material wood in 2009, and 3397100m<sup>3</sup> of raw material wood every year after 2011. The wood production of raw material forest base every year will exceed the demand of the raw material wood of the pulp and paper factory, and the social wood supply is not need from the project region. Thus, under conditions that the raw material forest base reaches the designed growth quantity and outturn percentage, annual wood production can meet the requirement of raw material wood by annual production of 900,000ton chemical pulp.

#### **5.2.2.3 Wood consumption of other corporations in project region**

According to the investigation results of "Analysis of Industry Structure and Wood Demand of Wood Processing Industry in Guangxi (2005)" developed by the National Forest Research Center, there are 119 wood processing corporations in the project region. The annual total production capacity is: wood-based panels and panels & square lumber 1,018,300m<sup>3</sup>, paper & pulp and chip production 437,000ton. The total consumption of annual wooden materials is: commercial timber 1,419,800m<sup>3</sup>, remainder and fuel wood in cutting area 971,400ton. In the consumed commercial timber, eucalyptus wood is 768,800m<sup>3</sup> (including: the chip produced from eucalyptus wood 560,200m<sup>3</sup>), accounting for 54.1%; other wood is 651,000m<sup>3</sup>, accounting for 45.9%.

### **5.2.3 Analysis of matching between raw material forest base scale and pulp factory scale**

#### **5.2.3.1 Analysis of rationality of the project designed wood growth quantities**

According to the investigation of the growth quantities in the current eucalyptus sample

land, taking consideration of the forest operation and management measures of Stora Enso Company, the project designed wood growth quantity is ---- in *Application Report*.

Investigation, summary and statistics of the growth quantities of sample land of social forest and national forestry farm in the project region is carried out. In the investigated sample land, the annual accumulated growth quantities of eucalyptus forest are more than -----.

In the operation of raw material forest base, Guangxi Stora Enso Forestry Co. Ltd. Worked out a series of forestation and safeguard measures to improve the wood growth quantities of the raw material forest base. For the temporary lack of wood material supply, the company formulates a set of integrated system to purchase, supervise and manage the social wood, and only to purchase wood passing the national forest certification, actively preventing the indiscriminate felling of trees caused by purchasing social wood.

### **5.2.3.2 Analysis of matching between raw material forest base scale and pulp factory**

Calculated according to the production scale of the pulp and paper factory, after reaching the production target, annually needed raw material wood is  $3,397,100\text{m}^3$ .  $4,529,500\text{m}^3$  of stumpage accumulation is needed, calculated according to 75% of outturn percentage.

-----.

Thus, the planned  $160,000\text{hm}^2$  raw material forest bases can primarily meet the requirements of wood material of the 900000ton pulp and paper factory. The planned scale of the raw material forest bases and the pulp and paper factories are matched.

## **5.3 Status quo evaluation of the environment**

### **5.3.1 Land utilization**

The status quo evaluation of land utilization adopts the data of spatial resolution 30m multispectral image and 15m full-color image taken by American ETM satellite in 1999 – 2000. The statistical results by interpreting and analyzing the data are: there are 15 prefectures and counties in the project region and 10 prefectures and counties are involved in the subordinated 8 forestry farms of Gaofeng Group. The total land areas of these region is  $55,024.89\text{km}^2$ , including woodland  $31,554.46\text{km}^2$ , accounting for 57.3% of the total land areas; lawn  $2982.40\text{km}^2$ , accounting for 5.4% of the total land areas;

farmland 16,763.63km<sup>2</sup>, accounting for 30.5% of the total land areas; land for urban and rural housing as well as land for industrial and mining use 1,930.78km<sup>2</sup>, accounting for 3.5% of the total land areas; waters area 1,696.24km<sup>2</sup>, accounting for 3.08%.

### 5.3.2 Soil erosion and land degeneration

The type of soil erosion in the project region mainly is light-degree erosion, subsequent with medium-degree erosion, severe erosion, strong-intensity erosion and extreme-intensity erosion, respectively accounting for 2.87%, 1.80%, 0.44%, 0.34%, 0.63% of the total area (27,451.71km<sup>2</sup>) of the project region. Most of the land does not generate soil erosion effect, and in the land where soil erosion occurs, the land with light-degree erosion accounts for approximately half of the areas. The areas where severe erosion occurs are mainly distributed over the coastal part of southern Beihai, and are mainly, affected by typhoon, formed under the joint effect of the wind power and water power. The areas with extreme-intensity erosion mainly are distributed over Xingye County of Yulin City. The soil erosion modulus in the project region is 3,553.9t/km<sup>2</sup>·a, and the annual average soil erosion amount is 5,925,300t/a.

### 5.3.3 Land ecology

The forestry area of the Autonomous Region is 13,662,200hm<sup>2</sup>, accounting for 57.7% of the total land area of Guangxi, and the animal and plant resource is abundant. The project regions mainly are the hilly and mountain season rain forest region in East-southern of Guangxi, rocky season rain forest region in West-southern of Guangxi and rocky evergreen and deciduous broad-leaf mixed forest region in Central Guangxi. Because of the long-term human activities, the natural proterozoic vegetation has disappeared, mainly evolved into tropic season rain forest and season rain evergreen and broad-leaf forest or substituted by the man-made forest. Only a small piece of valley rain forest survives in small environment of partial valley.

The main ecological sensitive region in the project region includes the nature reserves and key prevention area of water and soil loss, and the nature reserve mainly is wildlife reserve, forest ecological system reserve, geologic vestiges reserve, ocean and ocean ecological system reserve, the key protective species are White Head Langur, Golden Camellias, etc.

### 5.3.4 Landscape ecology

The landscape type in the evaluation scope mainly is forestry landscape, subsequent with farming landscape. The total summation of three kinds of environment resource section of forest, bush and shrub is the model land of the evaluation region, where the forest is high- and sub-stable element with strongest control capacity on the ecological environment

quality in the environment resource blocks.

### 5.3.5 Woodland resource

The area of forestry land in the project region is 1,479,300  $\text{hm}^2$ , including woodland 1,159,800 $\text{hm}^2$ , accounting for 78.4%. Categorized by the usage of the woodland, the total area of commercial forest is 53,800 $\text{hm}^2$ , accounting for 64.5%. The woodland area of commercial forest, whose height is above 500m, slope is less than 30°, stumpage quality is medium or above, and is suitable for the development of fast-growing and high-yielding eucalyptus forest, is 664,960.5  $\text{hm}^2$  (the area of suitable forest, not including economical forest, bamboo grove, rocky shrub, not fully grown forestation land, natural updating forest and nursery, is 500,338.4 $\text{hm}^2$ ).

## 5.4 Analysis of impact on biological diversity and ecological sensitive objects

### 5.4.1 Analysis of impact on species diversity

Guangxi has started planting eucalyptus since 1956, with 50 plus year of introduction history. In 1980's, by co-operation with Australia, good species of eucalyptus were cultivated for Huangxi and the surrounding region. There are 600,000  $\text{hm}^2$  of artificial eucalyptus forests in Guangxi until the end of 2006.

The project intends to develop industry raw material forests within the scope of man-made forests. The types of existing woodland are man-made forest or mixed forest of eucalyptus, pine, acacia, and partial stocked land, shrubbery, cutting blank, burn blank, etc. The height of these woodlands is lower, the slope is gradual and the human interference is strong. The primitive and secondary natural forest is primarily disappeared.

In term of the uniformity of the species distribution, the project construction will increase 129,200 $\text{hm}^2$  of man-made eucalyptus forest, the increased area of man-made eucalyptus forest accounts for 13.5% of the total stumpage area of the commercial forest in the project region. After the implementation of the project, the planting rate of the coniferous forest will be reduced from 33.5% to 23.5%, and the man-made eucalyptus forest will increase from 10.1% to 18.9%. The uniformity of the species distribution of the commercial forest in south Guangxi will be affected by the increased 160,000  $\text{hm}^2$  man-made eucalyptus forest, and the species distribution will be simplified.

The area of increased man-made eucalyptus forest is large, so the simplification effect will occur in partial species distribution. The eucalyptus adopted in this project are species that have been introduced for several years, and the eucalyptus planting area is centralized in the man-made forest, so the project construction will not have adverse impacts on the species diversity in the region as long as the primitive and secondary natural forest is not damaged in the region.

## **5.4.2 Relation between the raw material forest base and the ecological forest and the public welfare forest**

### **5.4.2.1 Relation between raw material forest bases and ecological protective forest and the public welfare forest**

The raw material forest bases constructed in this project belongs to the fast-growing and high-yielding pulp-made and paper-made timber stands of the commercial forest. Analyzed according to the current fulfilled woodland subcompartment information, the selected raw material forest base is primarily distributed in the commercial forest region. Only few woodlands selected in Beihai is not in the scope of the commercial forest.

There is inlaid relation between the selected woodland in the project and the ecological protective forest and public welfare forest, but the condition of occupying the public welfare forest and ecological forest to develop pulp raw material forest does not exist.

### **5.4.2.2 Analysis of impact on nature reserves and forestry parks by the construction of raw material forest bases**

There is 15 state level and autonomous region level nature reserves, 7 state level and autonomous region level forestry parks and many scenic areas, distributed over the administrative area of the 15 counties and 8 national forestry farms involved in the construction of the raw material forest bases.

The distances between the selected woodlands and the 12 nature reserves are more than 2km, so the construction of the raw material forest base will not affect these nature reserves.

The distances between the selected woodlands and Nalin Nature reserves, Longshan Nature reserves, Daqingshan Nature reserves are less than 1km, and partial woodlands are at the edge of nature reserves or are close to the boundary of nature reserves. The environment evaluation holds that the man-made eucalyptus forest with short-term rotation is not suitable for planting within the range of 1km from the boundary of nature reserves, and between the selected woodland in the project and the nature reserves there should be an isolation belt with at least width of 1km. So the environment evaluation requires removing the aforesaid woodlands from the selected woodlands, which is 948.5hm<sup>2</sup>.

Some of the selected woodlands in the project beset Chongzuo and White Headed Langur Nature reserve, and some of the selected woodlands are located within the range of 1km from the boundary of these nature reserves. So the environment evaluation requires removing 2000hm<sup>2</sup> of subcompartment.

In the selection of raw material forest bases, after removing the woodland within 1km range of the reserves and with existing inlaid distribution, the project construction will not

generate adverse effect on the region ecological sensitive objects.

### 5.4.3 Impact on environment of forest type structure change

#### (1) Forest category structure change

After the implementation of the project, there will be an increase of 129,200 hm<sup>2</sup> of man-made eucalyptus forest. Most of these forests are from low-yielding coniferous forests and coniferous and broad-leaf mixed forests, and some are from the broad-leaf forest, wasteland, shrub bushes, clear cut area and burned area and so on. By then, the area of the eucalyptus forests in the commercial woodland of the project region will reach 278,100 hm<sup>2</sup>, accounting for 29.2%, an increase of 13.59% to the status quo. The area of coniferous forest (Chinese red pine, *Pinus yunnanensis*, foreign pine and fir, etc.) in the commercial woodland will be reduced from 48.76% to about 43.4%.

#### (2) Impacts on ecological environment by the forest category change

After the implementation of this project, forestation management of the woodland will be greatly intensified, especially by Stora Enso. The company has experience of the man-made eucalyptus forest operation in Brazil, which is a plantation-style management model. In this operation mode, the operation objective is to increase the maximum outturn capacity of the land, while the forest ecological function is weakened. Therefore, after the implementation of the project, the ecological functions of the selected forest will be reduced.

The project will adopt the woodland operation model of high-input and high-yield of the commercial forest, which is in line with the national differentiated forest management requirements.

#### (3) The pure and mixed forest problem after the forest category change

However, selected woodlands of this project are close to the neighboring social woodlands. The good management model of the project raw material forest bases will inevitably have demonstration and driving effect on the man-made eucalyptus forest planting in Guangxi, and the surrounding social woodlands will inevitably follow to plant eucalyptus. In this case, large area of pure forest may possibly occur. The Forestry Department shall keep it under control through the rational layout of tree species of commercial forests, and adjusting and controlling logging quota.

70% of the woodland in this project came from national forestry farms. In order to avoid large area of pure forest, first of all, native trees shall be planted between the selected woodlands of the project in national forestry farms and the peripheral national forestry farms. National forestry farms, as part of the joint-venture forestry company of this project, has the obligation to properly plant native conifers or other broad-leaf trees around the selected woodlands, in order to achieve mixing of forest.

#### 5.4.4 Impacts on the understory vegetation by the project construction

(1) For the woodland whose current tree species is eucalyptus, the project construction will not change the dominant species characteristics of its understory vegetation, but in order to improve the growth rate of eucalyptus during the project construction, forestation management measures will be enhanced to remove weeds using herbicides, manual weeding, so the abundance of the understory vegetation will be affected to a certain degree during the tending period after the young plantation.

(2) For the woodland whose current tree species is coniferous or other species, the original understory vegetation will decrease significantly in the process of harvesting and regeneration, forest land cleaning, soil preparation. In the process of forest management, the planted tree species are changed, so the dominant species characteristics of understory vegetation may be changed. After 2 ~ 3 years, the similar understory vegetation characteristics to the existing eucalyptus forest will be gradually formed.

(3) For the woodland whose current woodland type is shrub forest, scattered forest, its diversity of vegetation is abundant, and the vegetation component is mainly the shrubs and herbaceous vegetation. After the implementation of the project, the ecosystems of man-made eucalyptus forest will form, and the understory vegetation abundance will decrease compared to the original. But the area of this part of forest is less. It is only a small part of the raw material forest base.

(4) For the woodland of cutting or burned blank, the current ground vegetation has been damaged. It will be gradually restored after a period of time, and after creating the man-made eucalyptus forest, due to enhanced management, the understory vegetation recovery will be slowed, the restored vegetation diversity is less than the woodland where no man-made forest is created.

Generally speaking, after the implementation of the raw material forest base project, the understory vegetation diversity of the woodland will decrease, but because the current project area are mostly man-made forest, the understory vegetation is not very abundant, and the diversity difference of the vegetation between man-made forests with different tree species is not obvious, in the forestation of raw material forest base of eucalyptus, the impacts on the understory vegetation of the project region is greater after harvesting until two years before forestation, reasonable forest management measures should be taken to reduce their impact. The impacts on the understory vegetation are acceptable in the third ~ sixth year.

#### 5.4.5 Impact on wild animals

##### 5.4.5.1 Impact on wild animals in the woodland

The selected woodlands of the raw material forest bases are mainly distributed over areas

with an altitude of below 500m, with frequent human activities, involving no the local natural forests or secondary forests. Forestation management activities in general do not contribute to the disturbance of wild animals, nor to change the wildlife habitat and migration corridors. Forest roads with a width of 3.5m have little or no effect on the activities of wild animals.

However, in the forest harvesting and forestation period, the strong interference will be generated to the wild animals whose habitat is man-made forest, and some animals have to be evacuated, migrated, and the logging activities is likely to cut off the animal's dispersal and migration routes.

#### 5.4.5.2 Impact on the wild animal under enhanced protection

In terms of the selection of location of the raw material forest base for this project, after the removal of the woodland within 1km away from protection areas and the woodland of mosaic distribution (i.e., to avoid the karst hills and mountain areas, mainly the few woodland of Dongmen Forestry Farm are located in the plain area of Karst region), the region that is suitable for the white-head langur's activities, is not in the region of raw material forest base, so no direct impact will be generated on the living space of the white-head langur.

The national first-grade protection animals such as Chinese leopard, clouded leopard, Sika deer, forest musk deer, pythons and so on in the project region, are distributed in high-altitude mountain areas. Their suitable habitat is a complex ecosystem. Nature reserves have been established in the project region which can provide the living environment. The woodlands of this project are in low hill areas with frequent human activities. At present in these areas very few large wild animals appear. At the same time, in choosing woodlands, while the protection areas are avoided, so it will not generate the direct impact on the living space of wild animals under enhanced protection.

### 5.5 Analysis of impact on soil fertility

#### 5.5.1 Analysis of impact on soil quality

In the forest management of the project, according to the analysis results of the soil nutrient and requirement of nutrient by eucalyptus, a scientific formula fertilization is carried out. Nutrients can be completely absorbed by the eucalyptus after fertilization, so the forest fertilization will not produce the salinity problems, but there is still soil compaction. Other reasonable forest management measures (such as scarification) should be adopted for improvement.

The pesticides will inevitably enter into the soil, and reacts with the solid, gas, liquid substances in the soil to change the chemical composition of the soil. The pesticides with



higher toxicity may even kill some insects and microorganism in the soil, and inhibit the activity of the soil-converting enzyme, thereby affecting the transformation of soil nutrients. A reasonable application of pesticides, using pesticides of low-toxicity and high- efficiency, can decrease this impact.

### **5.5.2 Impact on soil fertility of forest**

The operation model adopted by the man-made forest is intensive operation. In the artificial pure forests, due to that absorption characteristics of trees is consistent, the structure of the necessary nutrients is the same, and some nutrients in the soil pool are consumed extremely, the soil fertility recession and the productivity declining occur in most of eucalyptus, pine, fir, Yang, etc. man-made forest.

The domestic and foreign forest location experiment results show that, for the tree's nutrients absorbed from the soil, a significant portion will retribute to the soil in the form of litter fall. In the environment without any human interference, forest ecosystems can achieve self-sufficiency of nutrients through their own material cycle.

In the implementation of the project, the eucalyptus logging residues and litter fall can be left in the forest, the eucalyptus forest biological cycle of basic nutrient elements will not be disrupted, the soil nutrients can basically be maintained at a low equilibrium level, then the consumption of soil fertility is smaller than that under the full-tree utilization model of current eucalyptus forest operation.

After changing the forest planting species, if effective measures are not taken, the soil fertility decreasing will occur.

## **5.6 Analysis of impact of soil erosion**

### **5.6.1 Analysis of impact on soil erosion**

#### **5.6.1.1 Impact trend of the water and soil loss caused by the implementation of the project**

Analysis shows that, after the coniferous forest is converted into the eucalyptus forest, with the canopy density, understory vegetation, forest litter coverage and other factors affected by the different operation and management of woodland, the situation is different. But the rotation of the man-made eucalyptus forest is short, so the disturbance to the surface is significantly higher than coniferous forest. The resulting soil erosion will increase significantly.

### 5.6.1.2 Analysis of water and soil loss caused by the forest management mode of this project

#### (1) Woodland cleaning and soil preparation

Many studies have shown that the burn clearance (or complete clearance) and soil preparation before forestation, are the main reasons leading to water and soil loss.

According to the company's forest management regulations, the project will only clean the woodland with more than 70% coverage of weeds, shrubs and eucalyptus bud in the woodland, and reserves the shrub-grass under 15cm in the lower of the forest after cleaning. This ground clearance keeps certain coverage, and can reduce the impact of the water and soil loss in the forest cleaning.

However, in the operation procedures, the burning is allowed if necessary. The ground vegetation in the forest will be burned after burning, the bared surface is easy to form water and soil loss, the soil preparation of burning will significantly increase the water and soil loss of the forest. So the environment evaluation requires canceling the burning regulation, and suggests adopting manual cleaning program to clean the forest hard to clean: using the brush cutter or other tools to remove the shrubs and weeds with bandwidth of 1.5 to 2m along the contour and planting raw.

There are 1~1.5 months from soil preparation to planting seedlings. If the bared surface after soil preparation encounters the heavy rain during this period. The water and soil loss phenomenon possibly take place. In the soil preparation procedures, for the different woodland slope, setting the drain, retaining walls and other measures are taken to try to retain the surface runoff, and reduce the water and soil loss.

#### (3) Tending in sapling stage

The company generally adopts the spraying herbicides method to weed in the young forest. Select Spring and Summer season of vigorous shrub growing to apply herbicides, after the application of the herbicides, the shrub under the forest will gradually be withered, which reduces the biological diversity under the forest, but the withered shrub will remain in the lower of the forest, and will not be cleared. The water and soil loss will not increase under the condition of leaving over the lower of forest.

When the levee expansion and scarification is carried out in the young forest, there are local disturbances on the surface. However, small amount of water and soil loss caused by hole expansion and scarification can be retained when there are some covering remains.

#### (4) Cutting

The cutting of the project woodland will follow the National *Management Rules on Forest Tree Cutting and Regeneration*

The technical requirements of cutting: when the gradient is less than  $5^{\circ}$ , the area of once clear-cutting reconstruction is not more than  $10\text{hm}^2$ . When the gradient is within  $6\sim 15^{\circ}$ , not more than  $5\text{hm}^2$ ; when the gradient is within  $16\sim 25^{\circ}$ , not more than  $3\text{hm}^2$ ; the mountain with slope of more than  $25^{\circ}$  adopts the strip clear-cutting reconstruction.

In the cutting process, in order to prevent the soil damage of the woodland caused by the vehicle rolling, in trimming branches and transportation process, the original leafy forest is turned into the bared surface. Meanwhile the large number of human activities increases surface soil disturbance, particularly to the timber logging road. The mechanical logging will destroy surface vegetation, leading to the soil compaction, and form a new cycle severe water and soil loss phase.

#### 5.6.1.3 Analysis of intensity of water and soil loss in forest management process

98% of the selected raw material forest bases are in slight and light erosion region, and only 2% of the regions belong to medium erosion. Generally, under the current forest management mode, the water and soil loss of the current eucalyptus forest is larger from the felling to the first year of forestation, and it will be reduced in the second year. The water and soil loss of the coniferous regenerated woodland will increase in the long run, but these effects generally will not upgrade the original soil erosion modulus.

Generally, the water and soil loss can be controlled in the current erosion level of the woodland, and will not further increase the grade of the soil erosion modulus.

### 5.6.2 Analysis of impact on land degeneration

#### 5.6.2.1 Analysis of impact on rocky desertification

Analyzed according to the Guangxi rocky desertification distribution and geomorphic maps, the rocky desertification phenomenon of Jiangzhou Prefecture of Chongzuo City and Fusui County in the project region mainly occurs in the karst high hilly and the karst geomorphologic type with middle ups and downs and low mountains.

In Jiangzhou Prefecture of Chongzuo City and Fusui County, the project selects  $5000\text{hm}^2$  of woodland, coupled with the selected  $10666\text{hm}^2$  of woodland in Dongmen Forestry Farm. The total selected woodland is  $15666\text{hm}^2$ . According to the overlay analysis of the raw material forest distribution map with the rocky desertification distribution maps and topography and landforms distribution map, the selected woodland in Chongzuo city avoids the rocky desertification area, and also tries to avoid the desertification-prone region such as the hilly and mountain area in the karst lava region.

#### 5.6.2.2 Analysis of impact on sandy land

A part of the woodlands selected in Beihai is sandy land. According to the forest management experience on sandy land of Beihai City, eucalyptus has a strong

adaptability. At present, there are successful experiences of planting eucalyptus on sandy land. The survey shows that better results are achieved when planting man-made eucalyptus forest on the sandy land in Shankou Forestry Farm of Beihai.

Therefore, under the reasonable operation and management, planting eucalyptus on sandy land can meet the requirements of fast-growing and high-yielding in the aspect of growth quantities.

## **5.7 Impact on the water conservation areas**

### **5.7.1 Analysis of impact on water resource by eucalyptus**

The woodlands selected in this project are located in southern Guangxi, and its climate is similar to Leizhou. On the analogy of the water consumption of eucalyptus in Leizhou Peninsula, it is determined that the annual transpiration of the man-made eucalyptus forest in this project is about 500mm, the crown cover interception of the man-made eucalyptus forest is about 150 to 200mm, and the annual interception and transpiration of the lower vegetation is about 30 to 100mm. The change range of soil evaporation is large, mainly related to the soil characteristic, the water validity of soil and surface soil cover, which is about 200 to 400mm annually. Thus, the total transpiration of man-made eucalyptus forest in the project region is about 880 to 1200mm/a.

As for each affiliated project city of the raw material forest of this project, the annual rainfall of Beihai is 1700mm/a, Fangchenggang is 2000mm/a, Yulin is 1600mm/a, and Nanning is 1500mm/a. The impact on the water balance of the drainage area by the man-made eucalyptus forest shall be less.

However, the annual rainfall of Chongzuo is about 1250mm, and the range of change is large. The evaporation of the man-made eucalyptus forest in the year with little rain is likely approaching the rainfall, so certain impact on the water balance of the drainage area can possibly occur in the year with less rain.

Moreover, the root of eucalyptus is distributed at very shallow location, and it can not absorb the underground water at all, so the underground water level will not be reduced.

### **5.7.2 Analysis of impact on water quality**

The investigation report of *Monitoring and Research of the Impact on the Main Environment Factors by the Man-made Eucalyptus and Acacia Forest with Short-term Outturn Circulation*, written by Professor Wen Yuanguang, Forestry College, Guangxi University, shows that: for the man-made eucalyptus forest, the annual average ground through-flow is 45.03 t/hm<sup>2</sup>, the annual average sediment loss amount is 0.29 t/hm<sup>2</sup>, the fertilizer loss of the water and soil is 0.039 kg/hm<sup>2</sup>, and the loss in the year of forestation

accounts for the greater proportion. The data shows that the soil fertilizer loss in the woodland is small, which have slight impact on the environment.

### **5.7.3 Impact on the self-restraint of water resource in the project region**

The nature reserve with water resource self-restraint function in the project scope is Shiwandashan, West Damingshan, and Nalin Nature reserve. The woodland selected by the project is far away from the majority nature reserves with water resource self-restraint function, with only one neighboring Shanglin Longshan Nature reserve, and the distance can be kept more than 500m away also. Moreover, the woodland with water resource self-restraint function in the project region includes the shelter forest on both sides of rivers. The selection of the raw material forest in this project have avoided the woodland within the range of 200m away from both sides of rivers, so the project implementation can not affect the water resource in the project region.

### **5.7.4 Analysis of impact on the drinking water within the forest base scope and the peripheral area**

The raw material forest base selected by the project is far away from the majority of water resource protection areas, with a distance of more than 2km.

However, within the range of Beihai region there is the condition that the selected raw material forest bases are relatively close to the water resource protection area, involving four lakes and reservoir type of water resource protection areas and one deeply exploited underground water resource protection area.

Of which, Longtan Village is the water source site of deeply exploited underground water. The protection area is established at 50m radius outside the well mouth, and no quasi-protection area is established. This project has 85.9 hm<sup>2</sup> of raw material forest in Longtan Village. The selected woodland is not in the scope of the water source protection area, and the water source is deeply exploited well. The possible affected region with the general non-point source loss is the shallow underground water, so the adverse impact on the water source will not occur.

The involved four reservoir water sources in the selected raw material forest bases in the project are water source of Hepu Reservoir in Beihai, water source of Niuweiling Reservoir in Beihai, water source of Qingshuijiang Reservoir in Beihai and water source of Hongchaojiang Reservoir in Hepu County. In terms of the woodland distribution, the selected woodlands are all not in the scope of the protection area of water source, but within the scope of quasi-protection area.

According to the requirements of *Regulations for Prevention and Management of Pollution in Protection Zone of Drinking Water Source*, in the first-grade protection area of drinking

water source, “new construction, enlargement construction and construction projects with no relation to the water supply facilities and water source protection are forbidden”, “planting is forbidden”, “farming and pasture activities are forbidden”, etc. i.e. the forestation of industry raw material forest is not allowed in the first-grade protection area. In the secondary protection area and quasi-protection area, there is no regulation on planting, so the forestation activities can be carried out in these areas. Thus, the selected woodlands in this project comply with the requirements of *Law of the People's Republic of China on Prevention and Control of Water Pollution* and *Regulations for Prevention and Management of Pollution in Protection Zone of Drinking Water Source*.

In *Law of the People's Republic of China on Prevention and Control of Water Pollution* issued on Feb. 28<sup>th</sup>, 2008, the contents related to forestation are Article Three of “Priority is given to protect drinking water source”, “Prevention and control of agricultural non-point source pollution”; the Article Forty-seven of “The used pesticide shall comply with the national regulations and standards related to the safe using of the pesticide”. *Regulations for Prevention and Management of Pollution in Protection Zone of Drinking Water Source* issued in 1989, provides the partition and prevention requirements of the drinking ground water and underground water source protection area.

According to the research report of Professor Wen Yuanguang, the water and soil loss as well as nutrient element loss of the eucalyptus forest is small. Meanwhile the scientific and rational forestation measures shall be adopted in the procedure of forestation in this project. Stora Enso Company also establishes forestation technical standards, security and health management scheme inside the company on basis of the relevant regulation of the nation and Guangxi. Under such forestation management model, the project forestation activities will generate little area pollution, complying with the requirements of *Law on Prevention and Control of Water Pollution*.

Considering that this part of woodland is close to water source protection area, it is suggested, in the procedure of forest management of the raw material forest bases of this part, to properly adjust the forestation model, reduce the frequency of tending fertilization in the woodland, and properly prolong the rotation, in order to further reduce the impacts on the ground water and shallow underground water by the water and soil loss in the forest management process. At present, Stora Enso has not used pesticides in the forest management process. It is suggested to try to avoid using pesticides in the future forest management process and forbid use of pesticides with high toxicity and high residue.

## 5.8 Analysis of impact on ecological landscape

After the implementation of the project, the landscape element such as the slash, suitable land for forest, forest without stumpage, open ground in the forest, rocky hill, nursery and so on will be changed to the landscape element of forest, consequently enhancing the

landscape percentage of woodland, but the impact on the landscape structure is small since the areas of this part of land is less.

In the procedure of the forest management of the raw material forest bases, the felling in the rotation, the woodland cleaning, soil preparation will change the landscape type of the woodland temporarily, but the change is short term. The project implementation will not change the landscape components in the region in the long run.

According to the principle of raw material forest base layout, after the project is implemented, the current landscape components within the project area will not be changed, the forest will still be the stable element type with the strongest ecological environment quality regulating and controlling capability of the whole project area and the superiority will still be the top one.

As the kind of tree planted in raw material forest base construction is unitary and the trees are planted in large areas concentratedly, which makes the landscape fragmentation in project area reduced. Although the type of landscape elements will not be changed, the distribution pattern of the landscape elements in the space will be changed. The raw material forest base of the project will form a distribution pattern with relatively centralized plates to form the structure of landscape so that the heterogeneity of the landscape is reduced, consequently reducing the anti-interference and the recovery capability of the landscape.

Generally speaking, the construction of the project will not generate remarkable effect on the ecological landscape of the whole project area.

## **5.9 Analysis on effect of farm chemicals and chemical fertilizer application on environment**

### **5.9.1 Analysis on the effect of farm chemicals on environment**

1) Mainly based on prevention and reducing the probability of farm chemical application to control non-point source pollution caused by farm chemicals from the fountainhead.

Stora Enso reduces occurrence of plant diseases and insect pests via taking the following several measures: ① hygiene quarantine is conducted for imported tree species to prevent plant diseases and insect pests from being brought in; ② controlling the saplings planted in nursery and when plant diseases and insect pests are discovered, they can be brought under control immediately to prevent them from being brought into forest land; ③ the block mixing mode of different clonal tree species is adopted in eucalyptus forest bases to reduce the occurrence of plant diseases and insect pests; ④ plant disease resistance of eucalyptus itself is comparatively strong; meanwhile, Stora Enso has been continuously researching on new plant disease-insect pest resistance eucalyptus.

Up till now, therefore, no plant diseases and insect pests have occurred in the eucalyptus forests planted by the company and no farm chemicals such as biocide have been used, which reflects that the plant diseases and insect pests prevention and control measures adopted by the company are effective.

## 2) Application of grass killer

During tending period, in order to prevent eucalyptus seedlings from being covered by weeds, shrubs and tree stumps within the forest land should be cleared. Three herbicides that will be adopted for the project are glyphosate (N-glycine), grass comfort (10.8% glyphosate + 0.8% 2,4-drop) and paraquat (also named Gramoxone and the component is 1,1'-methyl - 4,4' - bipyridine). They are not hypertoxic, highly toxic or highly residue level farm chemicals. As artificial application of grass killer may splash the chemical onto the trees nearby which need to be reserved, Stora Enso adopts manual grass killing in most parts of the operated forest and only a small amount of grass killer is used.

Grass killers are only sprayed on to the leaves of weeds that should be killed or smeared on the tree stumps with sprouts that should be killed after being diluted with water in seasons when grass and trees are growing vigorously and there is no wind and no rain. In such an application mode, the quantity of farm chemical running off into water body is little, the effect on environment is little but the enrichment of under-vegetation will be reduced.

## 3) Chemicals used in nursery

The chemicals mainly used in nursery during seedling growing period are root growing powder (indolebutyric acid, solar root and bornyl solution), bactericide (Leiduomei-manganese zinc, chlorothalonil, sandofan and Dithane M-45); biocide (dioxathion, fipronil, Rogor, Rogor oxide); grass killer (glyphosate); antiseptics (potassium permanganate and formaldehyde), etc. Rogor and Rogor oxide are highly toxic and highly remained farm chemical and the consumption should be restricted.

Those chemicals are only used within the nursery and the waste water generated during seedling growing period is all recovered for reuse and will not enter the around water bodies.

### 5.9.2 Analysis on the effect of chemical fertilizer application on environment

According to the "Investigation of current situation of fertilizer application in Guangxi eucalyptus forest region and the regional water body eutrophication" conducted by Nong Bi-chang, etc., the water samples of Qinglian Forestry Center and Bingyang Wuling Forestry Center present a poorly nourished state, the water sample of Bobai Forestry Center presents a moderately nourished state and the water sample of Heci Qingyuan Forestry Center presents an eutrophication state. The later is mainly caused by the complete cultivation adopted when preparing soil for forestation and small and shallow



holes wantonly adopted for fertilizer application, which makes the accumulation of lost nourishments because of rain wash. The key factor that makes eucalyptus forest land eutrophicated is N, which has something to do with the facts that N fertilizer is mainly applied for eucalyptus and the soil preparation for forestation and fertilizer application method.

According to the result of *Monitoring and Research on the Effects of Eucalyptus and Acacia Short-rotation Artificial Forest on Major Environmental Factors* conducted by professor Wen Yuan-guang, the Forest Science Institute of Guangxi University, the volume of lost nourishment in water and soil in the recovery process of the three vegetations is in very small quantity, thick pod acacia ( $0.036\text{kg}/\text{hm}^2$ )  $< E. urophylla \times E. grandis$  forest ( $0.039\text{kg}/\text{hm}^2$ )  $< \text{shrub-grass slope}$  ( $0.054\text{ kg}/\text{hm}^2$ )

The N, P and K loss of the three pieces of sample land all occurred during the year of forestation, the nourishment loss was remarkably reduced in the second and third years and the situation was basically stabilized in the fourth and fifth years. The nourishment loss changes synchronously with the surface runoff rate and the sediment loss. The erosion strength of the soil in forest land is slight and decreases rapidly as the age of vegetation recovery increases.

This project is the industrial raw material forest base. In order to improve the growth rate of eucalyptus, the fertilizer must be applied in forest land. The factors such as forest land surface runoff, penetration, soil and water loss, unreasonable fertilizer application, etc. make the nitrogen and phosphorus in fertilizer discharged into river, lake and reservoir, which may causes eutrophication of water body.

Stora Enso adopts scientific formula and fertilizer application method for soil testing and fertilizer application, not only meeting the requirement of eucalyptus fast-growing but maintaining the soil strength to a certain extent. In the forest culture and management process of the project, chemical fertilizers are only used during afforestating period and tending period (the first 18 months) and the adopted chemical fertilizers are limestone, phosphate fertilizer, NPK compound fertilizer and after fertilizer is applied, soil is returned immediately to prevent the fertilizer from being lost in rainy days. In forest culture and management process, the dead and fallen leaves, branches, trees, shrubs and grass, etc. and the logging residues should all be left in the forest land to reduce surface runoff and prevent, to a certain extent, fertilizer from polluting water body with runoff.

In summary, the chemical fertilizer application times of the raw material forest base are comparatively fewer, fertilizer applications are conducted reasonably according to specification, the adopted forest culture and management measures are superior than that adopted for other eucalyptus forest lands, chemical fertilizer loss is not easy to occur and the effect on environment is comparatively less because the surface pollution caused by fertilizer application is comparatively light.

## 5.10 Analysis of environmental effect of other forest management activities

### 5.10.1 Road construction in forest region

940.0km of roads in forest region are newly built, occupying an area of about 2.82~3.76km<sup>2</sup>, which makes the service functions of that part of forest land changed for ever. As most of forest lands are scattered in low mountains and low hills, in the forest road construction process, the surface vegetations in the places such as roadbed construction areas and the places for earthy borrowing and earth discarding are rooted out or buried, which makes the surface exposed and is easy to cause soil and water loss. Meanwhile, in operations such as excavation, roadbed filling and building, discarded earth and stone piling, etc., the original landforms, slopes and lengths of slopes, etc. are changed, forming a rough surface, which provides a cause for water and soil loss.

On basis that the current forest roads are efficiently utilized in this project, the roads are complemented and perfected according to the requirement of base construction. The width of the road surface is designed based on 2.0-3.0m so the vehicles can pass safely to avoid land occupation and soil exposure as much as possible and the maximum longitudinal slope is 13% to reduce the possibility of water and soil loss. The forest roads with a width of 2.0-3.0m will basically not exert any impact on the activities of wild animals.

Road construction should be conducted in dry season to avoid excessive runoff and erosion. The road surfaces should be pressed solid before the rainy season comes. In forest road construction, excavation and fill back should be avoided or reduced as much as possible and when it is unavoidable, excavation should be handled appropriately and the damaged vegetation on the slope surface should be filled back and recovered as soon as possible to fix soil.

### 5.10.2 The effects of cutting and logging

The effects of cutting and logging include the following several aspects:

- (1) Soil: soil hardening and erosion are caused by large area of clear cutting and logging via rolling. Fertility loss of the soil is caused by cutting and logging. Hardened soil caused by mechanical grinding makes the water adsorption capability of the soil reduced so that soil erosion is caused by surface runoff. The whole tree utilization after cutting and the trees that continuously absorb nutrients from soil more possibly cause soil fertility loss;
- (2) Water: the increase of soil erosion along logging roads will cause increase of deposits in river so as to affect the water quality the aquatic animal and aquatic plants depending on;
- (3) Wild animals: the effects on wild animals are mainly reflected from the interference on

their reproduction and nesting. Large area of clear cutting and logging via rolling will damage the nests of the wild animals in that area and affect the space of wildlife activity;

(4) Large area of clear cutting is also damage to surface landscape. Forestation configuration enquires eucalyptus of different ages and rational cutting planning should be worked out according to forest cutting specification; meanwhile, the surface vegetation in forest land should be well protected.

## **5.11 Protective measures concerning effects on ecological environment**

### **5.11.1 Protective measures for biological diversity**

(1) The public welfare forest and the forest lands within the range of 1km from nature reserves in the selected forest land are excluded. A certain quantity of public welfare forests should be reserved in some sensitive areas within the project area to make the base construction and public welfare forests scattered in a intersected way to reduce the environmental and ecological risk of artificial eucalyptus forest and to achieve sustainable operation;

(2) It is suggested in environmental assessment that the area of the selected forest land scattered in intersected way with White-headed Langur Nature Reserve and the selected forest lands within a region 1km from the border of the reserve should be excluded and the area of the excluded subcompartment is about 2000ha to ensure that the construction of this project will not generate any unfavorable effect on the activity of wild white-headed langur in Chongzuo White-headed Langur Nature Reserve;

(3) As far as the raw material forests contiguous to the forest land of the nature reserve is concerned, the selected forest lands within a range of 1km out of the border of nature reserves should be excluded in order to prevent the effect on the critically protected wide animals and plants within the reserve;

(4) The subcompartments should be rationally divided, the forestation area should be appropriately controlled and the area of a single subcompartment should be 100~200hm<sup>2</sup>;

(5) When preparing land for forestation, attention should be paid to protecting natural broad leaf trees and various shrubs in gulches and on ridges and protecting natural marshes;

(6) The broad leaf trees and shrub and grass vegetations in under-stocking/gullies should be reserved for protecting and recovering biological diversity;

(7) When clearing land for forestation and preparing, it is strictly prohibited to burn the land and when forestation is conducted on a slope, preparation should be conducted according to different slope conditions. Complete cultivation preparation can be conducted on a slope less than 15 ° and when complete cultivation preparation is conducted on a slope with a length greater than 200m, a horizontal vegetation belt with a width of no les

than 3m should be reserved every 100m. Dibble cultivation or horizontal belt preparation can be conducted on a 16-25 ° slope and the original surface vegetation should be reserved between every horizontal belt. Dibble cultivation can be conducted on a 26-35 ° slope and the tree pits should be arranged in delta pattern;

(8) Multi clonal blocky intersected configuration forestation should be adopted and local needle-leaved trees or other broad leaf trees should be appropriately planted around the selected forest lands of state-owned forest centers to achieve mixed forest;

(9) The local forestry authority avoids large area of eucalyptus planting in project area and forming large area of pure eucalyptus forest via reasonably arranging commodity forest land tree species, regulating and controlling cutting index and quota and directing forest farmers in tree species selection and planting;

(10) Popularizing plant disease and insect pests overall prevention and control and enhancing forest protection as well as reducing the consumption of chemicals to the minimum;

(11) Avoiding large-area grass killer application and grass killers are only used in spring and summer when grass and trees are growing vigorously;

(12) Reasonable forest land arrangement, tree age combination and cutting planning should be adopted. Meanwhile, biological buffering zones should be configured to provide wild animals with a corridor for migration;

(13) Relevant environmental protection knowledge education should be conducted for personnel of various levels participating in project construction, especially the personnel working in the selected forest land close to nature reserve to improve their protection consciousness and quality. It is strictly prohibited to enter the reserve for catching and killing wild animals and all personnel should consciously protect wild lives.

### **5.11.2 Forest land soil fertility conservation measures**

(1) Land preparation should not be conducted in dry and post-rain season as much as possible to maintain the physical and chemical properties of the forest land as much as possible;

(2) Scientific formula and fertilizer application: before forestation and top application, analysis on the physical and chemical properties of forest land soil and soil nutrient diagnosis should be conducted and fertilizer types should be selected and determined according to diagnosis results. Formula top application should be adopted to supplement what is lack in soil and maintain nutrient element balance in soil;

(3) Reasonable time and mode of fertilization should be selected to improve the utilization efficiency of chemical fertilizer. Forest land clearing and preparation mode is also an important measure of preventing and controlling water and fertilizer loss of soil. Water and

fertilizer loss caused by adoption of unreasonable forest cultivation and management measures should be avoided;

(4) The dead branches, fallen leaves and vegetation in forest land should be protected and it is not allowed to collect dead branches, fallen leaves and root out turf in forest land. Forest land clearing should only be conducted when the coverage of weeds, shrubs and eucalyptus sprout in forest land is greater than 70%;

(5) The timber processing mode of local debarking immediately after cutting should be adopted so as to return the leaves, bark and branches in the cutting area back to forest land;

(6) It is strictly prohibited to adopt the forest land clearing mode of burning in order to effectively protect the humus layer of the original forest land, reduce water and soil loss and reduce surface evaporation.

### **5.11.3 Soil and water conservation**

(1) Among the selected forest lands, local tree species should be planted in the forest land, in which fast-growing tree species are not suitable for planting;

(2) Forest land clearing should be conducted for the forest lands with a coverage of weeds, shrubs and eucalyptus sprout greater than 70%. In forest land clearing, it is required for the forest land shrubs and grass not to be higher than 15cm and it is not allowed to adopt complete cultivation and burning for clearing forest land;

(3) Appropriate forest land clearing time should be selected and it should be avoided to clear forest land and conduct grass killing for young stands in rainy season;

(4) Reasonable land preparation method should be adopted based on the slope of the forestation land. Tractor-ploughing preparation can only be conducted for forest lands with a slope of  $\leq 15^\circ$ . Adoption of advanced earth breaker for ploughing should be popularized. Hole type or belt type land preparation along contour line should be adopted for the forest lands with a slope of  $16-25^\circ$  ;

(5) Hilly area belt preparation must be conducted along the contour line, a green grass belt with a width of no less than 1.0m should be reserved between belts and when the length of slope exceeds 200m, a 3m green grass protection belt should be reserved every 100m;

(6) During land preparation, facilities such as drainage exit and retention wall, etc. should be configured at a place with comparatively greater slope to stop surface runoff so as to retard water and soil loss;

(7) When tending young forest, local soil loosening and grass killing should be conducted,

surface vegetation should be reserved as much as possible and the cut-off weeds should be kept in original place and it is not allowed to use grass killers in large areas;

(8) Dead branches and fallen leaves under the forest should be protected to improve the forest land water source conservation capability and maintain soil fertility;

(8) When cutting and logging are conducted, the surface vegetation should be reserved as much as possible, the density and quantity of logging roads should be reduced and *Management Rule on Forest Tree Cutting and Regeneration* should be strictly executed;

(9) Dry season should be selected for construction of forest roads to avoid excess runoff and erosion and the road surface should be pressed solid and hardened as much as possible before rainy season;

(10) In construction of forest roads, excavation and fill-back should be avoided as much as possible and when it is unavoidable, the excavated earth should be appropriately handled and the vegetation on filled-back slope surface should be recovered as soon as possible to fix soil.

#### **5.11.4 Non-point source pollution control measures**

(1) When selecting forest land, the supply area of drinking water source should be avoided, a certain protective distance should be reserved on two banks of river (50m on two sides of a main river and 20m on two sides of a branch) no tree species with long rotation should be planted;

(2) Soil should be tested, scientific formula should be adopted for fertilizer application and it is strictly prohibited to apply fertilizer indiscriminately;

(3) Fertilizer application should be conducted according to the fertilizer application specification worked out by the company, hole digging fertilizer application mode should be adopted for the places with comparatively greater slope and the hole must be covered with soil immediately after fertilizer application and it is strictly prohibited to spread fertilizer;

(4) Research and development of disease-resistant tree species should be conducted and clonal intersected blocky mixed forest cultivation and management mode should be adopted to reduce the probability of plant disease and insect pest occurrence so as to reduce the consumption of farm chemical;

(5) When farm chemical must be used, the application must be conducted strictly according to operation specification in days with no wind and rain to prevent farm chemical from entering water bodies.

### 5.11.5 Measures for retarding the effect of landscape

- (1) Within pulp raw material forest planting range, forest stands with different and alternated three ages should be designed according to the requirement of pulp factory for raw material forest;
- (2) Local broad leaf forest (local tree species) or other forest stands should be planted around artificial forest or independent piece of land and the suggested planting area proportion should be 10% of the pulp raw material forest area;
- (3) Wide animal corridor should be formed in reserved forest within the range of pulp raw material forest, including establishment of buffering belt on banks and corridor belt crossing ridges and connecting valleys;
- (4) Measures for reserving small pieces of forest and single tree should be designed in pulp raw material forest base.

### 5.11.6 Forest diseases and insect pests prevention and control measures

The policy of “Prevention First and Conducting Overall Management” should be adhered to for disease and insect pest prevention and control and the major adopted measures are:

- (1) Seed and seedling quarantine should be well done to strictly prevent disease and insect from entering the bases;
- (2) Disinfection should be well conducted for nursery land and nursery stock nutrient substrate;
- (3) Excellent varieties with strong resistance and clonal forestation should be adopted and multi clonal configuration forestation should be adopted to reduce ecological risks. Disease resistant, wind resistant, high-yield and high quality clonal seedling resources (materials should be continuously selected and cultured and provided to the bases for forestation;
- (4) Scientific forestation, reasonable fertilizer application, appropriate density and strengthened disease and insect resistance capability of forest stands;
- (5) Prediction and forecasting of diseases and insect pests should be well conducted to control their occurrence and spreading of diseases and insect pests in time;
- (6) A disease and insect pest prevention, control and management program should be worked out and strictly executed, overall prevention and control of diseases and insect pests should be popularized. Biological prevention and control should be the main means to reduce chemical consumption. Low residue and low toxic farm chemicals should be adopted for chemical prevention and control in order to improve the application efficiency

of farm chemicals and to reduce the negative effects of farm chemicals on natural environment to minimum.

#### **5.11.7 Enhancing base environment monitoring measures**

- (1) The joint venture should enhance the technical exchange and cooperation with the environment monitoring authority within the region and work out a perfect forest land and peripheral environment monitoring program;
- (2) A certain quantity of monitoring points should be configured within the project base, Normal tour inspection and periodical investment combination should be adopted to closely monitor the variation of various indexes of the forest land and peripheral environment (including soil erosion, soil fertility, water resource, biological diversity and diseases and insect pests, etc.). When something abnormal is discovered, the cause should be found out and the corresponding tactics and measures should be worked out;
- (3) Water used in artificial forest of the bases and the quality of the water should be monitored, especially in places with a rainfall less than 1200mm;
- (4) Resource and environment monitoring databank and graphic information bank should be established for the forest lands of the project to provide services to project operation management and sustainable operation.

### **5.12 Conclusions and suggestions**

#### **5.12.1 Conclusions of ecological environment effect assessment**

##### **5.12.1.1 Biological diversity**

The eucalyptus in the project area is an imported tree species for many years, the eucalyptus planting areas are centralized in artificial forest lands and will not damage the regional primitive forest and second growth forest. The construction of the project will not exert unfavorable impact on regional species diversity.

After the project is implemented, the artificial eucalyptus forest lands will be increased from 10.1% to 18.9% and the species distribution will be simplified.

The raw material forest bases selected for the project are basically distributed in commodity forest regions and there are a few selected forest lands that are not within the region of commodity forest land region in Beihai City. The relationship with these nature reserves should be sufficiently taken into consideration of land selection for raw material forest bases and be strictly avoided.

Guangxi began to import eucalyptus as early as at the beginning of 1970's. Currently artificial eucalyptus forest area is about 750000 hm<sup>2</sup>. The raw material forest base project



area of this project is the major artificial eucalyptus forest planting area in Guangxi and the selected tree species is the extensively planted tree species in Guangxi in recent years.

After this project is implemented, plantation management mode will be adopted, which will greatly enhance the forest culture and management strength and reduce the ecological function of the selected forest land; however, adoption of high-input and high-yield forest land operation mode in commodity forest land complies the national forestry classified operation requirement. Because of the plantation management mode plus that the peripheral social forest lands following the example of eucalyptus planting, the problem of large-area pure forest may appear. It is suggested in the environment assessment that appropriate needle-leaved trees and other non-broad-leaf trees should be appropriately planted between the forest lands selected in state-owned forest farms and the forest lands of peripheral state-owned forest farms to achieve mixed forest. The problem of large-area pure eucalyptus forest caused by eucalyptus planting imitating by other forest farmers should be controlled by local forestry authority via rational tree species arrangement in commodity forest lands and the measures such as cutting index quota, etc.

The diversity of under-plants in artificial forest mainly depends on forest stand structure, environmental conditions and man-made interference and has nothing to do with the forestation tree species of artificial forest. Generally speaking, after the raw material forest base project is implemented, the diversity of under-vegetation of the forest land will be somehow reduced; however, as most of the forests in the project region at present are artificial forests and the under-vegetation is not very much enriched; meanwhile, the difference in terms of under-vegetation diversity of artificial forests with different tree species is actually not remarkable; therefore, the effect of eucalyptus raw material forest base forestation on under-vegetation of the project area is not great.

The forest lands selected for the raw material forest do not involve local natural forests and second growth forests and generally speaking, the forest lands selected for the raw material forest will not aggravate the interference to wild animals and will not change the habitat and immigration corridor of wild animals. Cutting of forest land and forestation, however, will generate intensive interference to the wild animals taking artificial forest as the habitat. The most sensitive wild animals in the project region are state-protected grade 1 animal, white-headed langur and other protected animals are leopard, clouded leopard, sika deer, musk deer, python, etc. After excluding the forest lands within the range of 1km from nature reserves and the forest lands with intersected distribution, the areas suitable for white-headed langurs' activity is not within the range of the lands selected for raw material forest base and no direct effect will be generated on the living space of white-headed langur. The forest lands selected for the project are low hill area with frequent activities of human beings. When selecting forest land, it is required to avoid nature reserve so no direct effect will be generated on the living space of critically protected wild

animals in the region.

#### **5.12.1.2 Land resource utilization**

Except the construction of forest roads supporting the raw material forest base, which will change the utilization type of original land, the construction of raw material forest bases do not change the utilization type of the land

The activities such as land preparation, application of farm chemicals and chemical fertilizers, cutting and logging, etc., in raw material forest base management process will generate certain effects on physical structure and chemical composition of soil; however, the effects are very small and can be avoided or retarded via rational forest culture and management measures.

Land strength declination and productivity reduction are the phenomena generally exist in artificial forests with tree species of eucalyptus, pine, China fir and poplar, etc. compared with needle-leaved trees, the nutrient circulating rate of eucalyptus is high, the rotation period of time is short. The nutrient volume of eucalyptus seasonal timber is slightly greater than that of slash pine and far greater than that of massion pine. In case that the residues after cutting and dead branches and fallen leaves are all left in forest land, the soil nutrient consumption of eucalyptus is still greater than that of needle-leaved trees. After changing the planted tree species of the forest land, if effective measures are not taken, reduction in forest land soil fertility may be caused.

#### **5.12.1.3 Soil erosion**

In raw material forest land operation and management of this project, the rotation period of artificial eucalyptus forest is short, the disturbance to ground surface is remarkably more serious than that of needle-leaved forest; therefore, the water and soil loss thus caused will remarkably increase.

98% of the selected forest land of the project is in micro-eroded and slightly eroded areas and in current forest culture and management mode, the water and soil loss of the current eucalyptus forest land will somehow decreases so the erosion, generally speaking, can be controlled at current erosion level of the forest lands

The forest lands in Chongzuo City selected for this project have avoided rock desertificated area and also avoided the areas where stone desertification is easy to occur such as the hills and uplands of karst lava area.

#### **5.12.1.4 Effect on water environment**

The total evaporation capacity of the artificial eucalyptus forest of Stora Enso is about 880-1200mm/a and for areas with comparatively abundant rainfall, such as Beihai, Fanfchenggang, Yulin and Nanning City etc. the effect of artificial eucalyptus forest on water volume balance of these basins is not great. The annual rainfall of Chongzuo City is

relatively small and the fluctuation is comparatively great so certain effect on basin water volume balance may be generated in the year with less rainfall.

Eucalyptus grows fast, the rotation period is short, the water volume demanded for young eucalyptus is great and the yield is also high, which is the real cause of great water consumption. Additionally, eucalyptus root system is distributed in very shallow position; therefore it will not lower underground water level.

The annually average water and soil nutrient loss of artificial eucalyptus forest is 0.039kg/hm<sup>2</sup> and the loss of the year of forestation occupies a comparatively great proportion. It is indicated in data that the loss of soil fertility in forest land is very little and the effect on environment is slight.

The nature reserves with water conservation forest function within the project area range are Shiwandashan Nature Reserve, Xidamingshan Nature Reserve and Nalin Nature Reserve and only Shanglinlongshan Nature Reserve is comparatively close to the raw material forest base; however, the distance can also be maintained at more than 500m. Meanwhile, in raw material forest selection, the forest lands within 200m from two banks of river are avoided so the implementation of the project will not affect the water resources within project area.

The raw material forest base selected by the project is far away from the majority of water resource protection areas, with a distance of more than 2km. However, within the range of Beihai region there is the condition that the selected raw material forest bases are relatively close to the water resource protection area, with involved four lakes and reservoir type of water resource protection areas and one deeply exploited underground water resource protection area.

Selection of the forest land for the project complies with the requirements of *Law of the People's Republic of China on Prevention and Control of Water Pollution, Regulations for Prevention and Management of Pollution in Protection Zone of Drinking Water Source*.

However, considering that this part of the forest land is near the protection zone for water source, it is recommended that the measures, such as proper adjustment of forest management mode, reduction the frequency of fertilization in the forest and proper extension of felling period, be taken in this part of base of raw material forests to further reduce impact of soil erosion on surface water and shallow groundwater during forest management process. Currently, Stora Enso hasn't used pesticide yet during forest management. It's recommended that application of pesticide be avoided as much as possible during forest management process in the future. Use of highly toxic and high-residue pesticide is prohibited.

#### **5.12.1.5 Impact on ecological landscape**

Implementation of the project won't change existing components of the landscape within

the project area. The forest will still be the element type, which has high metastability and the strongest control capability for eco-environmental quality. However, due to single tree species for planting and contiguous cultivation in large area, distribution pattern with relatively concentrated blocks will form in the project area, whose heterogeneity of landscape decreases, subsequently reducing anti-interference ability and recovery capability of the landscape. In general, project construction won't have significant impact on the ecological landscape in the entire project area.

#### **5.12.1.6 Application of pesticide and fertilizer**

During prevention of diseases and insect pests in the base of raw material forests, focusing on the prevention, clonal and disease-resistant varieties are selected and simultaneously reasonable forest management measures are taken to reduce the probability of diseases and insect pests in the forest land, which can reduce the usage of pesticide. Method of pesticide application is only used when diseases and insect pests can't be controlled by the prevention measure.

When selecting pesticide and herbicide, pesticide with low residue and toxicity is mainly used to improve the usage efficiency and reduce its negative impact on natural environment.

Reasons, such as surface runoff in the forest land, permeation, soil erosion and unreasonable application of fertilizer, can result in discharge of substances in the fertilizer, such as nitrogen and phosphorus, into rivers and reservoirs, which may cause eutrophication of water body. The fertilizer is applied less frequently in the base of raw material forests of the project. Under the condition of taking better management measures for forest management than other eucalyptus forests, the problem of pollution in the surface water body, caused by the loss of fertilizer, won't be induced.

#### **5.12.1.7 Environmental impact caused by other forest management activities**

During the period of construction of the road in the forest, bare and rough ground will form, which will provide a reason of inducing soil erosion and change the land use function of this part of forest land permanently. Therefore, implementation of road construction shall be chosen to be carried out during dry season, while the road surface shall be compacted before rainy season. Excavation or embankment should be avoided or minimized. Otherwise, excavated earthwork should be properly disposed and vegetation on the slope of embankment be restored as soon as possible.

Felling and logging operations may lead to soil erosion, soil fertility loss and consequent increment of sediments in the river. Large-area clear cutting and logging of bowls would destroy the lairs of wild animals in the region and affect the activity space of wild animals, space. Meanwhile, Large-area clear cutting can also damage the landscapes on the surface.

### 5.12.2 General Conclusion

The scale of designed base of raw material forests for the pulp of the project is 160,000 hm<sup>2</sup>, while planned layout is conducted for eight state-owned forest farms belonging to Guangxi Gaofeng Group and 15 counties (cities, prefectures) in Beihai, Fangchenggang, Yulin and Chongzuo, which are in the south of Guangxi. According to the statistics made through the subcompartment of the forest land, forest land with area of 132,400 hm<sup>2</sup>, which meets the requirements of environmental protection and occupies 82.7% of the area of planning base of raw material forests, has been fulfilled to subcompartment of the forest land.

The tree species for planting selected for the project are eucalyptus and acacia. New forest with area of 123,056.0hm<sup>2</sup> has been planned, while tending is conducted for current 36,944.0hm<sup>2</sup> eucalyptus forests. Design rotation period is 6~7 years and annual timber output 3,118,400 m<sup>3</sup>, which can meet the demand of wood pulp factory.

Project construction is coordinated with *National Special Plan of the Forest-Paper Integration Project Construction in "The Tenth Five Year", General Planning for Construction Project for Bases of Fast-Growing and High-Yield Plantation in Key Regions, Development Planning for Fast-Growing and High-Yield Plantation in Guangxi in Eleventh Five-Year" and 2020, and Outline for Ecological Construction Plan in Guangxi, Opinions of People's Government Guangxi Zhuang Autonomous Region on Accelerating Construction of Base of Raw Material Forests for the Pulp.*

The forest land selected for the project doesn't damage primary and secondary natural forests in the region, while project construction doesn't show adverse effects on the regional species diversity and can lead to increment of new plantation of eucalyptus with area of 129,000 hm<sup>2</sup>, which can make the proportion of eucalyptus, planted in the project area, increase by 8.8% and may result in singleness of species distribution in the project area. Through scientific cultivation of eucalyptus and adoption of scientific forest management measures, adverse environmental impacts, such as reduction of biodiversity, declining of soil fertility and soil erosion, can be avoided.

Generally, ecologically sensitive areas are avoided for the base of raw material forests during the design stage of selecting land. The forest land in the project area has rich resources. Project construction shows some impact on the change of current compositions of the forest, while artificial forest management mode to be taken exposes disturbance intensity on the forest land and impact with a certain degree on integrity and stability of the ecosystem in the project area, particularly the integrity of plant communities. During construction process of the base of raw material forests, forests are planted and various ecological protection measures are implemented in accordance with the specifications for forest management, whose impact on the ecological environment can be acceptable.

### 5.12.3 Suggestions

In order to prevent the occurrence of the problem of large-area pure forests in the base of raw material forests after the implementation of the project, it's suggested that 10% acacia still be retained or other native tree species be mixed for long-term forestation program in the future.

Meanwhile, for the problem of possible large-area pure forests that appear in the selected forest land and surrounding forest lands, it's suggested that Guangxi Forestry Bureau properly plant native conifers or other broad-leaved trees around the forest land, which is selected for the project of state-owned forest farm, to realize mixing. Meanwhile, measures such as rational layout, regulation and control of harvesting quotas and indicators shall be conducted by local forestry sector to control commercial tree species in the forest land and prevent occurrence of large-area pure forests.

During implementation process of the project, pay attention to re-employment, resettling and old-age security for the forestry staff of the state-owned forest farms.

## 6 Analysis on Environmental Effect during Construction

### 6.1 Brief Introduction of Construction

Designed project covers 236.3hm<sup>2</sup> area. The project construction divides into 3 periods. The eucalyptus KP production line with the capacity of 900 thousand tons/year and auxiliary facilities will be built in the first period. High-quality package cardboard production line with the capacity of 450 thousand tons/year and its auxiliary facilities will be built in the second period. High-quality fine paper production line with capacity of 450 thousand tons/year and its supporting facilities will be built in the third period.

According to different work types and intensity during construction, the number of constructors will be around 1000 per day, while reaching 2000 in peak period. The details of construction condition can be seen in table 6.1-1.

**Table 6.1—1 Table of Construction Condition**

| Construction period | Construction project                                  | Construction content                                                           | Work type                                     | Construction time (month) | Major environmental effect                                                                         | Construction time |
|---------------------|-------------------------------------------------------|--------------------------------------------------------------------------------|-----------------------------------------------|---------------------------|----------------------------------------------------------------------------------------------------|-------------------|
| Phase I             | 900 thousand tons/Year Eucalyptus KP                  | Excavation and leveling                                                        | Mechanical construction                       | 5                         | Soil and water loss, wastewater of construction, noise, dust and waste gas of construction machine | 2007~2009         |
|                     |                                                       | Concrete and Steel structure                                                   | Mixture of manual and mechanical construction | 6                         | Wastewater of construction, noise, dust and waste gas of construction machine                      |                   |
|                     |                                                       | Installation and adjustment of mechanical electrical and measurement equipment | Mixture of manual and mechanical construction | 17                        | Wastewater of construction and noise                                                               |                   |
| Phase II            | 450 thousand tons/year high-quality package cardboard | Concrete and steel structure                                                   | Mixture of manual and mechanical construction | 6                         | Wastewater of construction, noise, dust and waste gas of construction machine                      | 2009~2010         |
|                     |                                                       | Installation and adjustment of mechanical electrical and measurement equipment | Mixture of manual and mechanical construction | 24                        | Noise and wastewater of construction                                                               |                   |
| Phase III           | 45 thousand tons/year high-quality fine paper         | Concrete and steel structure                                                   | Mixture of manual and mechanical construction | 6                         | Wastewater of construction, noise, dust and waste gas of construction machine                      |                   |

| Construction period | Construction project | Construction content                                                           | Work type | Construction time (month) | Major environmental effect           | Construction time |
|---------------------|----------------------|--------------------------------------------------------------------------------|-----------|---------------------------|--------------------------------------|-------------------|
|                     |                      | Installation and adjustment of mechanical electrical and measurement equipment |           | 24                        | Wastewater of construction and noise | 2011~2012         |

## 6.2 Analysis on the Effect of Air Environment during Construction

During construction, operational links affecting air environment include loading and transportation of construction materials, leveling ground, concrete mixing, residential area of construction and layout of sewage pipes. Major discharged pollutants include total suspended particles (TSP), nitrogen oxides, carbon monoxide total hydrocarbons and oil smoke.

### 6.2.1 Analysis on Dust Effect

Total suspended particles mainly come from some operational links such as concrete mixing, loading and transportation of construction materials and leveling ground, among which the link of excavation and leveling ground produce contribute to the most of pollution which will last for 5 months. On the other hand, concrete mixing also produces same quantity of pollution and will last for 6-9 months. In the period of equipment installation, the pollution of total suspended particles comparatively decreases.

According to the test of similar projects, the concentration of total suspended particles reaches  $1.13\text{mg}/\text{m}^3$  per day in the place which is 50m away from construction site where measurement to reduce dust isn't take for excavation and leveling ground. The value is 2.8 times more than the second-class standard of GB 3095-1996 "Ambient Air Quality Standard"; The concentration is  $0.47\text{ mg}/\text{m}^3$  in the place where is 200m away from construction site, which is 0.6 times more than the standard. Within the range of 300m away from concrete mixing engineering spot, the content exceeds the second-class national standard of "Ambient Air Quality Standard". Total suspended particles of the project will generate negative effect on surrounding area including 5 villages—Po Kotang (200m), Xinwupo (40m), Haishanba (80m), Beimu salt site (20m) and Yaxin (100m).

Monitoring result after taking measures: Beyond the range which is 150m away from construction site, total quantity of suspended particles meets the requirement of second-class standard, which is shown in table 6.2-1. It can be seen that the effective scale of total suspended particles and effective strength significantly reduce after taking measures.

**Table 6.2-1 Monitoring Results of TSP during Some Construction**

| Item | Test site | Distance (m) | Test time |        |        |
|------|-----------|--------------|-----------|--------|--------|
|      |           |              | Summer    | Autumn | Winter |
| TSP  | 1#        | 100          | 0.28      | 0.09   | 0.07   |
|      | 2#        | 150          | 0.23      | 0.06   | 0.05   |



### 6.2.2 Analysis on the Pollution Caused by Mechanical Waste Gas

Main source of mechanical waste gas comes from fuel machines such as truck and diesel dynamics machines, whose main pollutants include carbon monoxide, nitrogen oxide and total hydrocarbons. Since many construction machines are large ones with high emission factor, nitrogen oxides in construction site, where construction machines are concentrated, may exceed standard. However, in most cases, pollution level is relatively low because construction machines are scattered and operated at different times. Based on the similar engineering monitoring (excavation and leveling stage, construction machines include trucks, diesel engines, excavators and compressors, with a wide terrain of construction area). In the place 50meters away from site, intensity of carbon monoxide and nitrogen dioxide are separately  $0.2\text{mg}/\text{m}^3$  and  $0.13\text{mg}/\text{m}^3$  per hour,  $0.13\text{mg}/\text{m}^3$  and  $0.062\text{mg}/\text{m}^3$  per day, reaching Secondary Standard in Ambient Air Quality Standard.

During the period of excavation, leveling and structural stage, the number of construction machines is relatively high compared to the lower number in equipment installation stage. Therefore, influence of mechanical waste gas is also larger in the fore-stage of construction.

### 6.2.3 Analysis on Poisonous and Dangerous Gas Pollution

Poisonous and dangerous gas such as paint odor, smells from chemical containers and gas of welding are generated during construction and installation period. Though being poisonous, discharge amount of these gases are low, only affecting construction site and neighboring areas and influence construction workers' health, with little impact on external environment.

### 6.2.4 Analysis on Smoke Pollution

Because of the large-scale project and a large amount of food provided for approximately 1000 construction workers per day, 5~6 canteens will be built during the construction, so smokes from cuisine might cause a slight pollution in the small-range of environment.

According to the investigation of smoke emitted from restaurants, smoke treated by range hood has a small influence range (generally 50~100m). So we can see the smoke emitted from the project will somehow have negative impact on the air, but the range is so small that the neighboring sensitive points will not be impacted by and large.

## 6.3 Analysis on Sound Environment Impact during Construction

### 6.3.1 Analysis on Major Sound Resources in Construction

Because of different construction methods and machines, the noise grade fluctuate a lot

in the construction stage, which will impact earth and stone period worst, followed by engineering period and decoration period.

Planned project might apply the construction machines listed in Table 6.3-1. Noise value is 65~110 dB (A) in the place which is 15m away from sound source. These noises are intermittent, paroxysmal and unstable sound ones.

**Table 6.3-1 Noise Values of all Kinds of Construction Machines**

**Unit: Leq [dB (A)]**

| Machine Type                  | Power rating (kW) | Distance from sound source, m | Noise grade, dB(A) |
|-------------------------------|-------------------|-------------------------------|--------------------|
| Compactors, front-end loaders | 92<br>220         | 15                            | 70-85              |
| Pavior                        |                   |                               | 80-85              |
| Truck, self-dumping truck     | 239               |                               | 80-95              |
| Scraper, sorter               |                   |                               | 80-95              |
| Hoist                         |                   |                               | 75-90              |
| Pump                          |                   |                               | 65-75              |
| Concrete mixer, water pump    |                   |                               | 75-85              |
| Generator, compressor         |                   |                               | 75-90              |
| Pneumatic impact spanner      |                   |                               | 80-85              |
| Jackhammer, rock drill        |                   |                               | 85-95              |
| Vibrator, saw                 |                   |                               | 70-85              |

### 6.3.2 Prediction Mode

During the construction, mechanical noise of each site can be treated as point sound source. According to propagation and attenuation mode of point sound source, noise value with different distance from point sound value can be estimated. The prediction mode is as following.

$$LP=LPO-20\lg(r/r_0)-\Delta L$$

Given: LP——Prediction value of construction noise;

LPO——Reference degree of monitoring construction noise;

r——Prediction point distance;

$r_0$ ——Monitoring point distance;

$\Delta L$ ——additional attenuation amount.

### 6.3.3 Evaluation Criteria

During the construction, environmental evaluation standard is based on Standard of Noise Limits of Construction Site (GB12523-90),

**Table 6.3-2 Noise Limitation in Boundary of Construction Site** Unit: Leq[dB(A)]

| Construction Stage | Main Noise Source                                           | Noise Limits |                           |
|--------------------|-------------------------------------------------------------|--------------|---------------------------|
|                    |                                                             | Day          | Night                     |
| Earthwork          | Bulldozer, Excavator, Loader etc                            | 75           | 55                        |
| Piling             | Various pile hammers                                        | 85           | Construction is forbidden |
| Structuring        | Concrete mixer, Immersion battery vibrator and electric saw | 70           | 55                        |
| Decorating         | Crane, elevator                                             | 65           | 55                        |

### 6.3.4 Prediction Result

**Table 6.3-3 Noise prediction of some construction machines**

| Distance from source (m) | Intensity of source dB (A) |      |      |      |      |      |
|--------------------------|----------------------------|------|------|------|------|------|
|                          | 70                         | 75   | 80   | 85   | 90   | 95   |
| 50                       | 55.5                       | 60.5 | 65.5 | 70.5 | 75.5 | 80.5 |
| 100                      | 49.5                       | 54.5 | 59.5 | 64.5 | 69.5 | 74.5 |
| 150                      | 46.0                       | 51.0 | 56.0 | 61.0 | 66.0 | 71.0 |
| 200                      | 43.5                       | 48.5 | 53.5 | 58.5 | 63.5 | 68.5 |
| 250                      | 41.6                       | 46.6 | 51.6 | 56.6 | 61.6 | 66.6 |
| 300                      | 40.0                       | 45.0 | 50.0 | 55.0 | 60.0 | 65.0 |

**Table 6.3-4 Noise prediction of sound sensitive point close to construction site**

**Unit:dB(A)**

| No. | Village       | Relative location to region | Distance from region boundary (m) | Predication (max) | Standard Value of Evaluation |       | Evaluation |       |
|-----|---------------|-----------------------------|-----------------------------------|-------------------|------------------------------|-------|------------|-------|
|     |               |                             |                                   |                   | Day                          | Night | Day        | Night |
| 1   | Pokou Pond    | West                        | 200                               | 64                | 60                           | 50    | +4         | +13   |
| 2   | Xinwu Slope   | Southwest                   | 40                                | 78                | 60                           | 50    | +18        | +28   |
| 3   | Xiya Village  | North                       | 100                               | 70                | 60                           | 50    | +10        | +20   |
| 4   | Haishan Dam   | North                       | 80                                | 72                | 60                           | 50    | +12        | +22   |
| 5   | Beimu Village | South                       | 20                                | 84                | 60                           | 50    | +24        | +34   |

## 6.4 Analysis on Water Environment during Construction

According to different work type and intensity during construction, the average number of workers is around 1000 per day. Per capita water consumption is 200L and water discharge is calculated as 80 percent of water consumption, domestic sewage discharge is 160 m<sup>3</sup>/d. Major pollution is from chemical oxygen demand, biochemical oxygen demand and suspended substance. If the pollution is discharged directly without proper treatment, direct discharge will make some negative effect on environment.

Construction in phase I project totally lasts for 28 months. The first 5 months belong to excavation and leveling phase, during which mechanical construction is dominantly conducted with constructors (less than 100 people). At this time, domestic waste water is treated by septic tank and then used for irrigation in the cassava land around the site.

During the following 23-month construction period, waste water treatment facility of the project can be completed 6 months earlier (for commissioning requirements) than other works, which means that waste water can be discharged into the sea via operating pollution discharge facility in the last 6 months of construction, while in the other 17 months waste water is treated by the integrated waste water treatment facility before being stored in the emergency pool, which is preferentially built in the factory, for natural evaporation.

Domestic wastewater of construction during phase III project directly enters into waste water treatment system, which had been built during phase I project, for treatment and discharge. No additional waste water facility is set.

Construction ingredients and washing and maintenance of mechanical equipment will produce a little of operation wastewater. Major pollution in it is suspended substance and petroleum. Measurements of oil separation and deposition should be carried out to productive wastewater. After reach discharge standard, the water can be used to water

and lower dust in construction, clean tire of transportation vehicles and so on. This part of wastewater has less impact on environment.

## 6.5 Analysis on Water and Soil Loss Effect during Construction

Analysis on water and soil loss effect during construction is discussed refer to 16.2.3.

## 6.6 Analysis on Environmental Influence of Solid Waste during Construction

Solid wastes in construction include waste slag, construction waste and domestic waste in construction area. Engineering quantity of land leveling and embankment of the project is 4074.7 thousand  $m^3$  (compacted volume). Conversion factor of volume to refilling volume is 1.18.

After conversion natural volume reaching 4808.2 thousand  $m^3$ , engineering quantity of vertical designing embankment of the project is 4808.2 thousand  $m^3$ , engineering quantity of excavation 4808.2 thousand  $m^3$ . In this case, the balance between embankment and excavation can be realized with no waste soil. Soil balance of the project is shown in table 6.6-1

**Table 6.6-1 Soil balance of the project, ten thousand  $m^3$**

| Project                                |                            |   | Embankment         |                  | Excavation         |                  |
|----------------------------------------|----------------------------|---|--------------------|------------------|--------------------|------------------|
|                                        |                            |   | Soil<br>Embankment | Surface<br>humus | Soil<br>excavation | Surface<br>humus |
| Factory<br>area                        | Land leveling              | a | 8.61               | 0.62             | 8.46               | 0.62             |
|                                        |                            | b | 28.26              | 1.85             | 27.66              | 1.85             |
|                                        |                            | c | 19.52              | 1.44             | 19.04              | 1.44             |
|                                        |                            | d | 1.48               | 0.79             | 19.05              | 0.79             |
|                                        |                            | e | 55.91              | 7.01             | 147.09             | 7.01             |
|                                        |                            | f | 230.95             | 8.46             | 143.24             | 8.46             |
|                                        |                            | g | 20.23              | 1.79             | 5.17               | 1.79             |
|                                        |                            | h | 69.91              | 3.81             | 68.67              | 3.81             |
|                                        |                            | i | 4.15               | 0.63             | 3.91               | 0.63             |
|                                        | Basic earthwork of uilding |   | 14.57              | 0.00             | 11.30              |                  |
| Drainage Pipeline area outside factory |                            |   | 0.700              | 0.125            | 0.700              | 0.13             |
| Total                                  |                            |   | 454.290            | 26.525           | 454.290            | 26.525           |

Construction waste: According to relevant information, 50-200kg of construction waste is produced in per building area. Total building area of the project is 546883 $m^2$ . The office building of the project takes the design of cast in sit reinforced concrete frame structure

and the workshop building takes the design of reinforced concrete frame and bent structures, so the generation coefficient is  $50\text{kg}/\text{m}^2$  and 22.5 thousand tons of construction waste will be produced. Around 50 percent of construction waste is recoverable waste, around 50 percent of which is 11 thousand tons of construction waste needs to be treated. This part of construction waste will be carried to the disposal site determined by Urban Development Department of Beihai city to avoid creating negative impact on environment.

Domestic waste: Calculated by  $0.5\text{kg}$  per person, quantity of produced waste is around  $500\text{kg}/\text{d}$ . According to the agreement assigned by construction enterprise and Environment Sanitation Department of Beihai city, this part of waste is collected by Environment Sanitation Department and then be sent to Beihai rubbish site.

The designed project plan to relocate  $60224\text{m}^2$  area of civil brick-wood and brick concrete structure houses. According to relevant information,  $1\text{m}^2$  area of house relocation produces  $0.39\text{m}^2$  area of waste, and  $1\text{m}^2$  area of construction waste weights  $1.35\text{t}$ , so the construction waste produced by house relocation of the project is around 32 thousand tons. These wastes should be sent to the disposal site determined by Urban Development Department of Beihai city.

## 6.7 Analysis on Health Effect of Population in Construction

With large scale and long-term construction period, the designed project requires 200-2000 workforce according to different types of work and strength, which will directly provide employment opportunities for the society. On the other hand, construction materials and clothing, food, house and transportation of constructors also indirectly promote the development of relevant industry, service industry and rural agriculture sideline industry in surrounding area, which also create employment opportunity for the society and promote the development of local economy.

In addition, during the period of engineering construction, the flow of mobile population increases the opportunity of the epidemic's spread and prevalence, bringing some new epidemic not existing in construction area and spreading the disease in construction area to outer area. Rivers and water resources will be polluted by domestic waste, feces and improperly treated domestic sewage which is dumped everywhere. If local residents and migrant workers drink the polluted water, incidence of such epidemics as hepatitis and shigellosis will increase. Such diseases will even prevail with improper or untimely treatment. On the other hand, earthwork easily forms the splashes, causing larger number of mosquito breeding places and resulting in the incidence and prevalence of such entomophilic epidemic as malaria. Dust,  $\text{NO}_2$  and  $\text{SO}_2$  generated in the construction process will lead to an increasing number of patients with respiratory tract infection and noise pollution in construction which can damage auditory system and

people's health. While the labor intensity of constructor become too high, their physical fitness will fall down and their resistance to disease weaken, leading to vulnerability to disease. Moreover, construction may bring negative impact on the health of constructors and surrounding residents.

## **6.8 Analysis on Influence of Offshore Swage Pipe Construction**

### **6.8.1 Analysis for construction process of submarine pipelines**

According to water depth and location in the sea area, in which pollution discharge pipeline for the deep water is located, submarine pipelines are divided into pipelines in inshore section and offshore section. Inshore section refers to the shallow sea area with water depth of less than 4m, which is more closed to the shore (the draft complying with pipe laying vessel of the project), while offshore section is the sea area with water depth of larger than 4m. Generally, different pipe laying modes are adopted for inshore section and offshore section.

#### **① Pipeline layout in offshore section**

According to the characteristics of sea area, pipe laying mode via pipe laying vessel is suitable for pipeline in offshore section of the project.

Laying method via pipe laying vessel is the most popular among the laying methods for submarine pipeline. According to the characteristics of pipe laying method, pipe laying vessel is used as the center to form pipe laying fleet, which is equipped with necessary machinery and equipment to implement offshore laying of the submarine pipeline. Firstly process pipe sections (single tube or double tube) at coastal pipe-making yard in accordance with design requirements and specifications. Then send pipe sections to the pipe laying vessel by the supply ship, connect them one by one and treat the joints well. Pipe sections are directly connected in the welding station on the deck of the pipe laying vessel. Then subsequently complete various inspections and gradually lay the sections of pipeline to the sea bottom with stinger while processing. This method has the advantage of fast construction.

Major procedures for pipe laying operation via pipe laying vessel are as follows:

- A. Weld the pipe sections in the welding station on the deck and connect the sections one by one;
- B. Inspect the quality of each welded joint, adopt anti-corrosion and insulated coating, process and repair thickening anti-corrosion concrete layer.
- C. Lay the pipe section to the sea bottom with underground slipway (stinger) of pipe laying vessel.

Pipe laying vessel and its operation are shown in Figure 6.8-1.



**Figure 6.8-1 Pipe Laying Vessel during Operation**



## ②Pipeline layout in inshore section

A. Pipe towing mode can be used for construction of pipeline in inshore section due to shallower water depth.

Pipe towing mode is the method of towing the fabricated pipeline through the sea area via the winch for the pipeline, which is installed on the land or the ship. According to the installation position of winch, the methods can be divided into shore towing method and vessel towing method. According to shore towing method, the winch of towing pipe is fixed on the land, while grouping, welding and inspection is conducted for the pipe on the pipe laying vessel. Conduct welding until the pipe has been towed on the shore. According to vessel towing method, the winch is installed on the pipe laying vessel on the sea area to tow the pipelines, which have been welded and fabricated, from the sea area.

Typical pulling force of winch is 180~270 ton, while 50×30m is required for construction site. Operation state of the winch is shown in Figure 6.8-2.



**Figure 6.8-2 Winch Pulling Pipes**

#### B. Cofferdam and excavation mode

The mode of using cofferdam and excavation trench is one of the common methods to make the pipeline cross the coast. The trench is mainly protected via two closed weirs of the cofferdam. For long-distance shoal, its construction shows higher uncertainty. Therefore, the mode of single-channel jetty is often used for the long-distance shoal, while the pipeline is welded and prefabricated on the edge of the jetty. Laying is conducted along the dam.

### **6.8.2 Analysis for impact of pollution when laying submarine pipeline during construction phase**

During construction period of laying submarine pipeline, there are two main aspects inducing environmental impact. Due to the disturbing effect of pipe laying operation, avoidance response may occur to the fishes (some nekton). However, pipeline construction operation develops at construction progress of 1km/day along the pipeline during moving process. After completion of construction, pipeline section will soon recover original production. Therefore, impact by ecological avoidance response is temporary.

During submarine construction process, suspended mud and sand, which directly lead to the death of benthic organisms, will affect water quality and have a certain impact on marine ecology. With analogy of the source strength of suspended mud and sand (12.5kg/s), which is generated during submarine pipeline laying via single point mooring in Maoming, concentration increments of suspensions in the surface and middle layer

can exceed grade 1 and grade 2 water quality standards during construction period of pipeline, while concentration increment of suspension in the bottom layer can exceed grade 3 water quality standard. Influence scope is about 450m on both sides of the pipeline. After laying the pipeline, impact of suspended mud and sand on the marine environment disappears. Because pipeline construction of this project only takes about 7 days, it shows extremely limited impact on the environment.

Because pipeline construction area is in smaller linear range and marine organisms are in larger activity area, partial construction can result in hazard to small amount of organisms. But it doesn't show large negative impact not on marine organisms. Mangroves are scattered on the beach, where pipeline passes through. Some damage will occur on the beach when the pipeline is being excavated. Therefore, mangroves shall be transplanted to the surrounding beach for planting so pipeline construction to reduce the adverse effect.

## 7 Predictions and Evaluation of Impact on Aquatic Environment in Sea Area

### 7.1 Hydrological Survey

For more details, please refer to §2.2.3 for the general hydrological situation of the sea area where Tieshan Port is located.

### 7.2 Numerical Simulation of Tidal Current and Analysis on Hydrodynamic Conditions

#### 7.2.1 Mathematical model of tidal current

Flow field in sea area is a major dynamic condition in ocean for the excursion, advection and diffusion of contaminants, suspended mud and sand, oil film as well as the basis for evaluating and predicting relative elements in the project. According to the evaluation on the water depth of the sea zone, the mode of two dimensional ocean current shall be employed for simulating and evaluating the distribution of ocean current fields in the sea area.

##### 7.2.1.1 Two dimensional tidal current and fundamental equation of diffusion

(1) Equation of continuity:

$$\frac{\partial h}{\partial t} + \frac{\partial(Hu)}{\partial x} + \frac{\partial(Hv)}{\partial y} = 0 \quad (1)$$

(2) Equation of motion:

$$\frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} + g \frac{\partial h}{\partial x} - fv + g \frac{u\sqrt{u^2 + v^2}}{C^2 H} = N_x \frac{\partial^2 u}{\partial x^2} + N_y \frac{\partial^2 u}{\partial y^2} \quad (2)$$

$$\frac{\partial v}{\partial t} + u \frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} + g \frac{\partial h}{\partial y} + fu + g \frac{v\sqrt{u^2 + v^2}}{C^2 H} = N_x \frac{\partial^2 v}{\partial x^2} + N_y \frac{\partial^2 v}{\partial y^2} \quad (3)$$

In the equation above:

h: Water level;

H: Water depth

u, v: The velocity components of x、y(namely east, north)respectively ;

f: Coefficient of Coriolis force;

C: Chezy coefficient,  $C=H^{1/6}/n$ , n is Manning coefficient;

$N_x, N_y$ : The flow turbulence coefficients in the x, y directions respectively;

t: Time;

g: Gravity acceleration;

Conditions for finite solution

Initial condition:

$$u(x,y) \big|_{t=0} = u_0(x,y)$$

$$v(x,y) \big|_{t=0} = v_0(x,y)$$

$$h(x,y) \big|_{t=0} = h_0(x,y)$$

Boundary condition;

Quayside boundary:

Water boundary:  $hw = hw(t)$  or  $uw = uw(t)$ ,  $vw = vw(t)$

#### 7.2.1.2 Dispersion of equation

Irregular triangular unit is employed for conducting dispersion treatment over plane two dimensional mathematical models, which may be more suitable for describing the configuration of buildings in the sea area and shape of natural quayside.

##### (1) Determination of first-order partial derivative

The grid form selected in the computation in the article is any triangle computational grid.

In a plane domain, any function  $F(x, y)$  may be presented with a binary polynomial, that is:

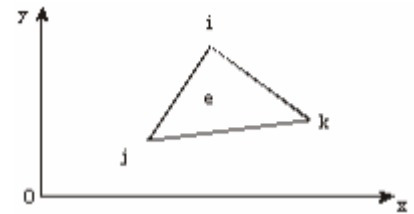
$$F(x, y) = \alpha_0 + \alpha_1 x + \alpha_2 y + \alpha_3 xy + \alpha_4 x^2 + \alpha_5 y^2 + \dots + \alpha_m x^m + \alpha_{m+1} y^m \quad (5)$$

For the sake of convenience, the article chooses its first-order approximants:

$$F(x, y) = \alpha_0 + \alpha_1 x + \alpha_2 y \quad (6)$$

In terms of the issues the article deals with, the approximants above can fully meet the engineering requirements.

The computational domains defined in the article are composed of finite triangular units. To any unit  $e$  (shown in the diagram on the right), when the node is known, the function from of this triangular domain may be completely determined. That is, the three coefficients of the equation (6) may be obtained, because the equation (6) is tenable to the whole triangular domain (including the three nodes). Thus, the article may write out the expressions of the three node values,  $F_i, F_j, F_k$ , and  $i, j$ , and  $k$  are arranged in the counter-clockwise direction.



Scheme of the triangular unit

$$F_k = \alpha_0 + \alpha_1 x_k + \alpha_2 y_k$$

In the equation,  $x$  and  $y$  are coordinates of the nodes while  $F$  is the node value.

Write the equations above into the matrix form:

$$\begin{bmatrix} 1 & x_i & y_i \\ 1 & x_j & y_j \\ 1 & x_k & y_k \end{bmatrix} \begin{bmatrix} \alpha_0 \\ \alpha_1 \\ \alpha_2 \end{bmatrix} = \begin{bmatrix} F_i \\ F_j \\ F_k \end{bmatrix} \quad (7)$$

Solve the equation (7), then:

$$\begin{bmatrix} \alpha_0 \\ \alpha_1 \\ \alpha_2 \end{bmatrix} = \begin{bmatrix} 1 & x_i & y_i \\ 1 & x_j & y_j \\ 1 & x_k & y_k \end{bmatrix}^{-1} \begin{bmatrix} F_i \\ F_j \\ F_k \end{bmatrix} \quad (8)$$

If

$$\begin{bmatrix} 1 & x_i & y_i \\ 1 & x_j & y_j \\ 1 & x_k & y_k \end{bmatrix} = [A] \quad (9)$$

The determinant to A

$$|A| = \begin{vmatrix} 1 & x_i & y_i \\ 1 & x_j & y_j \\ 1 & x_k & y_k \end{vmatrix} = 2S_e \quad (10)$$

Hereinto,  $S_e$  stands for the area the triangular unit.

The associate matrix of [A]

$$[A^*] = \begin{bmatrix} x_j y_k - x_k y_j & y_i - y_k & x_k - x_j \\ x_k y_i - x_i y_k & y_k - y_i & x_i - x_k \\ x_i y_j - x_j y_i & y_i - y_j & x_j - x_i \end{bmatrix}^T \quad (11)$$

$$\begin{aligned} a_i &= x_j y_k - x_k y_j; & b_i &= y_j - y_k; & c_i &= x_k - x_j \\ a_j &= x_k y_i - x_i y_k; & b_j &= y_k - y_i; & c_j &= x_i - x_k \\ a_k &= x_i y_j - x_j y_i; & b_k &= y_i - y_j; & c_k &= x_j - x_i \end{aligned} \quad (12)$$

Then, the equation (11) may be abridged as:

$$[A^*] = \begin{bmatrix} a_i & b_i & c_i \\ a_j & b_j & c_j \\ a_k & b_k & c_k \end{bmatrix}^T = \begin{bmatrix} a_i & a_j & a_k \\ b_i & b_j & b_k \\ c_i & c_j & c_k \end{bmatrix} \quad (13)$$

The inversion formula of the equation is:

$$[A]^{-1} = \frac{[A^*]}{|A|} = \frac{1}{2S_e} \begin{bmatrix} a_i & a_j & a_k \\ b_i & b_j & b_k \\ c_i & c_j & c_k \end{bmatrix} \quad (14)$$

Substitute the formula above into the equation (8) and work out the coefficient.

$$\begin{Bmatrix} \alpha_0 \\ \alpha_1 \\ \alpha_2 \end{Bmatrix} = \frac{1}{2S_e} \begin{bmatrix} a_i & a_j & a_k \\ b_i & b_j & b_k \\ c_i & c_j & c_k \end{bmatrix} \begin{Bmatrix} F_i \\ F_j \\ F_k \end{Bmatrix} \quad (15)$$

That is,

$$\left. \begin{aligned} \alpha_0 &= (a_i F_i + a_j F_j + a_k F_k) / 2S_e \\ \alpha_1 &= (b_i F_i + b_j F_j + b_k F_k) / 2S_e \\ \alpha_2 &= (c_i F_i + c_j F_j + c_k F_k) / 2S_e \end{aligned} \right\} \quad (16)$$

Substitute the formula above into the equation (5) and get the result:

$$\begin{aligned} F(x, y) &= [(a_i + b_i x + c_i y)F_i + (a_j + b_j x + c_j y)F_j \\ &+ (a_k + b_k x + c_k y)F_k] / 2S_e \end{aligned} \quad (17)$$

Thus the expression of the function  $F(x, y)$  in the triangular domain can be completely determined.

Suppose:

$$\left. \begin{aligned} N_i &= (a_i + b_i x + c_i y) / 2S_e \\ N_j &= (a_j + b_j x + c_j y) / 2S_e \\ N_k &= (a_k + b_k x + c_k y) / 2S_e \end{aligned} \right\} \quad (18)$$

This is the so-called shape function in the finite-element method, also known as area coordinate in mathematics, whose relationship with the cartesian coordinate is (derivation is omitted):

$$\left. \begin{aligned} x &= x_i N_i + x_j N_j + x_k N_k \\ y &= y_i N_i + y_j N_j + y_k N_k \end{aligned} \right\} \quad (19)$$

From the derivation above, we can see that any function within the triangular domain can be presented with  $F(N_i, N_j, N_k)$ , the area coordinate function. Meanwhile, the area coordinates,  $N_i, N_j$  and  $N_k$  are functions of  $x, y$ .

Therefore, when seek derivation of  $x, y$  with the function  $F$ , the derivation principle of compound function can be employed. That is:

$$\frac{\partial F}{\partial x} = \frac{\partial F}{\partial N_i} \frac{\partial N_i}{\partial x} + \frac{\partial F}{\partial N_j} \frac{\partial N_j}{\partial x} + \frac{\partial F}{\partial N_k} \frac{\partial N_k}{\partial x} \quad (20)$$

$$\begin{aligned} &= (b_i F_i + b_j F_j + b_k F_k) / 2S_e \\ \frac{\partial F}{\partial y} &= \frac{\partial F}{\partial N_i} \frac{\partial N_i}{\partial y} + \frac{\partial F}{\partial N_j} \frac{\partial N_j}{\partial y} + \frac{\partial F}{\partial N_k} \frac{\partial N_k}{\partial y} \\ &= (c_i F_i + c_j F_j + c_k F_k) / 2S_e \end{aligned} \quad (21)$$

In the irregular plane triangular grid (as shown in the figure on the right), the node M is the vertex of several neighboring units. In the numerical computation, however, application of partial derivation of a unit as the derivative of the node M will unnecessarily result in some deviations due to discretization and some differences in the numerical computation. Therefore, the article chooses weighted average instead of the equations (20) and (21).

$$F_x(M) = \sum (b_i F_i + b_j F_j + b_k F_k) / 2S \quad (22)$$

$$F_y(M) = \sum_e (c_i F_i + c_j F_j + c_k F_k) / 2S \quad (23)$$

In the formulas,  $F_x$  and  $F_y$  are the partial derivatives to  $x, y$ ;  $\sum_e$  means the summation of all the triangles with the node M as the vertex:

$$S = \sum_e S_e$$

## (2) Determination of second-order partial derivative

After working out the first-order partial derivative, the second-order partial derivative can be worked out by following the computing process of the first one.

## (3) Establishment of computation pattern

Substitute the equations (22) and (23) into the aforesaid two dimensional fundamental equation set and employ the forward difference in the time orientation and then each two dimensional fundamental equation set may be represented as difference scheme:

$$\frac{h_i^{n+1} - h_i^n}{\Delta t} + \frac{\partial}{\partial x} (Hu)_i^n + \frac{\partial}{\partial y} (Hv)_i^n = 0 \quad (24)$$

$$\begin{aligned} & \frac{u_i^{n+1} - u_i^n}{\Delta t} + u_i^{n+1} \left( \frac{\partial u}{\partial x} \right)_i^n + (v \frac{\partial u}{\partial x})_i^n + g \left( \frac{\partial h}{\partial x} \right)_i^{n+1} \\ & - f v_i^n + g w_i^n \left( \frac{u}{C^2 H} \right)_i^{n+1} = N_x \left( \frac{\partial^2 u}{\partial x^2} \right)_i^n + N_y \left( \frac{\partial^2 u}{\partial x^2} \right)_i^n \end{aligned} \quad (25)$$

$$\begin{aligned} & \frac{v_i^{n+1} - v_i^n}{\Delta t} + (u \frac{\partial v}{\partial x})_i^n + v_i^{n+1} \left( \frac{\partial v}{\partial y} \right)_i^n + g \left( \frac{\partial h}{\partial y} \right)_i^{n+1} \\ & + f u_i^n + g w_i^n \left( \frac{v}{C^2 H} \right)_i^{n+1} = N_x \left( \frac{\partial^2 v}{\partial x^2} \right)_i^n + N_y \left( \frac{\partial^2 v}{\partial y^2} \right)_i^n \end{aligned} \quad (26)$$



$$\begin{aligned} & \frac{P_i^{n+1} - P_i^n}{\Delta t} H_i^n + \left( \frac{\partial H u P}{\partial x} \right)_i^n + \left( \frac{\partial H v P}{\partial y} \right)_i^n \\ & = K_x \left( \frac{\partial^2 H P}{\partial x^2} \right)_i^n + K_y \left( \frac{\partial^2 H P}{\partial y^2} \right)_i^n + M \end{aligned} \quad (27)$$

After assorting, the computation formulas may be obtained:

$$h_i^{n+1} = h_i^n - \Delta t \left\{ \left[ \frac{\partial(Hu)}{\partial x} \right]_i^n + \left[ \frac{\partial(Hv)}{\partial y} \right]_i^n \right\} \quad (28)$$

$$\begin{aligned} u_i^{n+1} = & \{ u_i^n - \Delta t \left[ \left( v \frac{\partial u}{\partial y} \right)_i^n + g \left( \frac{\partial h}{\partial x} \right)_i^{n+1} - f v_i^n - N_x \left( \frac{\partial^2 u}{\partial x^2} \right)_i^n - N_y \left( \frac{\partial^2 u}{\partial y^2} \right)_i^n \right] \} / \\ & \{ 1 + \Delta t \left[ \left( \frac{\partial u}{\partial x} \right)_i^n + g \frac{w_i^n}{(C^2 H)_i^{n+1}} \right] \} \end{aligned} \quad (29)$$

$$\begin{aligned} v_i^{n+1} = & \{ v_i^n - \Delta t \left[ \left( u \frac{\partial v}{\partial x} \right)_i^n + g \left( \frac{\partial h}{\partial y} \right)_i^{n+1} + f u_i^n - N_x \left( \frac{\partial^2 v}{\partial x^2} \right)_i^n - N_y \left( \frac{\partial^2 v}{\partial y^2} \right)_i^n \right] \} / \\ & \{ 1 + \Delta t \left[ \left( \frac{\partial v}{\partial y} \right)_i^n + g \frac{w_i^n}{(C^2 H)_i^{n+1}} \right] \} \end{aligned} \quad (30)$$

$$\begin{aligned} P_i^{n+1} = & P_i^n - \left[ \left( \frac{\partial H u P}{\partial x} \right)_i^n + \left( \frac{\partial H v P}{\partial y} \right)_i^n - K_x \left( \frac{\partial^2 H P}{\partial x^2} \right)_i^n \right. \\ & \left. - K_y \left( \frac{\partial^2 H P}{\partial y^2} \right)_i^n - M \right] \frac{\Delta t}{H_i^n} \end{aligned} \quad (31)$$

In these formulas,  $i$  stands for the node number,  $n$  the number of time layers and  $\Delta t$  time step.

#### 7.2.1.3 Simulation and verification of flow field in sea area

##### (1) Computation domain, selection of hydrologic data and controlling condition

The computation domain is the sea area of Tieshan Port about 69.5km long (east to west) and 64.9km long (south to north) under evaluation, whose boundary points are shown in figure 7.2-1. The computation grids shall be densified near the sewage-discharged sea area with the minimum step length of 20m. The computation domain consists of 11,513 nodes and 22,278 triangular units and the division of grids is shown in figure 7.2-2.

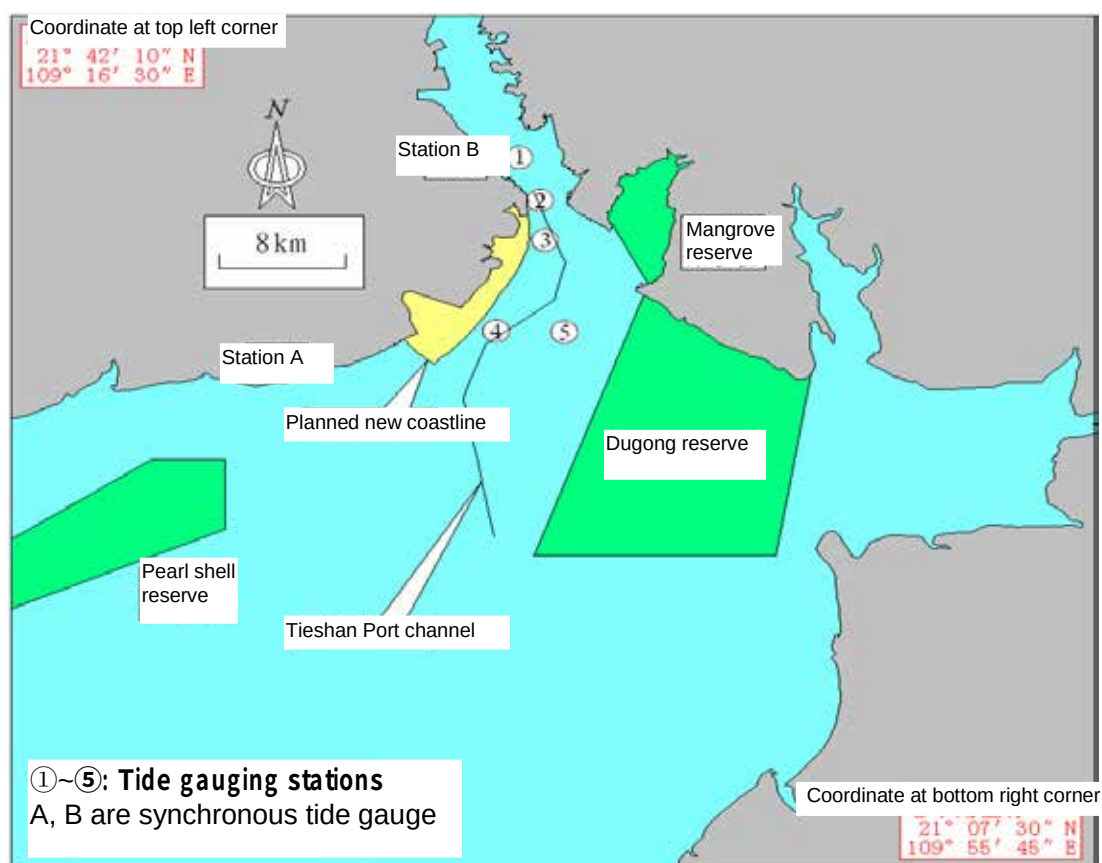


Figure 7.2-1 Computation domain and tide gauging stations

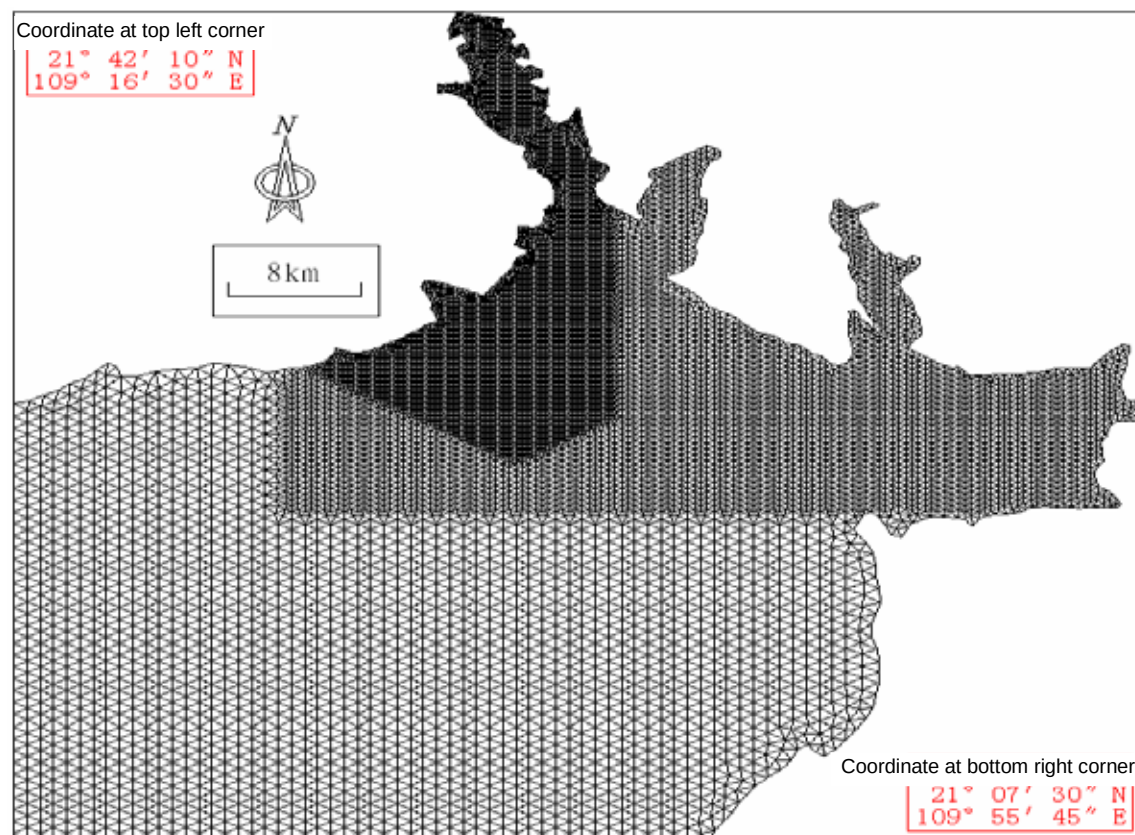


Figure 7.2-2 Grids of computation unit

Apply 2005 sea chart of Navigation Assurance Office of Navy Headquarters of PRC for underwater terrain.

As for the hydrologic data, apply the tidal current data measured by five tidal current stations and two tidal level stations concerning the neap tides on June 23 and 24 and spring tides on July 1 and 2 in 2007. Locations of the tidal current stations and tidal level stations are shown in figure 7.2-1.

The Manning coefficient  $n$  is debugged as 0.018~0.022.

## (2) Verification and computation

Computation is conducted in accordance with the aforesaid data and conditions and the verified results of current are shown in figure 7.2-3 and 7.2-4.

As shown in two figures, computed velocity value is basically consistent to the observed value and the error of tidal current is controlled within 5cm/s; the flow condition is also appropriate, basically reflecting the current situation in the sea area around the Tieshan Port and may be used as basic material for further analysis and computation.

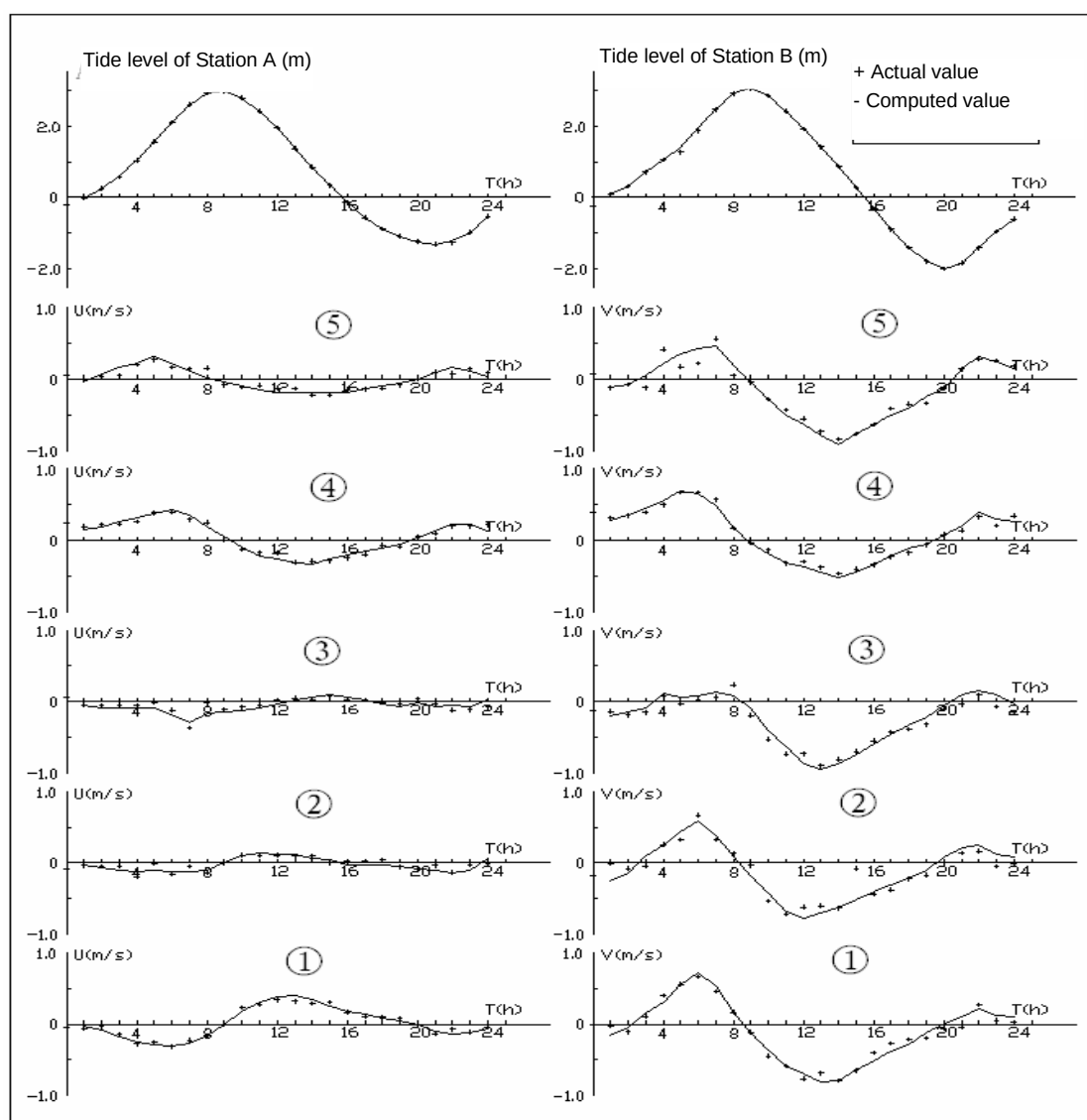


Figure 7.2-3 Hydrograph of prediction, computation and verification (Spring tide)

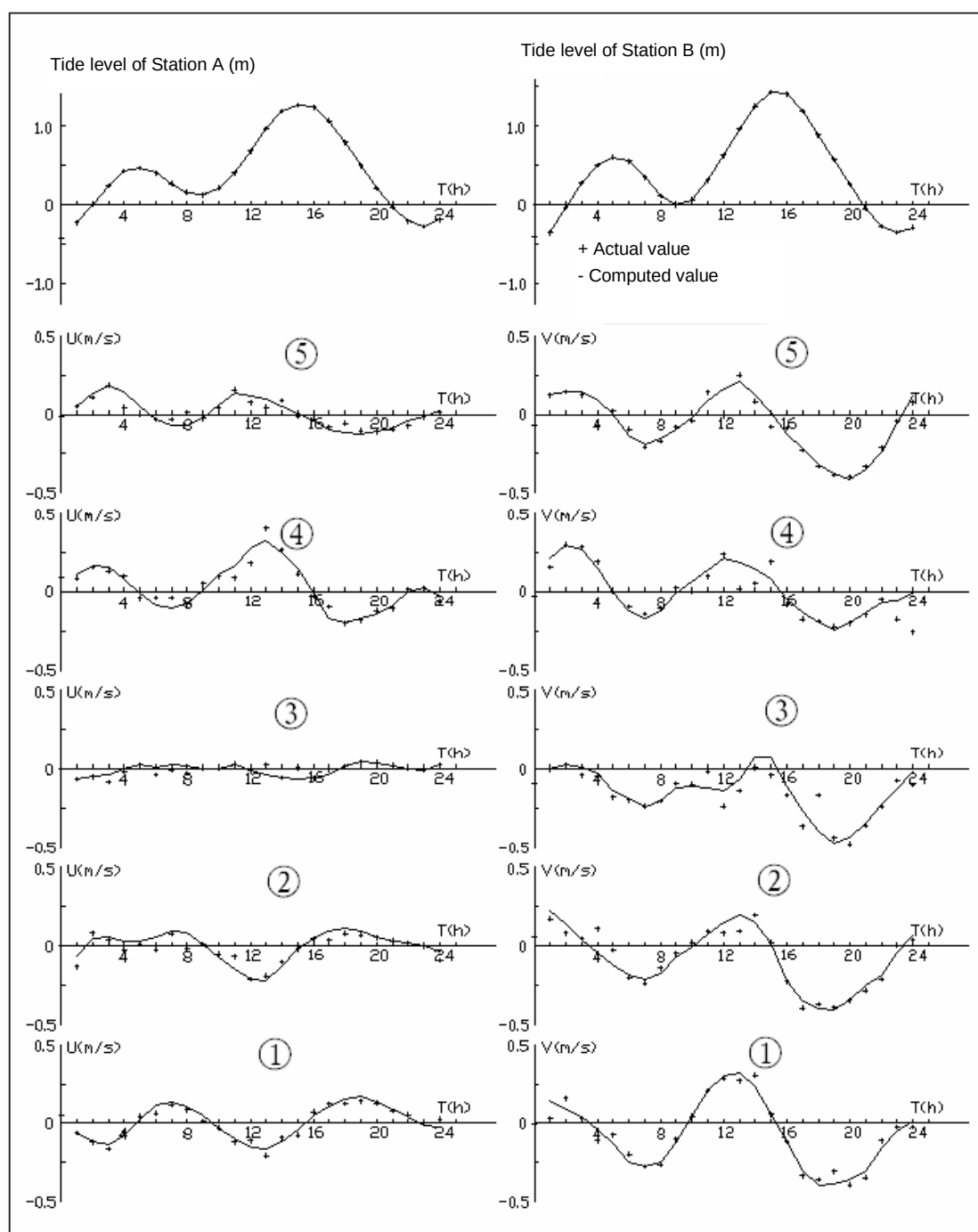


Figure 7.2-4 Hydrograph of prediction, computation and verification (Neap tide)

## 7.2.2. Flow Field Analysis

According to analysis of actual ocean current data surveyed, tidal current is the major ocean current in Beibu Gulf, with small seasonal change and low velocity of residual flow and diverse directions. In southeast Beibu Gulf, the flood current deflects to NE direction, ebb current to SW direction; ocean current usually goes to-and-fro, while the tidal current contrarotates a little in deep open sea and reciprocates from north to south and vice versus in areas in shore as affected by the coastline; the velocity of flow is lower in deep open sea and higher in narrow water channels affected by the landform; the velocity of ebb current is higher than the flood current within one tide cycle. Refer to figure 7.2-5 - 7.2-8 for calculation results of the flow field.

As shown in the figures, tidal current is highly dynamic and obviously affected by the landform and the surface flow in sea area of Tieshan Port. Velocity and direction of the tidal current in deep water area are greatly different from those on the riffle. The direction of tidal current in deep water area is basically parallel to the contour line of the sea area and the back flowing is obvious in some parts of the area. The pre-selected discharge outlet is right in the bay mouth of Tieshan Port where the velocity of flow is as high as 0.80m/s approximately.

To take into full account implementation of planning of Tieshan Port and distribution of tidal current field in the selected discharge area when the coastline is formed in the dock and to reason the feasibility of pre-selected discharge outlet in comprehensive and scientific manner, the distribution of flow field and riptide field caused by ebb and flood of large or small tides after implementation of the planning of Tieshan Port and construction of coastline are calculated through data simulation after adjusting unit configurations of the original tidal current math model. For details, refer to F.7.2-9 –F7.2-12. According to the calculation results, the velocity variation of flood and ebb in datum points that are set about 1km away from the planned coastline and in surrounding area for comparison (refer to figure 7.12-13) is shown in table 7.2—1 and 7.2—2, from which the conclusions are obtained as following condition: (1) According to the data of point ①②, the planned engineering will have slight impact on hydrodynamic, (2) According to the data of point ③④⑤, the flow section outside the new coastline is narrowed as the new coastline extends the land into the sea by 1.5-2km, increasing the velocity of flow outside the new coastline by 8-10% with little changes of direction; (3) According to the data of point ⑥⑦, new planned coastline will also obviously affect the water area in the south forming abrupt extension or shrinkage of flow sections and slow down the flow velocity by 10-15% with obvious change of flow direction.

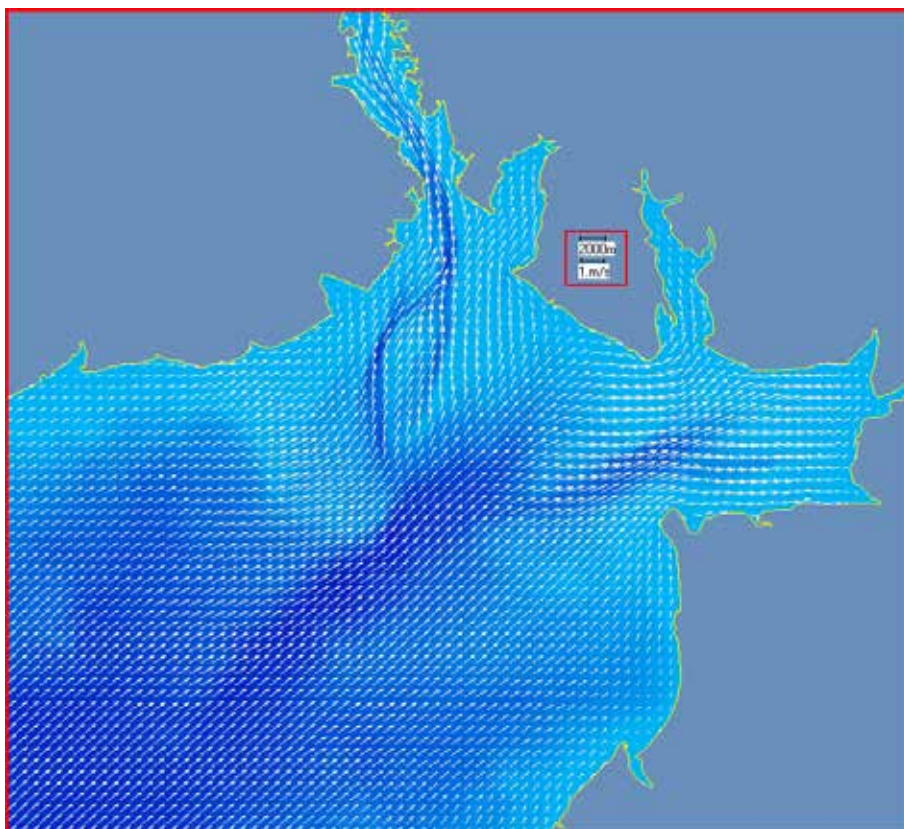


Figure 7.2—5 Current flow field (Spring tide, flood)

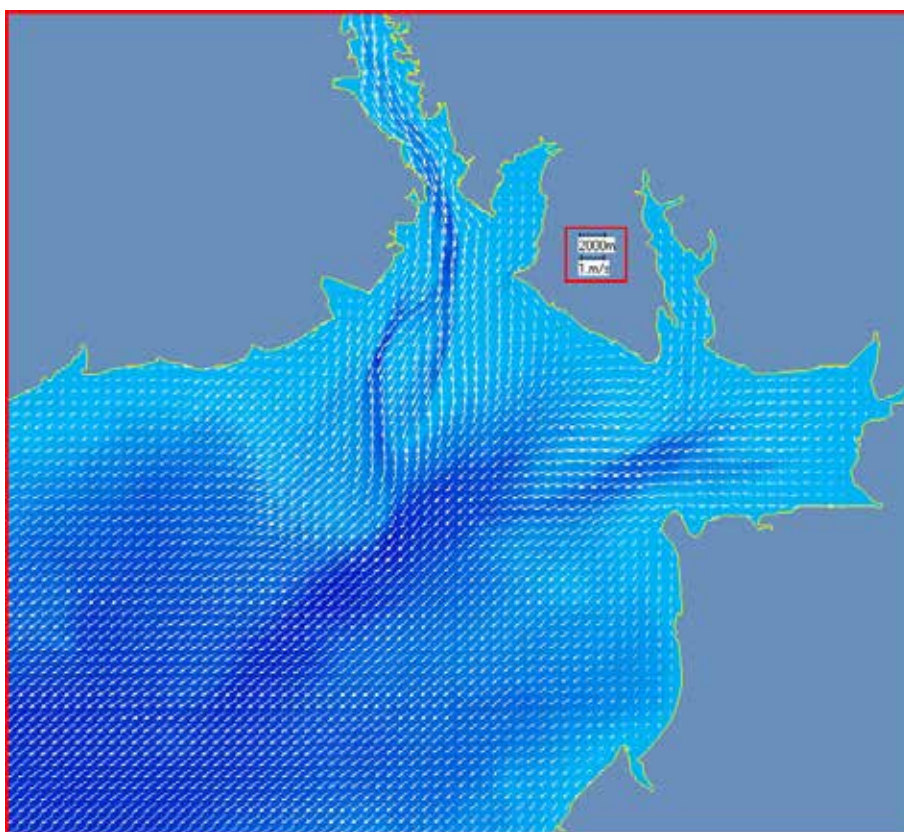


Figure 7.2—6 Current flow field (Spring tide, ebb)



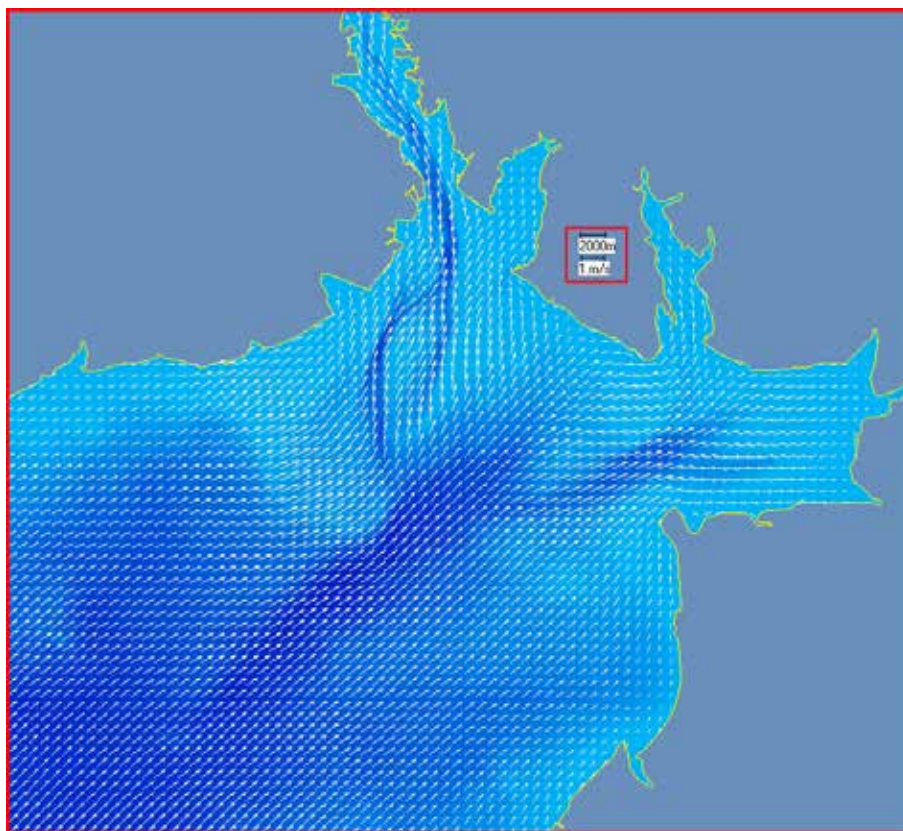


Figure 7.2—7 Current flow field(Neap, flood)

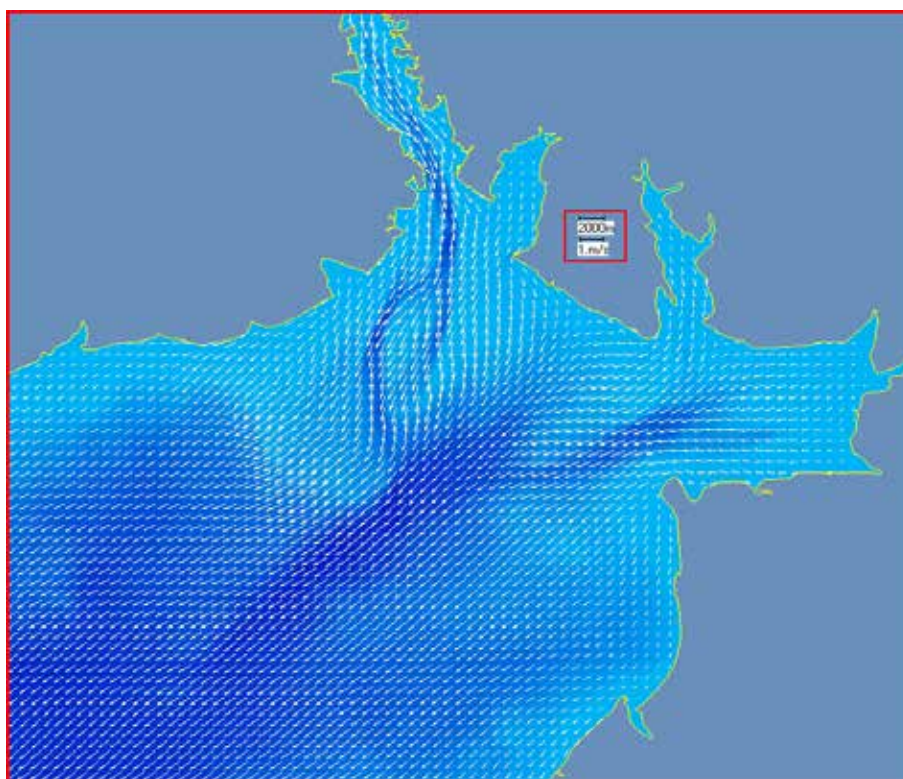


Figure 7.2—8 Current flow field (Neap, ebb)

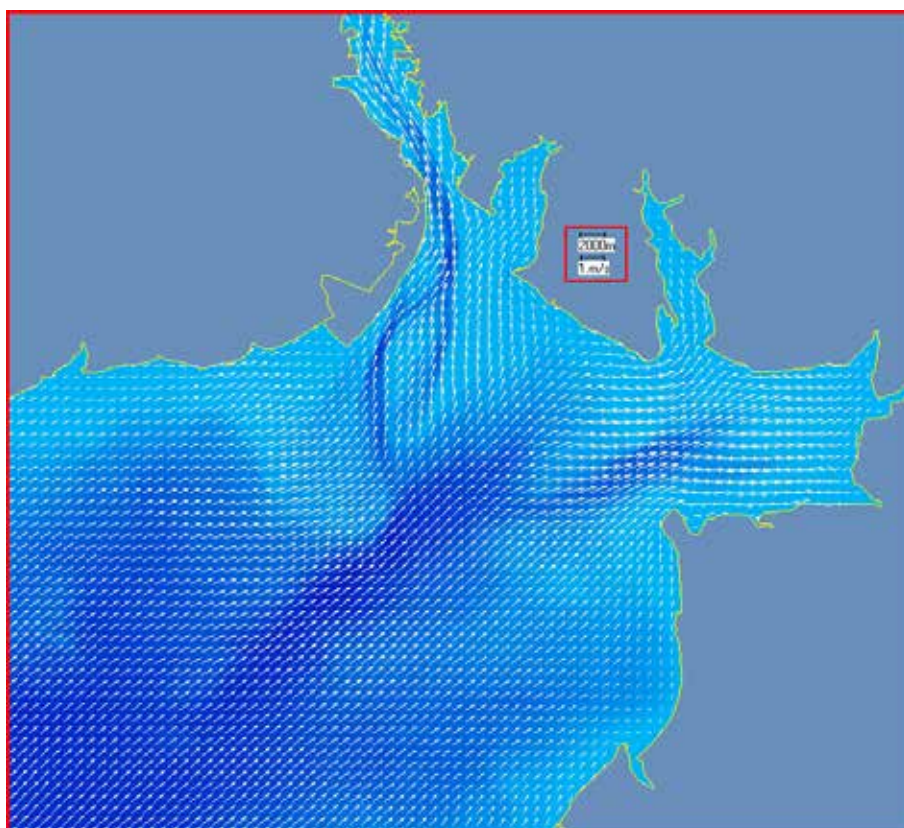


Figure7.2—9 Flow field after implementation of planned coastline (Spring tide, flood)

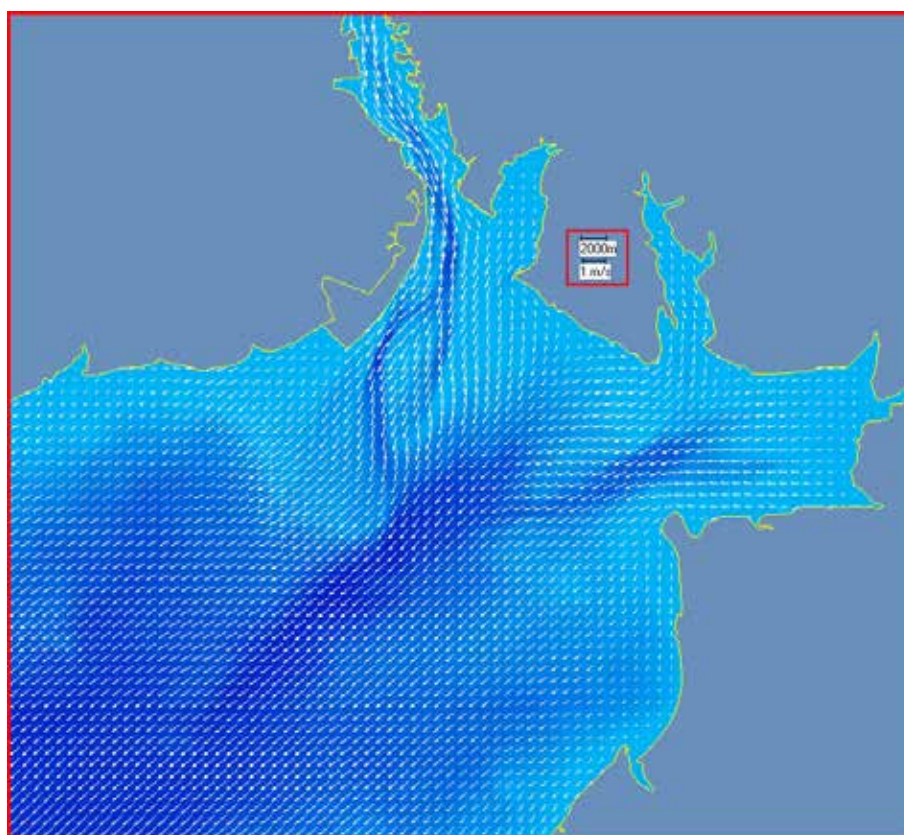


Figure7.2—10 Flow field after implementation of planned coastline (Spring tide, ebb)



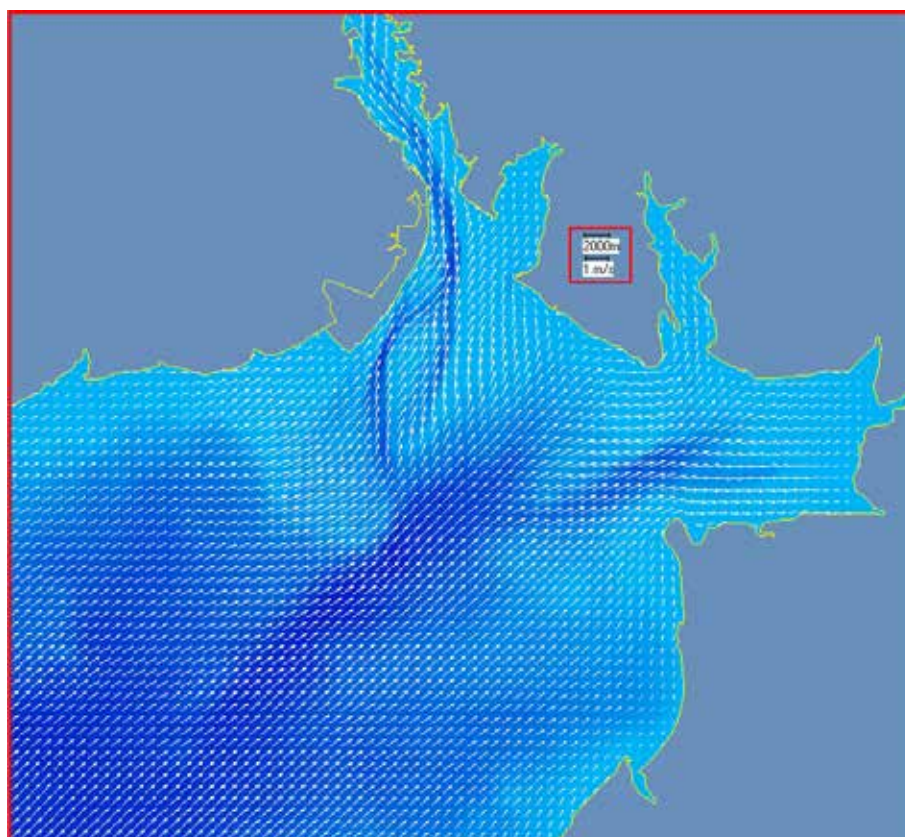


Figure 7.2—11 Flow field after implementation of planned coastline (Neap, flood)

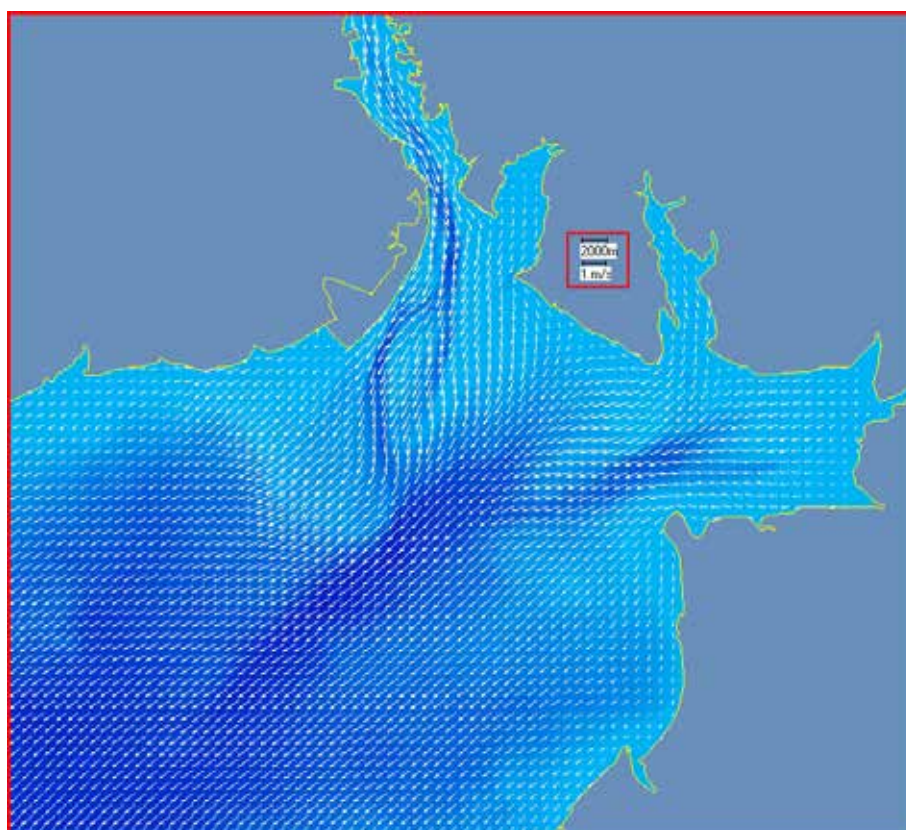


Figure 7.2—12 Flow field after implementation of planned coast line (Neap, ebb)

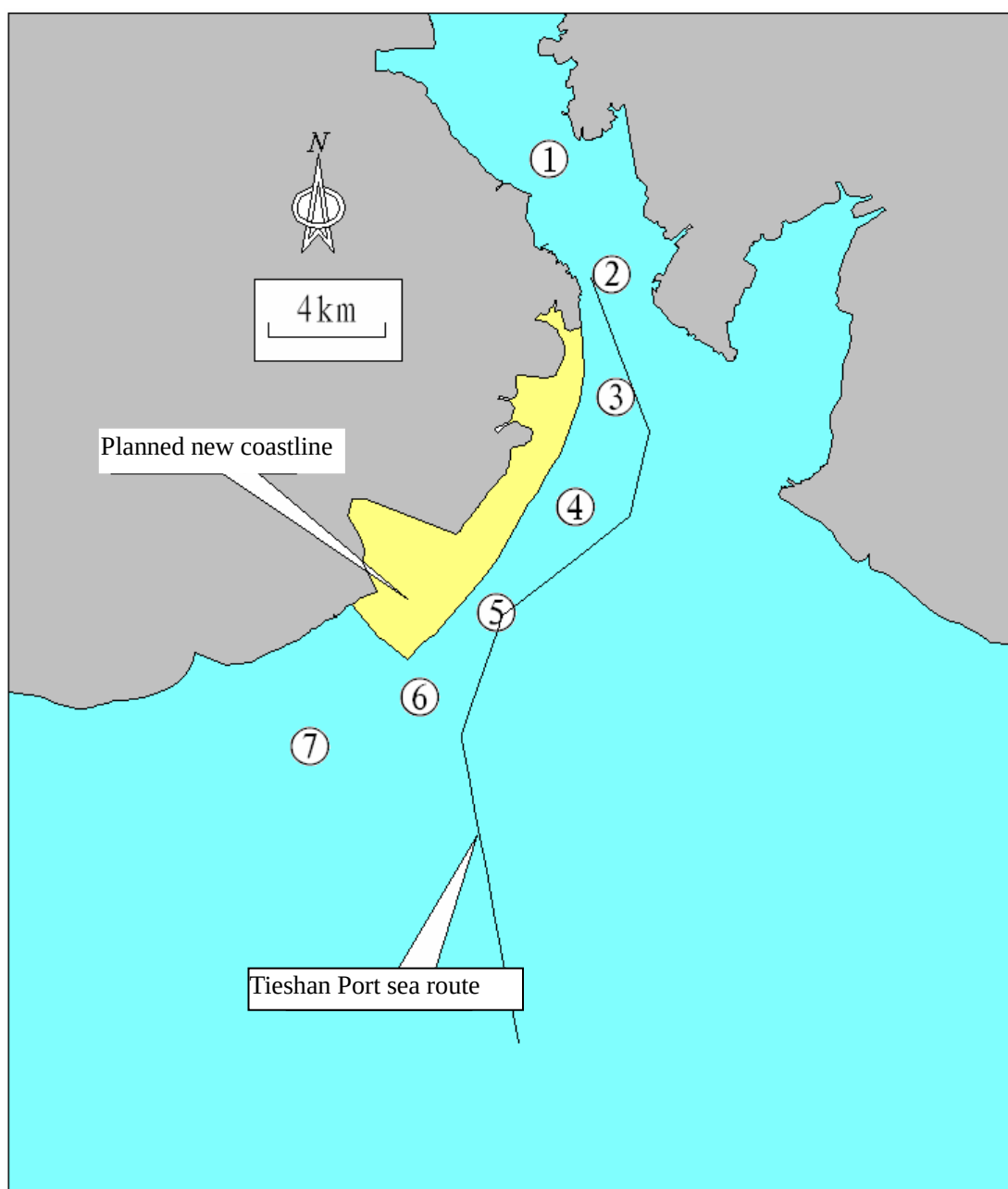


Figure 7.2—13 Datum point map for comparison of velocity before and after the planned engineering construction

**Table 7.2—1 Table of velocity comparison before and after the planned engineering in the harbor during spring tide**

| Time  | Point | Before the planned engineering |        |       |     | After the planned engineering |        |       |     | Variation of flow velocity |
|-------|-------|--------------------------------|--------|-------|-----|-------------------------------|--------|-------|-----|----------------------------|
|       |       | U                              | V      | UV    | A   | U                             | V      | UV    | A   |                            |
| Flood | 1     | -0.449                         | 0.617  | 0.764 | 324 | -0.457                        | 0.628  | 0.776 | 324 | 0.012                      |
|       | 2     | -0.196                         | 0.823  | 0.846 | 347 | -0.173                        | 0.822  | 0.840 | 348 | -0.006                     |
|       | 3     | -0.006                         | 0.724  | 0.724 | 360 | -0.020                        | 0.797  | 0.797 | 359 | 0.073                      |
|       | 4     | 0.453                          | 0.761  | 0.885 | 31  | 0.513                         | 0.804  | 0.954 | 33  | 0.069                      |
|       | 5     | 0.362                          | 0.674  | 0.765 | 28  | 0.373                         | 0.676  | 0.772 | 29  | 0.007                      |
|       | 6     | 0.412                          | 0.524  | 0.667 | 38  | 0.495                         | 0.370  | 0.618 | 53  | -0.049                     |
|       | 7     | 0.582                          | 0.350  | 0.680 | 59  | 0.552                         | 0.212  | 0.591 | 69  | -0.089                     |
| Ebb   | 1     | 0.400                          | -0.552 | 0.682 | 144 | 0.402                         | -0.555 | 0.685 | 144 | 0.003                      |
|       | 2     | 0.164                          | -0.697 | 0.717 | 167 | 0.151                         | -0.696 | 0.713 | 168 | -0.004                     |
|       | 3     | 0.052                          | -0.626 | 0.629 | 175 | 0.064                         | -0.682 | 0.685 | 175 | 0.056                      |
|       | 4     | -0.338                         | -0.616 | 0.703 | 209 | -0.408                        | -0.641 | 0.760 | 212 | 0.057                      |
|       | 5     | -0.265                         | -0.515 | 0.579 | 207 | -0.290                        | -0.533 | 0.606 | 209 | 0.027                      |
|       | 6     | -0.245                         | -0.425 | 0.490 | 210 | -0.279                        | -0.341 | 0.440 | 219 | -0.050                     |
|       | 7     | -0.294                         | -0.285 | 0.409 | 226 | -0.281                        | -0.192 | 0.340 | 236 | -0.069                     |

Note: U-Eastern component of flow velocity (m/s), V-North component flow velocity (m/s), UV-Flow velocity (m/s), A-flow direction (degree), the variation of flow velocity is the flow velocity before the engineering construction minus the one after the construction (m/s).

**Table 7.2—2 Table of velocity comparison before and after the planned engineering in the harbor during a neap**

| Time  | Point | Before the planned engineering |        |       |     | After the planned engineering |        |       |     | Variation of flow velocity |
|-------|-------|--------------------------------|--------|-------|-----|-------------------------------|--------|-------|-----|----------------------------|
|       |       | U                              | V      | UV    | A   | U                             | V      | UV    | A   |                            |
| Flood | 1     | -0.175                         | 0.243  | 0.300 | 324 | -0.177                        | 0.245  | 0.303 | 324 | 0.003                      |
|       | 2     | -0.076                         | 0.327  | 0.335 | 347 | -0.067                        | 0.324  | 0.331 | 348 | -0.004                     |
|       | 3     | -0.009                         | 0.299  | 0.299 | 358 | -0.013                        | 0.323  | 0.323 | 358 | 0.024                      |
|       | 4     | 0.199                          | 0.336  | 0.391 | 3   | 0.228                         | 0.349  | 0.417 | 3   | 0.026                      |
|       | 5     | 0.155                          | 0.298  | 0.336 | 2   | 0.160                         | 0.292  | 0.333 | 2   | -0.003                     |
|       | 6     | 0.189                          | 0.247  | 0.310 | 3   | 0.205                         | 0.177  | 0.271 | 4   | -0.039                     |
|       | 7     | 0.273                          | 0.181  | 0.328 | 5   | 0.248                         | 0.115  | 0.273 | 6   | -0.055                     |
| Ebb   | 1     | 0.277                          | -0.373 | 0.465 | 143 | 0.282                         | -0.380 | 0.473 | 143 | 0.008                      |
|       | 2     | 0.114                          | -0.479 | 0.492 | 167 | 0.104                         | -0.485 | 0.496 | 168 | 0.004                      |
|       | 3     | 0.027                          | -0.395 | 0.396 | 176 | 0.038                         | -0.442 | 0.444 | 175 | 0.048                      |
|       | 4     | -0.221                         | -0.379 | 0.439 | 210 | -0.255                        | -0.405 | 0.478 | 212 | 0.039                      |
|       | 5     | -0.162                         | -0.294 | 0.336 | 209 | -0.168                        | -0.305 | 0.349 | 209 | 0.013                      |
|       | 6     | -0.195                         | -0.227 | 0.299 | 221 | -0.197                        | -0.181 | 0.268 | 227 | -0.031                     |
|       | 7     | -0.264                         | -0.155 | 0.306 | 240 | -0.243                        | -0.084 | 0.257 | 251 | -0.049                     |

Note: U-Eastern component of flow velocity (m/s), V-North component flow velocity (m/s), UV-Flow velocity (m/s), A-flow direction (degree), the variation of flow velocity is the flow velocity before the engineering construction minus the one after the construction (m/s).

## 7.3 Overview of Discharge Outlet

### 7.3.1 Layout scheme for waste water discharge outlets in Tieshan Port area and approval

For development of Tieshan Port and neighboring industrial area, relevant department has conducted a great deal of analysis and demonstration work for site selection and planning for discharge outlets in this sea area, determined layout scheme for waste water discharge outlets in Tieshan Port area by using guarantee of standard reaching of water quality at the boundary of mixing zone for pollution discharge, standard reaching of the water quality objective of functional area of surrounding environment and avoidance of impact on the water quality as the control principle. The scheme has been approved by Environmental Protection Agency of Guangxi Zhuang Autonomous Region and approved contents are shown in Annex 10. Two discharge outlets---A1 and B3 are set for the scheme, while scheme B3 is selected for discharge outlets of the project (shown in Figure 7.3-1 and coordinate is E109 ° 35'48 "" N21 ° 30'54 "). Selection of B3 discharge outlet for the project is mainly based on two considerations: (1) A1 discharge outlet has been determined as the discharge outlet of the wastewater treatment plant, which is planned to be built in the Eastern zone of Tieshan Port. B3 discharge outlet selected for the project can take full advantage of the environmental capacity of its mixing zone, share the pressure caused by pollution discharge from A1 discharge zone, avoid or relieve the phenomenon of forming high-concentration area of pollutant in the mixing zone of A1 discharge outlet, maintain maximum pollution discharge capacity in northern and southern discharge zones in the sea area of Tieshan Port; (2) The distance from the wastewater treatment plant for the project to B3 discharge outlet is closer than that to A1 discharge outlet and more economically reasonable.

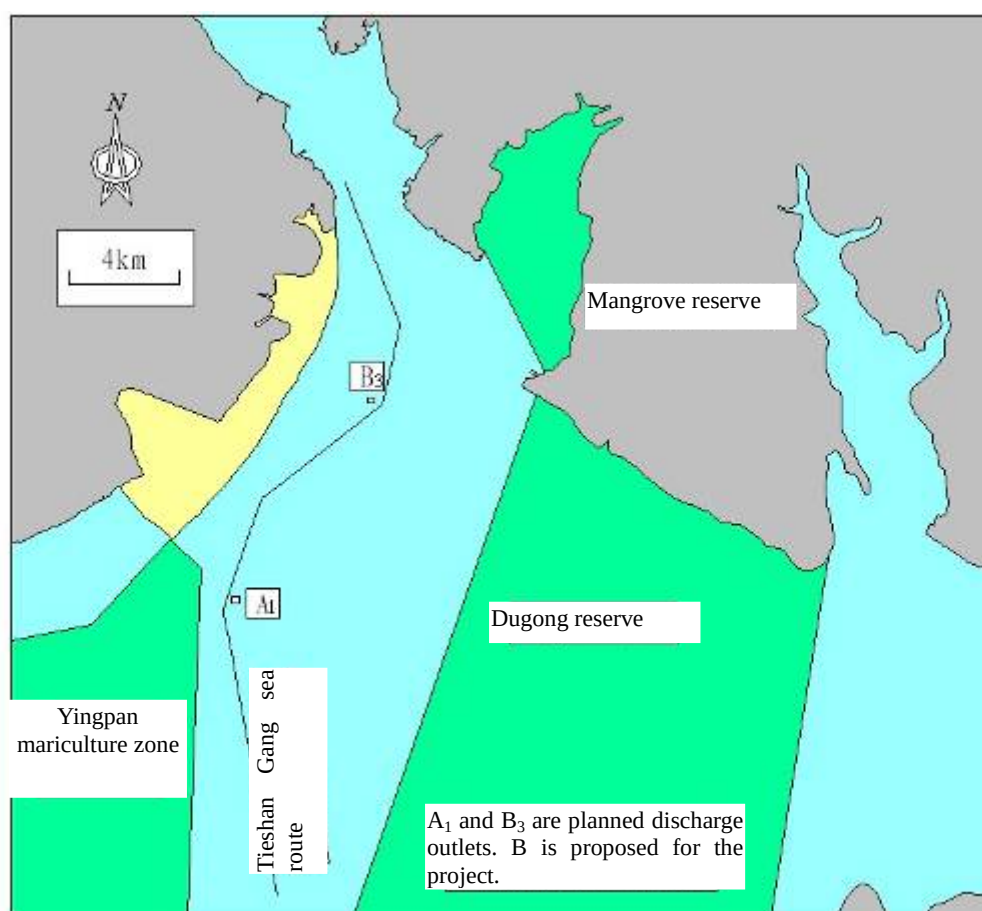


Figure7.3—1 Layout of planned discharge outlets and proposed outlet

### 7.3.2 Major results for demonstrating site selection for B3 discharge outlet of waste water in Tieshan Port area

#### 7.3.2.1 Terrain and landform

Tieshan Port is a platform submerged bay, which formed via the rising sea level on the basis of depression construction during late phase of freezing period. It forms a long and narrow tide channel with length of 40km (from the end of the bay to the shoal of the outer blocking gate) and width of 3~4km. According to comparison of two dynamic factors of Tieshan Port, tide and wave, tide is a dominant factor. The channel in the bay (deep trough) belongs to tidal action-based channel, which is a deep trough forming through shaping by currents of flood tide and ebb tide.

It reflects that the ebb delta growth obviously according to the distribution of landforms and sediments. There is a clear tide scour trough at the Bay mouth, which is the main trough of Tieshan Port. In the port entrance and outside-entrance water area, tide scour trough appears differently, forming two deep troughs- east and west trough, while the east trough is formed by the ebb tide, and west trough by the flood tide. The east trough is linking with the main trough; between the east and west trough stands the sandbar and shallow.

### 7.3.2.2 Characteristics of tidal residual current

Tieshangang Port is a platform submerged bay, in which the tide is dominant. Due to influence and constraint of the terrain, tide at the entrance of Tieshan Port shows as reciprocating current moving along the isobath with shorter bypass duration. Though the current gradually transits to rotary current from the exterior of the port to Weizhou Island, the long axis is still in NE~SW direction. Generally, duration of flood tide is longer than that of ebb tide, while flow rate of ebb tide is higher than that of flood tide. In addition, hydrograph of flow rate of flood tide shows bimodal shape, which appears near the medium tidal level. A stable time course sometimes occur on the curve of tidal level, which sometimes slightly falls back, resulting in reduction of flow rate of flood tide, even brief current of ebb tide. Generally, ebb tide transits to flood tide in clockwise direction and flood tide to ebb tide in counter-clockwise direction.

The circulation system of residual current in two troughs in Tieshan Port is shown in Figure 7.3-2. According to measured residual current, clockwise circulation "1" is in the southwest of Yingpan. It firstly flows from west to east. Then it is firstly forced to turn to the southeast and then to the south due to constraint of V-shaped shoal and contacting with circulation "2". The formation reason of this circulation is directly related to the presence of V-shaped shoal. Circulation "2" forms on the south of two troughs because there is a current in the direction from west to northwest. When it encounters V-shaped shoal, it's forced to turn and diverted. Turned current turns to the north along the western trough, while diverted current firstly turn to the south and then flow to the southeast after encountering the current, which is from the west of V-shaped shoal and flows to the east. These two branches meet at the shoal, prompting its formation and maintenance. circulation "3", residual current of two troughs, forms a clockwise circulation, which means that current flows from western trough to the north. Current from eastern trough flows to the south and that from the south of two troughs flows to the west. shoal movement of the circulation happens around two troughs, whose formation should be attributed to asymmetry between rising of two troughs and current of ebb tide. Ratio between flow rates of flood tides from western and eastern troughs is 1.6. ebb tide in eastern trough is 1.2h earlier than that in western trough. Increment of ebb tide is more obviously than that of flood tide in eastern trough, while this phenomenon isn't obvious in western trough. Ratio between flow rates of ebb tides from western and eastern troughs is 1.1. obviously, asymmetry between current of ebb tide and flood tide of two troughs necessarily results in net transport capacity of seawater in the north of western trough and south of eastern trough. The reason is that eastern trough stretches northward into the bay area and directly extends southward to the deep waters without hindrance by the shoal terrain. During ebb tide, seawater in the bay area withdraws from the eastern trough more easily.

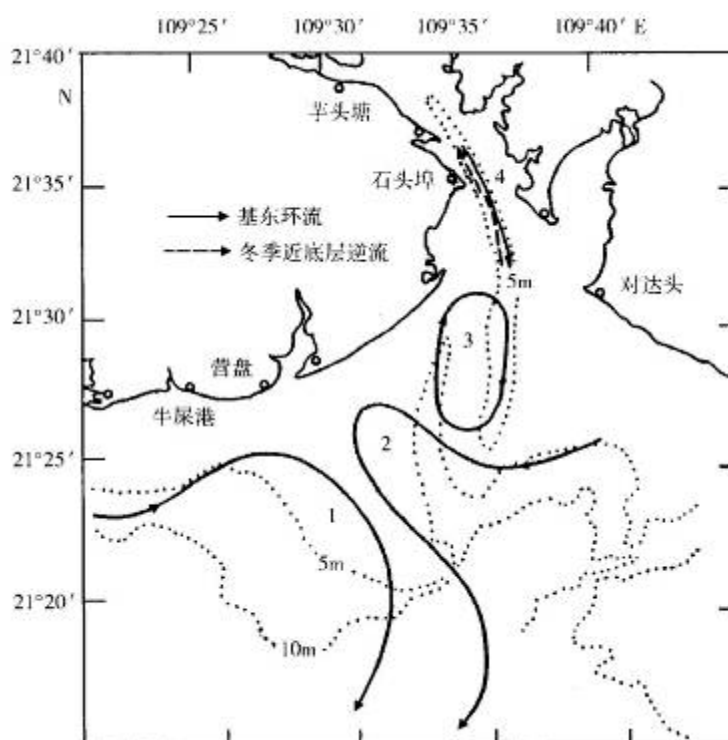


Figure 7.3-2 Basic circulating-current of Tieshangang Port

### 7.3.2.3 Constraint conditions for site selection for discharge outlet in the deep waters of the sea area

According to planning of Tieshan Port, functional zoning for environment of coastal waters in this sea area, distribution of environmental protection objectives and associated regulations and standards, constraint conditions for site selection for discharge outlet for waste water of the project are as follows:

- ① Site selection for discharge outlet shall comply with functional zoning for environment of coastal waters. Avoid setting discharge outlet in class I and II functional area as possible.
- ② Hydrodynamic condition, which is near the discharge outlet, is favorable for transport and diffusion of the pollutant to open sea and doesn't affect the use function of functional area beyond the mixing zone.
- ③ Generally, there is no impact on environmental protection objectives, such as mangrove reserve, Dugong reserve and pearl reserve.
- ④ Current channel is avoided and the distance to the center line of channel is not less than 200 meters.
- ⑤ Avoid exceeding the mixing zone required by the functional area of environment of coastal waters, while regional environmental quality shall meet the standard of class II functional area.
- ⑥ Environmental capacity of mixing zone with area less than 1 km<sup>2</sup> shall be larger than maximum discharge volume.
- ⑦ Control standard for COD concentration mixing zone: 3mg/L. Minimum dilution degree



shall be higher than or equal to 45.

⑧ To meet the regulations in Standard for pollution control of sewage marine disposal engineering, diffuser must be laid on the bottom with water depth of 7m, while its starting point is 200m from low-water line. Concentration limits for emission of various pollutants are also stipulated.

#### 7.3.2.4 Comparison and selection scheme for site selection for discharge outlet of waste water of the project

According to above constraint conditions, 4 comparison and selection schemes for site selection for discharge outlet of waste water of the project (B1, B2, B3 and B4). Site selection for discharge outlets is shown in Figure 7.3-3, while coordinates and hydrodynamic parameters are shown in Table 7.3-1.

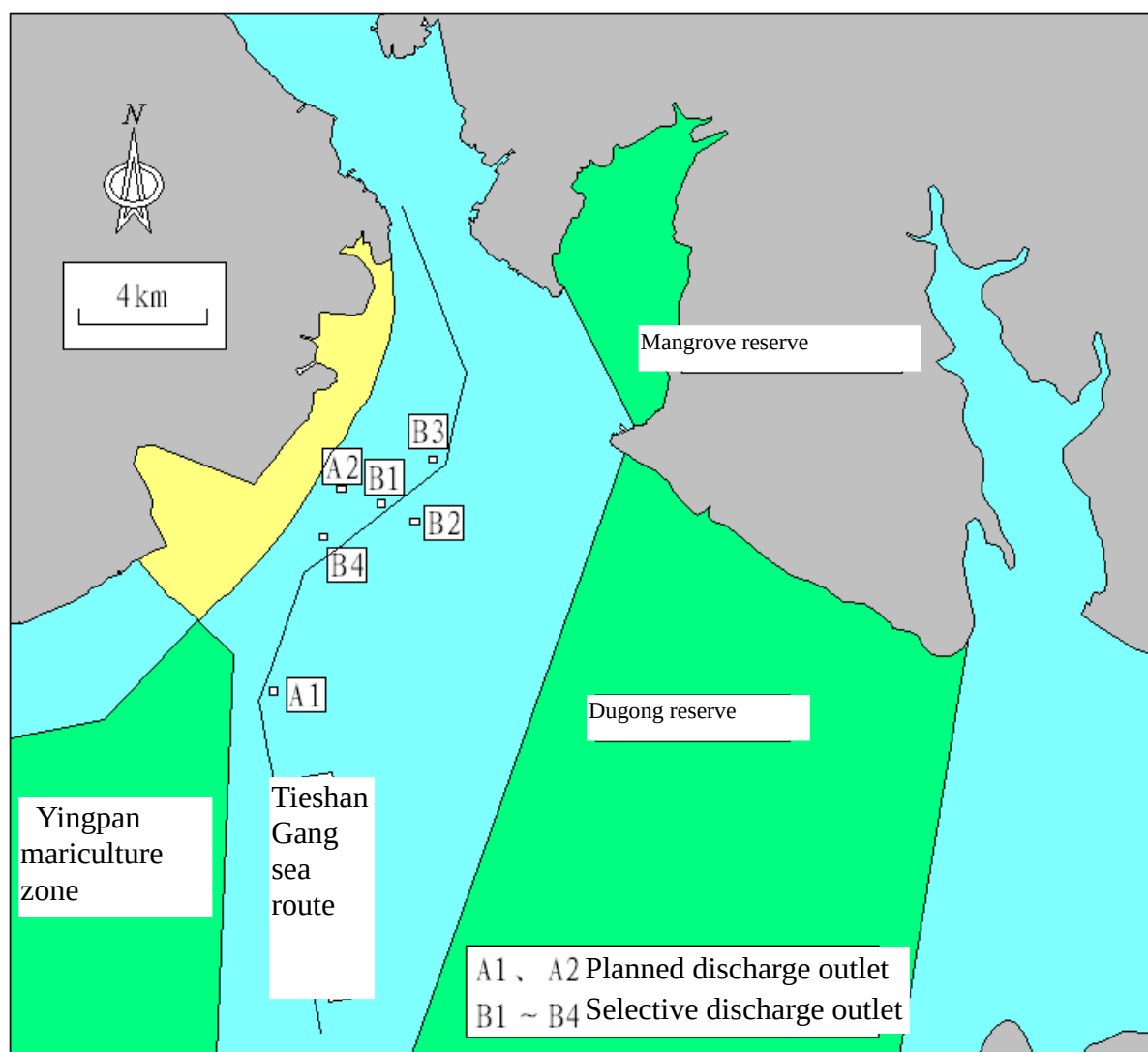


Figure 7.3-3 Site selection for discharge outlets



**Table 7.3—1                      Coordinates and hydrodynamic parameters for site selection schemes of discharge outlet**

| Point position | coordinate      |                | Elevation (m) | Average flow rate (m/s) |            |
|----------------|-----------------|----------------|---------------|-------------------------|------------|
|                | East longitude  | North latitude |               | Large tide              | Small tide |
| B1             | 109 ° 34 ' 56 " | 21 ° 30 ' 10 " | -4.5          | 0.419                   | 0.396      |
| B2             | 109 ° 35 ' 31 " | 21 ° 29 ' 52 " | -6.5          | 0.409                   | 0.384      |
| B3             | 109 ° 35 ' 48 " | 21 ° 30 ' 54 " | -10.0         | 0.503                   | 0.477      |
| B4             | 109 ° 33 ' 57 " | 21 ° 29 ' 36 " | -9.5          | 0.385                   | 0.363      |

### 7.3.2.5 Environmental capacity of each site selection scheme for discharge outlet

Environmental capacity of each comparison and selection discharge outlet were shown in Table 7.3—2. According to the table, site selection for discharge outlet B3 of waste water of the project leads to environmental capacity maximum, followed by site selection for discharge outlet B1.

**Table 7.3—2                      Environmental capacity of water body (>class II) with area of less than 1km<sup>2</sup>**

| Site selection scheme for discharge outlet     | B1   | B2   | B3   | B4   |
|------------------------------------------------|------|------|------|------|
| COD <sub>Cr</sub> environmental capacity (t/d) | 34.3 | 37.7 | 41.4 | 30.9 |

### 7.3.2.6 Environmental optimization for site selection for discharge outlet of waste water of the project

Site selection for discharge outlet shall comply with functional zoning for coastal water environment (avoid setting discharge outlet in class I and II functional area as possible ), benefit for transport and diffusion of pollutant to open sea and don't affect the use function of neighboring functional area out of the mixing zone and avoid affecting environmental protection objectives, such as Mangrove reserve, Dugong reserve and Pearl reserve. Current channel is avoided (the distance to the center line of channel is not less than 200 meters). Don't affect the use function of approved discharge zone (Maintain maximum pollution discharge capacity of the discharge zone, and the area affecting concentration overlap shall meet the standard of class II functional area). Environmental capacity of mixing zone with area of less than 1 km<sup>2</sup> shall be larger than maximum discharge volume. Concentration control standard for COD in mixing zone is 3mg/L. Environmental optimization for site selection for discharge outlet of waste water of the project complies with Standard for Pollution Control of Sewage Marine Disposal Engineering. According to

optimization result ( shown in Table 7.3—3, Table 7.3—4) , site selection scheme for B3 discharge outlet is better than other schemes. Therefore, it is recommended that waste water discharge outlet is set at point B3.

**Table 7.3—3 Environmental optimization results of site selection for discharge outlet**

**schemes under implementation of planned coastline of the port**

| Condition of selection and division                                          | Discharge outlet B1                                                                                                                                                                                                  | Discharge outlet B2                            | Discharge outlet B3 | Discharge outlet B4 |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|---------------------|---------------------|
| Impact on water environment                                                  | Under normal discharge condition, impact on water environment is only embodied by quality standard of COD-containing water of higher than Class II (mixing zone) in partial zone, which is near the discharge outlet |                                                |                     |                     |
| Impact on reserve                                                            | Slight                                                                                                                                                                                                               | Slight                                         | Slight              | Slight              |
| Environmental capacity                                                       | Smaller                                                                                                                                                                                                              | Larger                                         | Maximum             | Mimimum             |
| The distance from the planned coastline that may affect the use of shoreline | 2100m                                                                                                                                                                                                                | 3200m                                          | 2750m               | 1100m               |
|                                                                              |                                                                                                                                                                                                                      |                                                |                     | Possible impact     |
| The distance from the center line of the current channel                     | 280m                                                                                                                                                                                                                 | 800m                                           | 350m                | 540m                |
| Condition of water depth                                                     | Water depth $\leq$ 7m in the case of high tide                                                                                                                                                                       | Water depth $\leq$ 7m in the case of high tide | Water depth $>$ 7m  | Water depth $>$ 7m  |
| Conformance for environment of coastal waters functional zoning              | Show conformance                                                                                                                                                                                                     | Show conformance                               | Show conformance    | Show conformance    |
| Dynamic conditions of transport and diffusion                                | Sub-stronger                                                                                                                                                                                                         | General                                        | Strong              | Poor                |
| Impact on neighboring functional area out of the mixing zone                 | No obvious impact                                                                                                                                                                                                    | No obvious impact                              | No obvious impact   | No obvious impact   |

**Table 7.3—4 Environmental optimization results of site selection schemes for discharge outlet without implementation of planned coastline of the port**

| Condition of selection and division                                          | Discharge outlet B1                                                                                                                                                                                                  | Discharge outlet B2                            | Discharge outlet B3 | Discharge outlet B4 |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|---------------------|---------------------|
| Impact on water environment                                                  | Under normal discharge condition, impact on water environment is only embodied by quality standard of COD-containing water of higher than Class II (mixing zone) in partial zone, which is near the discharge outlet |                                                |                     |                     |
| Impact on reserve                                                            | Slight                                                                                                                                                                                                               | Slight                                         | Slight              | Slight              |
| Environmental capacity                                                       | Smaller                                                                                                                                                                                                              | Larger                                         | Maximum             | Mimimum             |
| The distance from the planned coastline that may affect the use of shoreline | 3500m                                                                                                                                                                                                                | 4700m                                          | 4000m               | 2800m               |
|                                                                              |                                                                                                                                                                                                                      |                                                |                     | Possible impact     |
| The distance from the center line of the current channel                     | 280m                                                                                                                                                                                                                 | 800m                                           | 350m                | 540m                |
| Condition of water depth                                                     | Water depth $\leq$ 7m in the case of high tide                                                                                                                                                                       | Water depth $\leq$ 7m in the case of high tide | Water depth $>$ 7m  | Water depth $>$ 7m  |
| Conformance for environment of coastal waters functional zoning              | Show conformance                                                                                                                                                                                                     | Show conformance                               | Show conformance    | Show conformance    |
| Dynamic conditions of transportation and diffusion                           | Sub-stronger                                                                                                                                                                                                         | General                                        | Strong              | Poor                |
| Impact on neighboring functional area out of the mixing zone                 | No obvious impact                                                                                                                                                                                                    | No obvious impact                              | No obvious impact   | No obvious impact   |

## 7.4 Forecast of environmental impacts by discharge outlet in the case of implementation of planned coastline\*

(\*planned coastline refer to the port construction development in Tieshangang Industrial Zone)

### 7.4.1 Substance transfer track

According to the regulation in GB18486-2001 Standard for Pollution Control of Sewage Marine Disposal Engineering, initial dilution degree  $\geq 45$  when annual guarantee rate is 90% and category of sea area for discharge and water quality is Class III waters. Therefore, diffuser lengths under different water depths are calculated and shown in Table 7.4-1 when initial dilution degree is 45.

**Table 7.4-1** **Determined parameters of the diffuser of the project**

| Waste water discharge volume Q (0,000t/d) | Initial dilution degree $S_0$ | Water depth Y (m) | Diffuser length $L_b$ (m) | Nozzle diameter | Nozzle quantity |
|-------------------------------------------|-------------------------------|-------------------|---------------------------|-----------------|-----------------|
| 13.6                                      | 45                            | 10                | 58.18                     | 0.3             | 9               |

The substance transfer track (within two tide cycles) at the discharge outlet is calculated and shown in figure 7.4-1 and 7.4-2. According to calculation results, reversing current is dominant in the estuary the discharge outlet is located; most of the substance transfer tracks are on the right side of the estuary in both flood and ebb tide, having a relatively light impact on dugong reserve and mangrove reserve. Moreover, affected by the flow, substances are transferred further during flood than during ebb. In another word, almost all the pollutants will move to the ocean from the estuary.

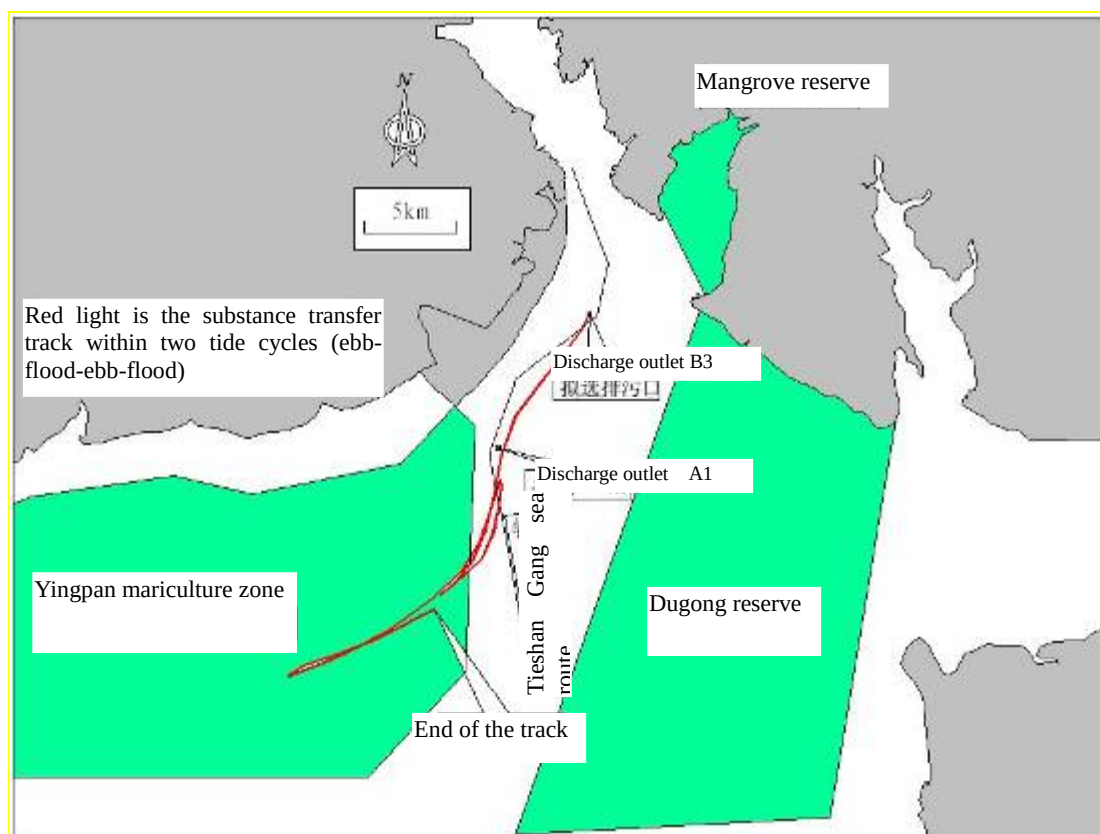


Figure 7.4-1 Substance transfer track at discharge outlet B3 (Within two cycles of flood and ebb tides)

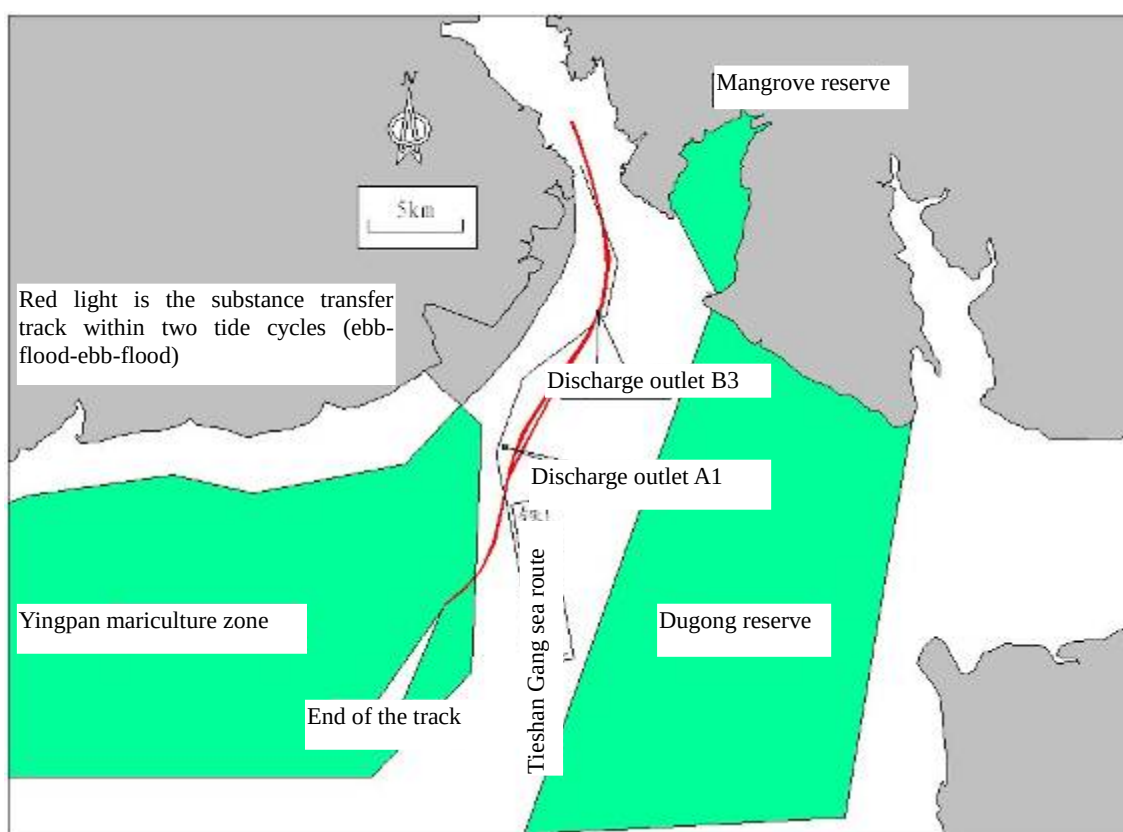


Figure 7.4-2 Substance transfer track at discharge outlet B3 (Within two tide cycles)

## 7.4.2 Impact on water environment in the case of discharge of waste water into the sea

### 7.4.2.1 Parameters of the diffuser used for the discharge outlet in the deep water

According to the regulation in GB18486-2001 Standard for Pollution Control of Sewage Marine Disposal Engineering, initial dilution degree  $\geq 45$  when annual guarantee rate is 90% and category of sea area for discharge and water quality is Class III waters.

Therefore, diffuser lengths under different water depths are calculated and shown in Table 7.4-2 when initial dilution degree is 45.

Table 7.4-2

Parameters of the diffuser of discharge outlet

| Waste water discharge volume Q (0,000t/d) | Initial dilution degree So | Water depth Y (m) | Diffuser length Lb (m) | Nozzle diameter | Nozzle quantity |
|-------------------------------------------|----------------------------|-------------------|------------------------|-----------------|-----------------|
| 13.6                                      | 45                         | 10                | 58.18                  | 0.3             | 9               |

### 7.4.2.2 Forecast of Impacts of COD contained in Waste Water on Water Environment

When estimating and calculating COD contained in discharged waste water to the deep water during the project, consider long-term COD load at discharge outlet and adopt

pollutant diffusion equation to simultaneously calculate the COD diffusion values at the two discharged outlets for 10 successive tide cycles. Then, the calculation results are superposed by COD background value.

(1) Forecast of impacts on water environment by discharged waste water after phase I project

According to the calculation by 2 discharge concentrations (Conversion factor of COD<sub>Cr</sub> and COD<sub>Mn</sub> is 2.5, and COD background value in this sea area is 1.5mg/L according to the data). Discharge volume is 76260m<sup>3</sup>/d, discharge concentrations are respectively 100 and 1410mg/L (accident discharge) and discharged COD<sub>Cr</sub> contained in waste water are 7.63, 19.06 and 107.53t/d in turn. The calculation results are used as the source strength for the forecast, listed in table 7.4-1 and figure 7.4-3 and 7.4-6.

**Table 7.4-3 Analysis of water environmental impacts by COD contained in discharged waste water after phase I project**

| Discharge concentration (mg/L) | Maximum possible affected area under different concentrations (km <sup>2</sup> ) |        |        |         |
|--------------------------------|----------------------------------------------------------------------------------|--------|--------|---------|
|                                | >5mg/L                                                                           | >4mg/L | >3mg/L | >2mg/L  |
| 1410                           | 0.1162                                                                           | 0.3384 | 1.8174 | 39.1841 |
| 100                            | local                                                                            | local  | Local  | 0.0075  |

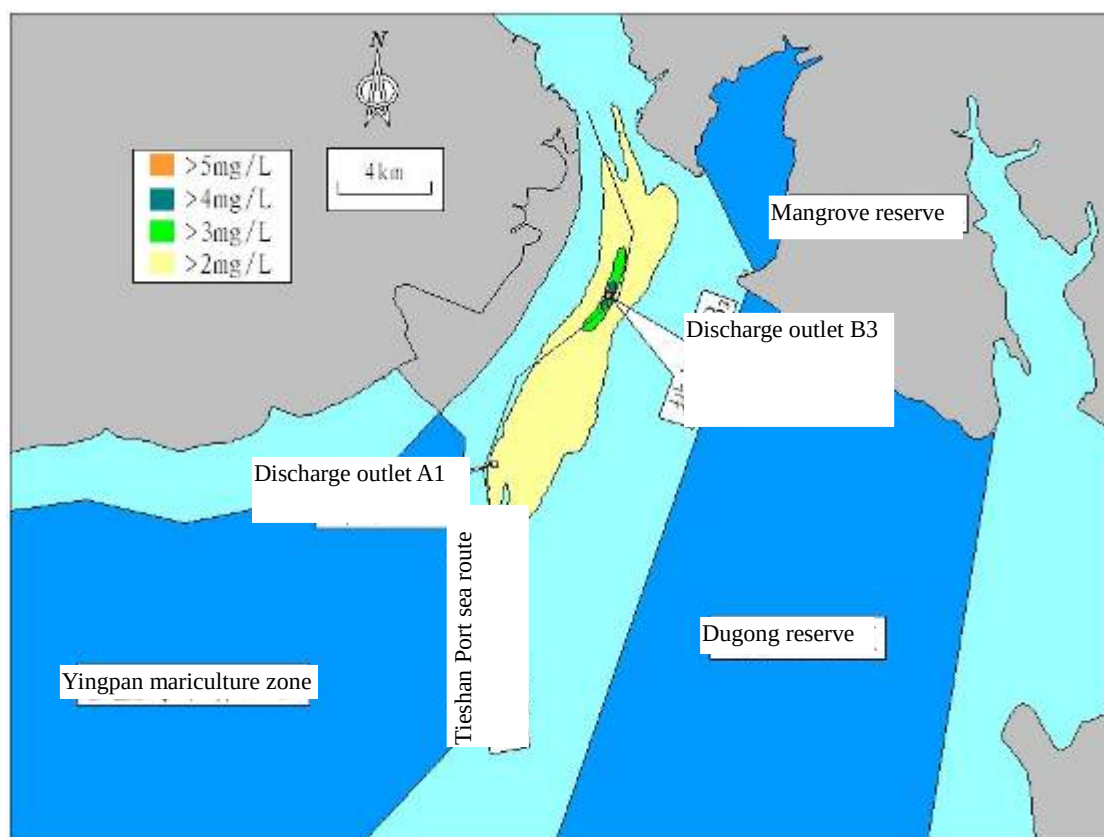


Figure 7.4-3 Envelope line of impacts under 1410mg/L COD concentration after phase I project

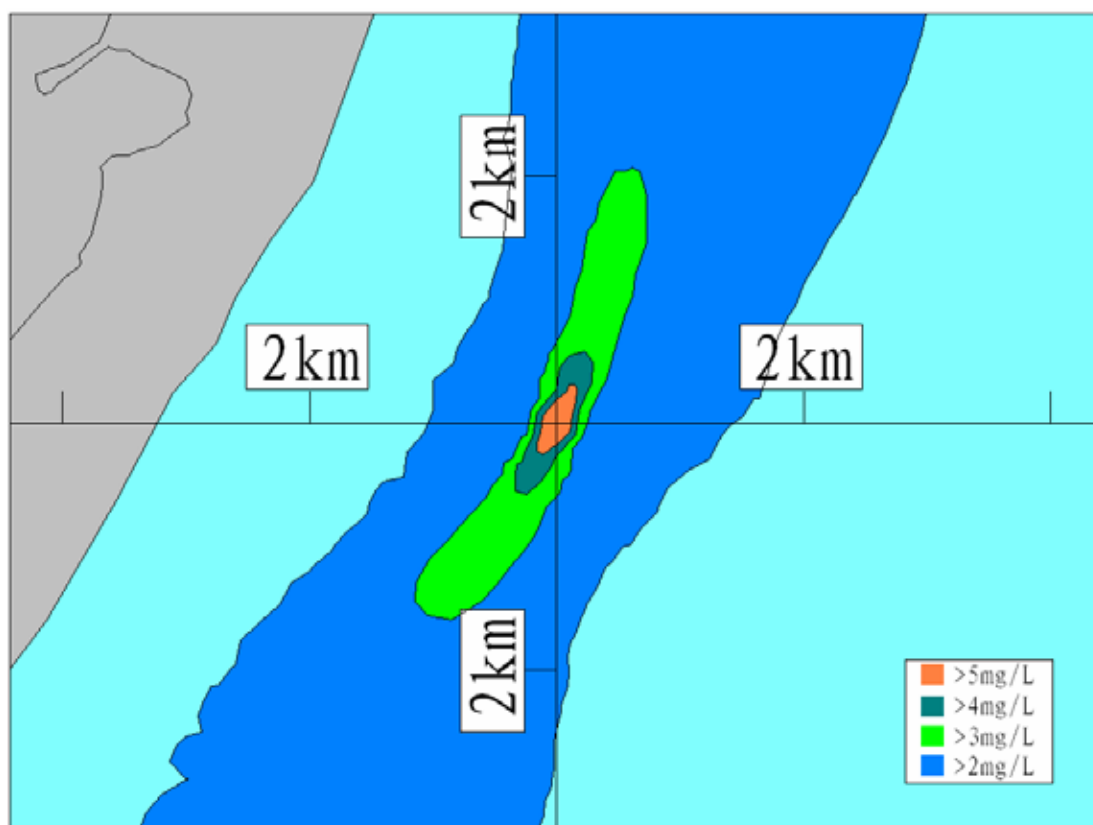


Figure 7.4-4 Envelope line of impacts under 1410mg/L COD concentration after phase I project (local)

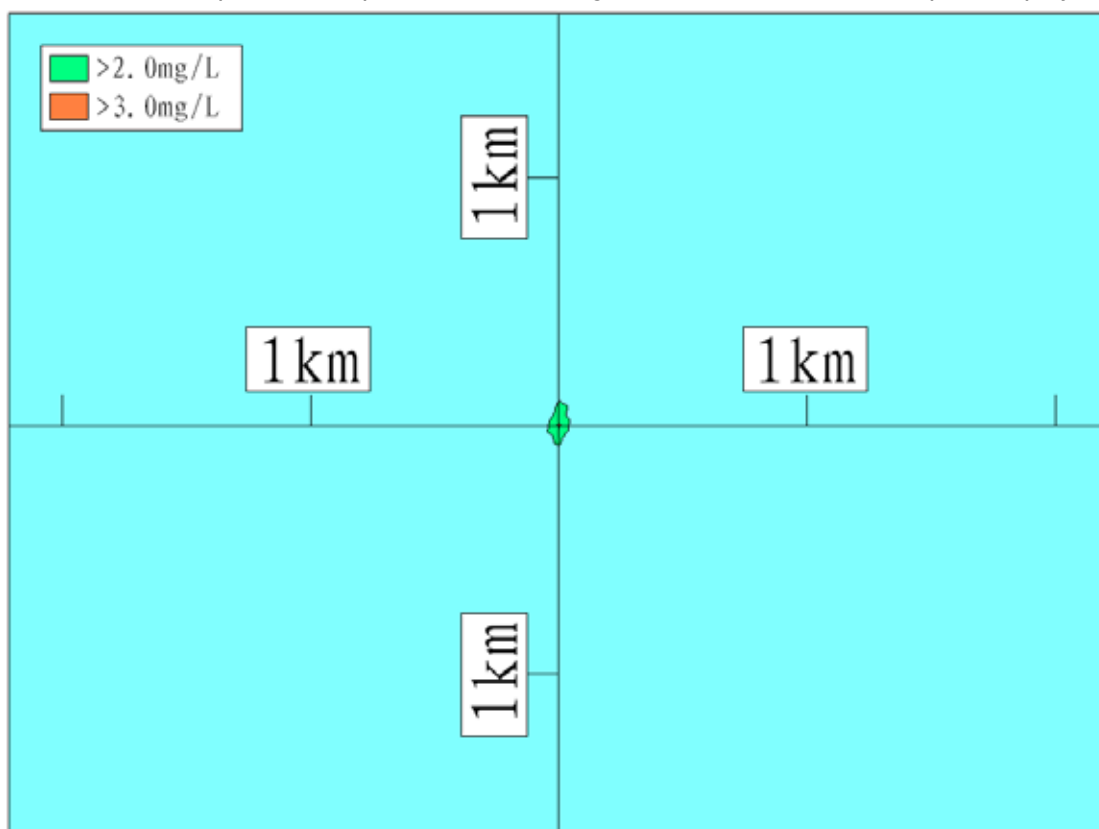


Figure 7.4-5 Envelope line of impacts under 100mg/L COD concentration after phase I project (local)

(2) Forecast of impacts on water environment by discharged waste water after phase II project

According to the forecast calculation by 2 discharge concentrations (Calculation assumptions are the same as above), the discharge volume is 93938m<sup>3</sup>/d, discharge concentrations are respectively 90 and 1250mg/L (accident discharge) and discharged COD contained in waste water are 8.46 and 117.4t/d in turn. The calculation results are used as the source strength for the forecast and listed in table 7.4-3 figure 7.4-6~7.4-8.

**Table 7.4-4 Analysis of water environmental impacts by COD contained in discharged waste water after phase II project**

| Discharge concentration (mg/L) | Maximum possible affected area under different concentrations (km <sup>2</sup> ) |              |              |               |
|--------------------------------|----------------------------------------------------------------------------------|--------------|--------------|---------------|
|                                | >5mg/L                                                                           | >4mg/L       | >3mg/L       | >2mg/L        |
| 1250                           | 0.1238                                                                           | 0.3490       | 1.8872       | 44.4981       |
| 90                             | <u>local</u>                                                                     | <u>local</u> | <u>Local</u> | <u>0.0093</u> |

(3) Forecast of impacts on water environment by discharged waste water after phase III project

According to the forecast calculation by 2 discharge concentrations (Calculation assumptions are the same as above), the discharge volume is 109158m<sup>3</sup>/d, discharge concentrations are respectively 90 and 1136mg/L (accident discharge) and discharged COD<sub>Cr</sub> contained in waste water are 9.82 and 124.0t/d t/d in turn. The calculation results are used as the source strength for the forecast and listed in Table 7.4-5 and figure 7.4-9~7.4-11.

**Table 7.4-5 Analysis of water environmental impacts by COD contained in discharged waste water after phase III project**

| Discharge concentration (mg/L) | Maximum possible affected area under different concentrations (km <sup>2</sup> ) |              |        |         |
|--------------------------------|----------------------------------------------------------------------------------|--------------|--------|---------|
|                                | >5mg/L                                                                           | >4mg/L       | >3mg/L | >2mg/L  |
| 1136                           | 0.1301                                                                           | 0.3586       | 1.9636 | 47.6637 |
| 90                             | <u>local</u>                                                                     | <u>local</u> | 0.0008 | 0.0146  |

(4) Summary

According to forecast of impacts on water environment by COD contained in discharged waste water in different periods of the engineering, under normal construction conditions, COD will only partially impact the water environment, almost without any superposition with areas impacted by COD discharged through outlet A1; The case of accident discharge will have a very large impact range of COD, but parts of the area will exceed Tier 4 quality standard of sea water in the mixing zone, without the risk of directly impact on dugong reserve, mangrove reserve and Yingpan mariculture zone.



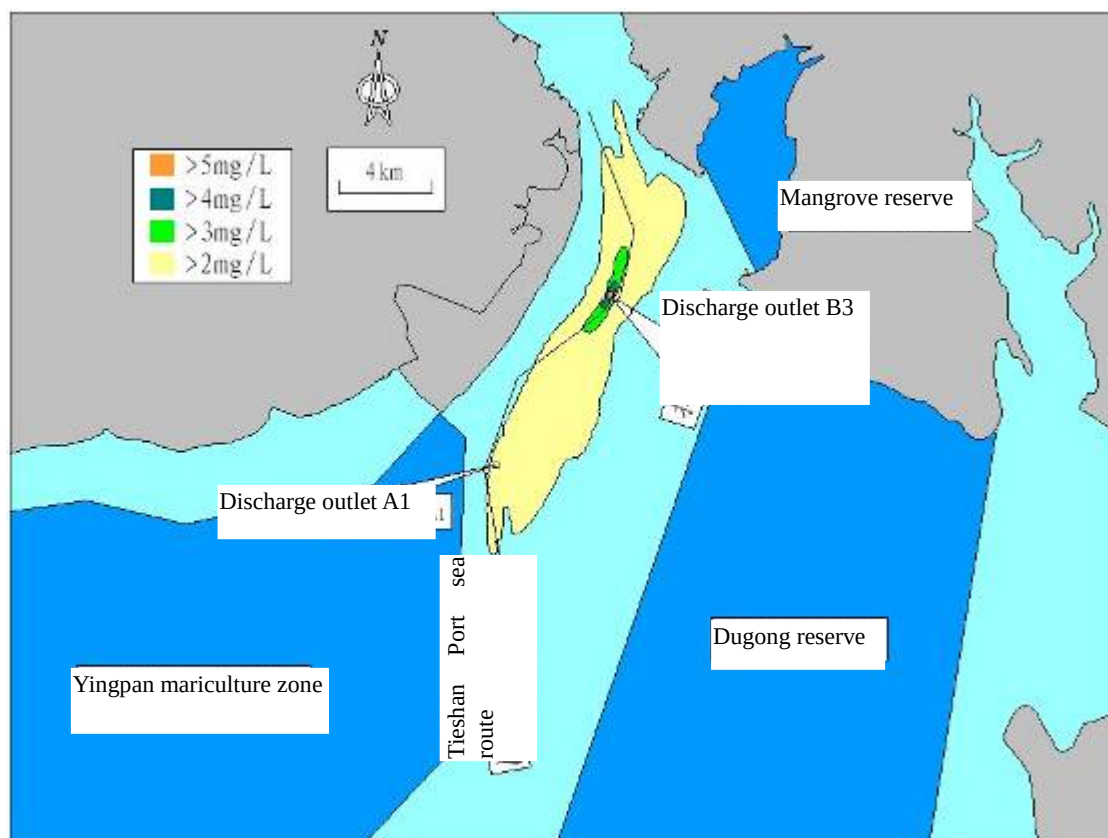


Figure 7.4-6 Envelope line of impacts under 1250mg/L COD concentration after phase II project

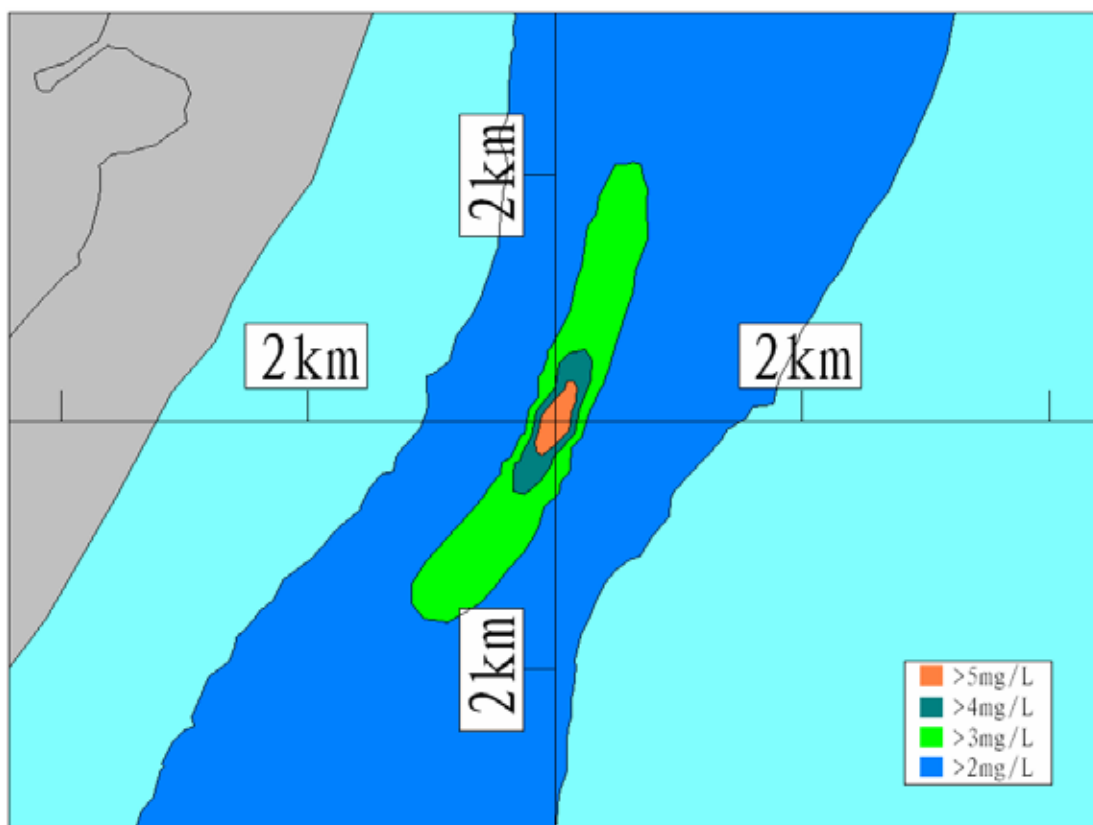


Figure 7.4-7 Envelope line of impacts under 1250mg/L COD concentration after phase II project (local)

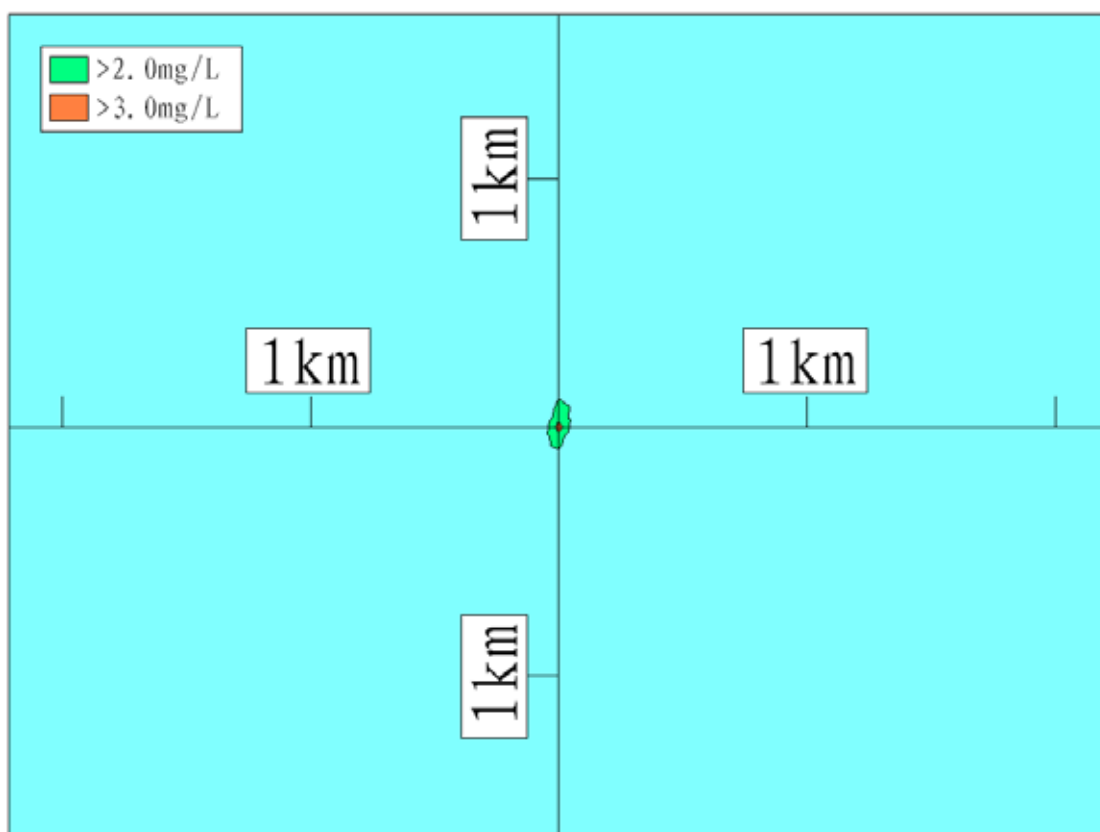


Figure 7.4-8 Envelope line of impacts under 100mg/L COD concentration after phase II project

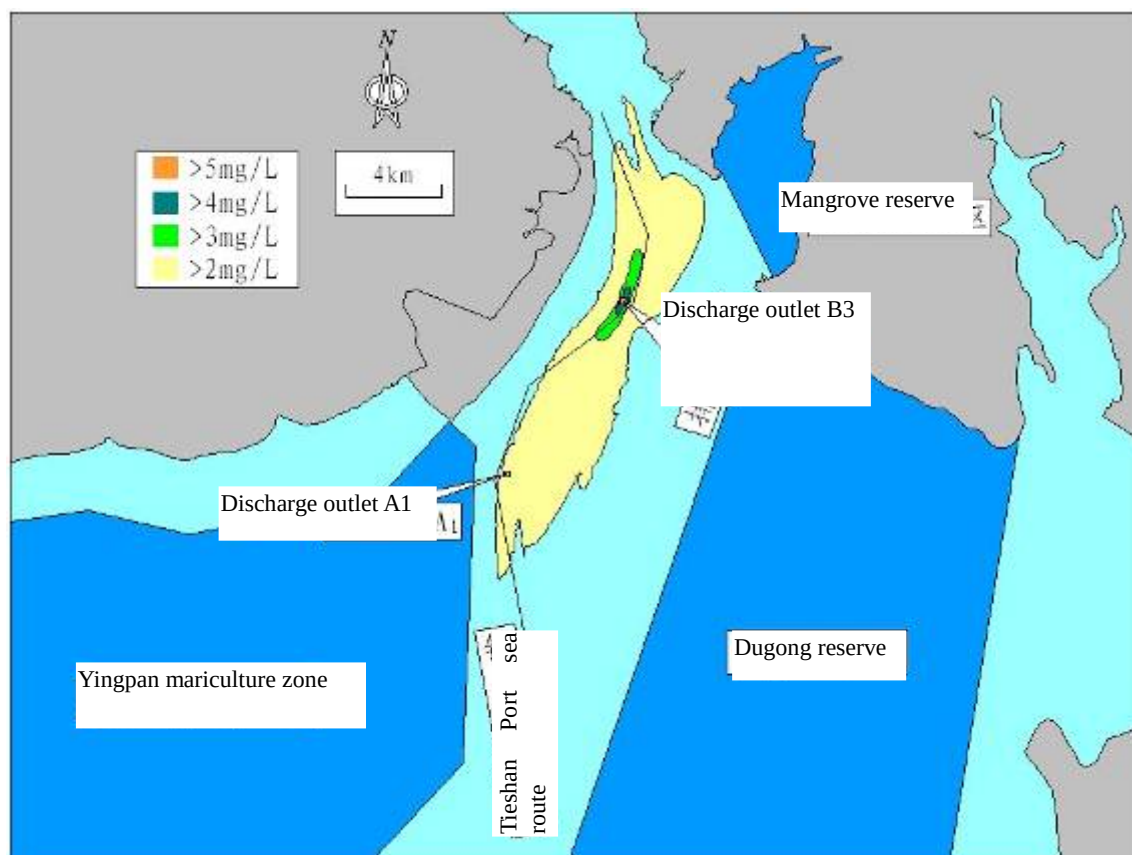


Figure 7.4-9 Envelope line of impacts under 1136mg/L COD concentration after phase III project

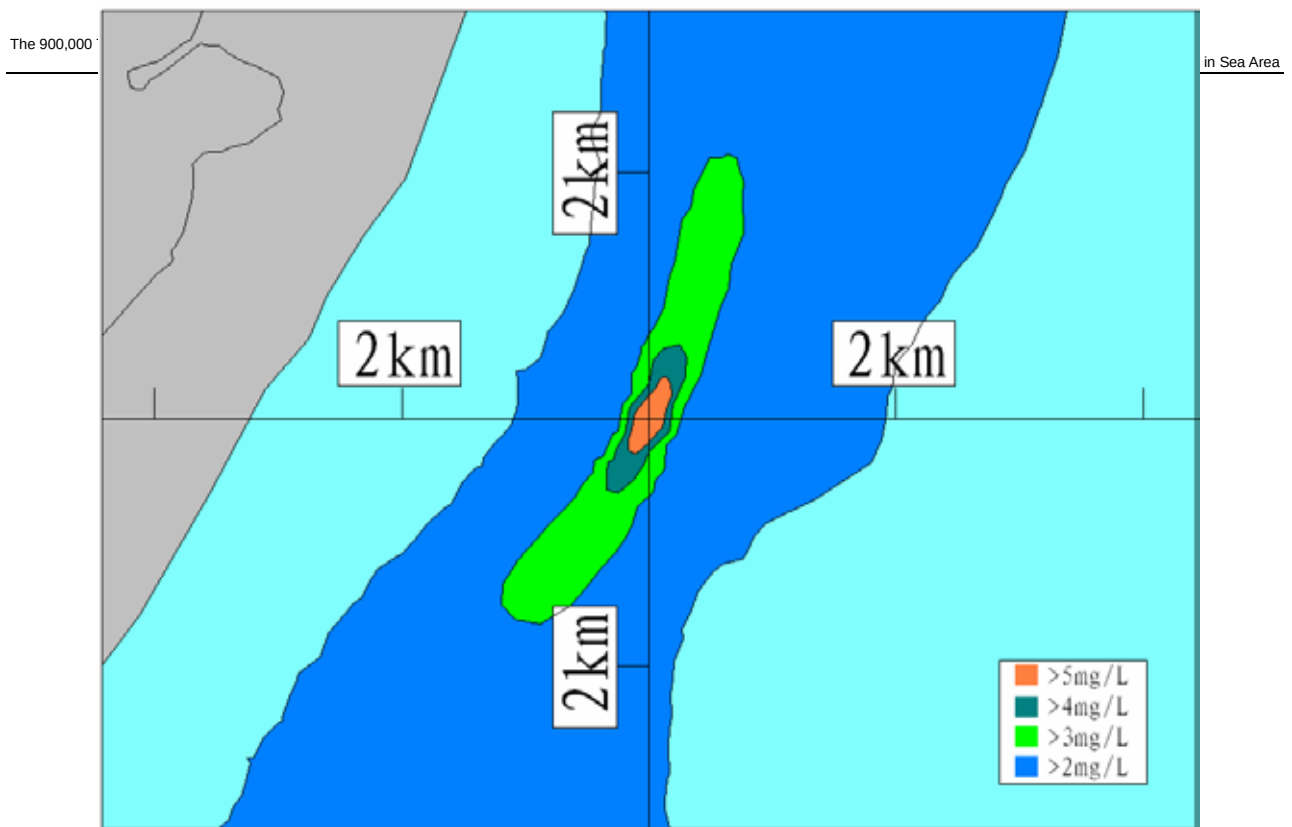


Figure 7.4-10 Envelope line of impacts under 1136mg/L COD concentration after phase III project (local)

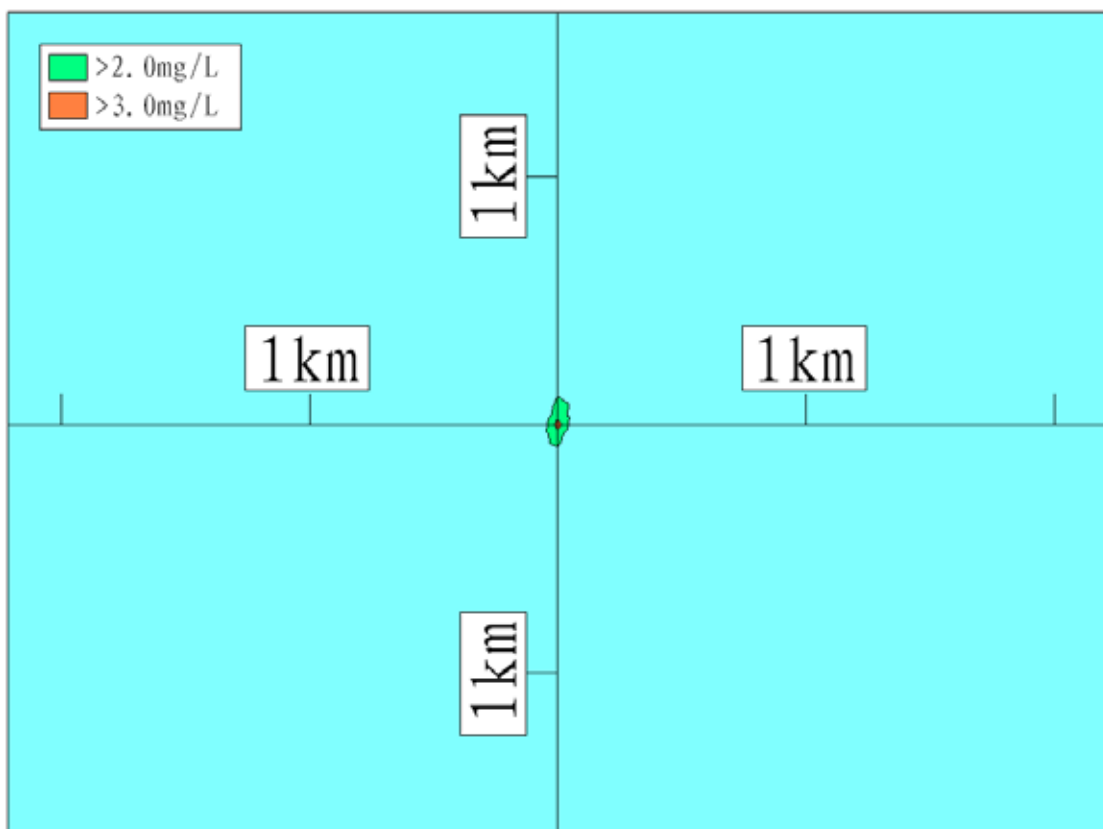


Figure 7.4-11 Envelope line of impacts under 90mg/L COD concentration after phase III project (local)

#### 7.4.2.3 Forecast of impacts by BOD contained in waste water on water environment

##### (1) Forecast of impacts on water environment by BOD contained in waste water after

phase I project

Discharge volume of BOD is 1.52t/d after phase I project. The calculation results are used as the source strength for the forecast and listed in Table 7.4-6 and Figure 7.4-12.

**Table 7.4-6 Analysis of impacts on water environment by discharged BOD contained in waste water after the phase I project**

| <u>Maximum possible affected area under different concentrations (km<sup>2</sup>)</u> |                  |                  |                  |
|---------------------------------------------------------------------------------------|------------------|------------------|------------------|
| <u>&gt;5mg/L</u>                                                                      | <u>&gt;4mg/L</u> | <u>&gt;3mg/L</u> | <u>&gt;1mg/L</u> |
| <u>Partial</u>                                                                        | <u>local</u>     | <u>Local</u>     | <u>0.0044</u>    |

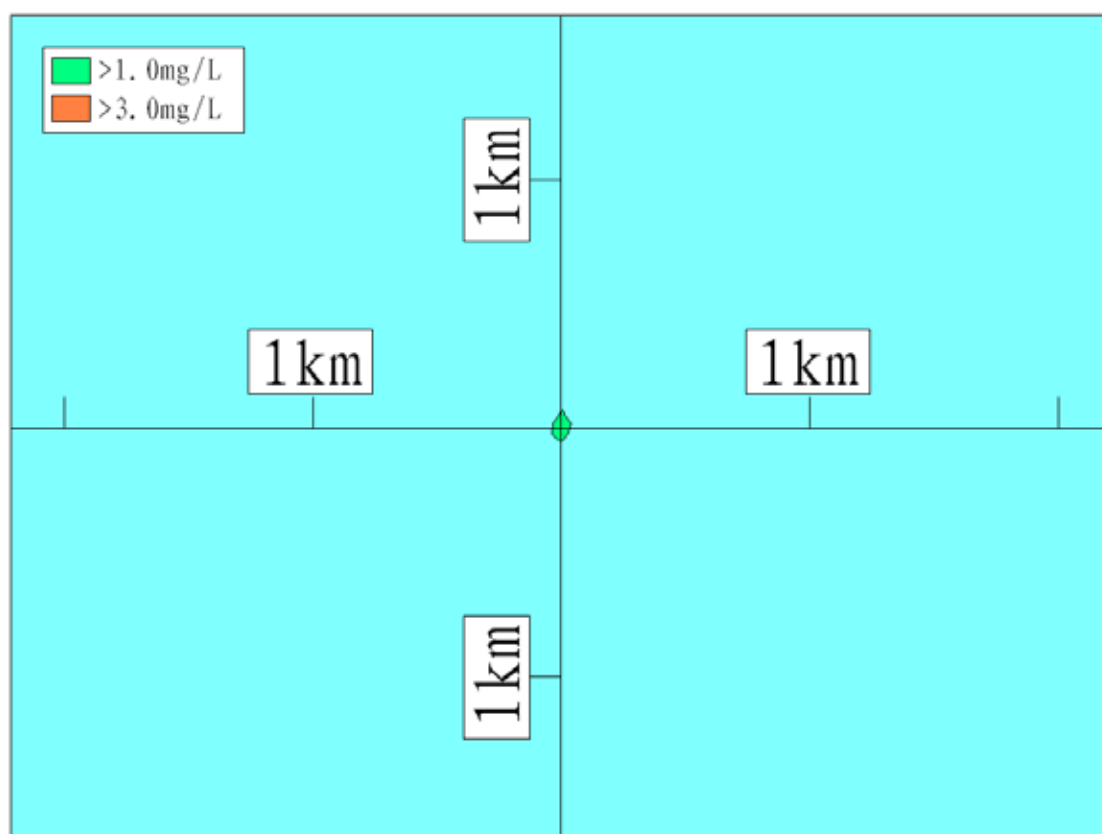


Figure 7.4-12 Envelope line of impacts under normal discharge of BOD after phase I project (partial zone of B<sub>3</sub>)

According to Figure 7.4-12 and Table 7.4-6, impact of BOD on the water environment is only limited to partial zone which is near discharge outlet B<sub>3</sub>. Maximum influence distance of water body with BOD concentration >1mg/L is 70m and doesn't directly affect protection targets of the water environment.

## (2) Forecast of impacts on water environment by BOD contained in waste water after phase II project

Discharge volume of BOD is 1.88t/d after phase II project. The calculation results are used as the source strength for the forecast and listed in Table 7.4-7 and Figure 7.4-13.

**Table 7.4-7 Analysis of impacts on water environment by discharged BOD contained in waste water after the phase II project**

| Maximum possible affected area under different concentrations (km <sup>2</sup> ) |        |        |        |
|----------------------------------------------------------------------------------|--------|--------|--------|
| >5mg/L                                                                           | >4mg/L | >3mg/L | >2mg/L |
| Partial                                                                          | local  | Local  | 0.0077 |

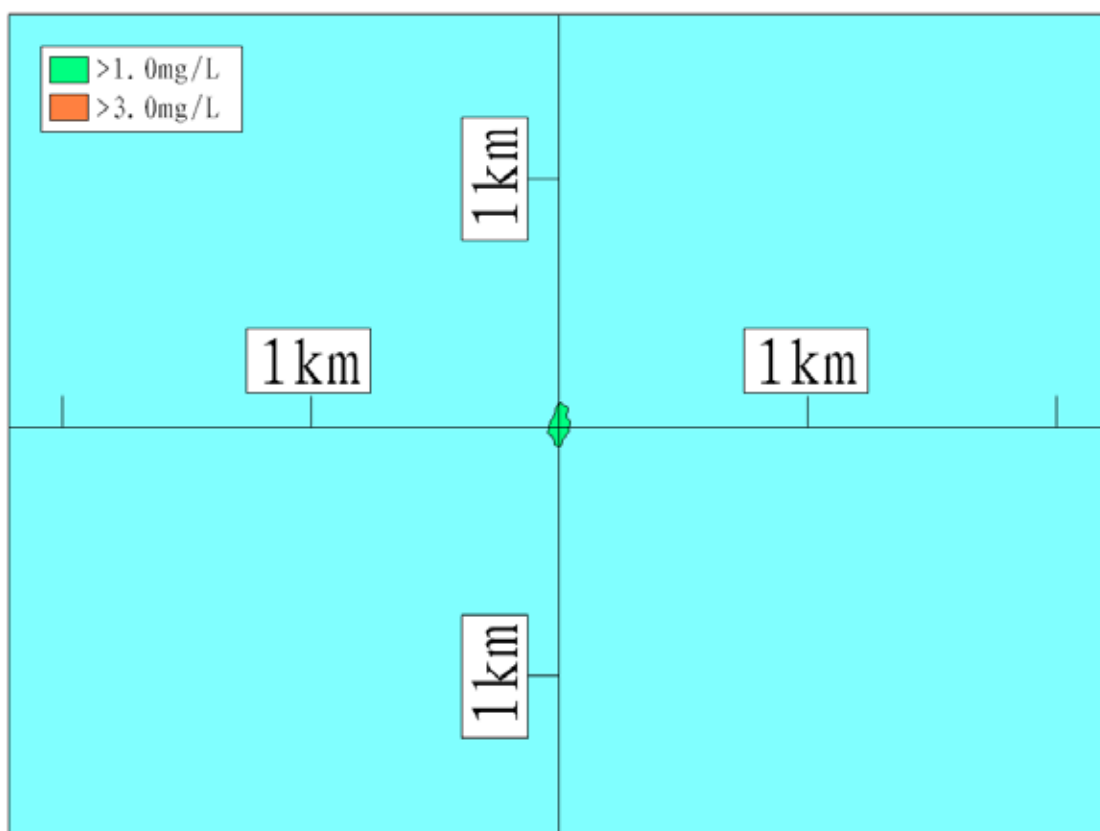


Figure 7.4-13 Envelope line of impacts under normal discharge of BOD after phase II project (partial zone of B<sub>3</sub>)

According to Figure 7.4-13 and Table 7.4-7, impact of BOD on the water environment is only limited to partial zone which is near discharge outlet B<sub>3</sub>. Maximum influence distance of water body with BOD concentration >1mg/L is 90m and doesn't directly affect protection targets of the water environment.

(3) Forecast of impacts on water environment by BOD contained in waste water after phase III project

Discharge volume of BOD is 2.18t/d after phase III project. The calculation results are used as the source strength for the forecast and listed in Table 7.4-8 and Figure 7.4-14.

**Table 7.4-8 Analysis of impacts on water environment by discharged BOD contained in waste water after the phase III project**

| Maximum possible affected area under different concentrations (km <sup>2</sup> ) |        |        |        |
|----------------------------------------------------------------------------------|--------|--------|--------|
| >5mg/L                                                                           | >4mg/L | >3mg/L | >2mg/L |
| Partial                                                                          | local  | Local  | 0.0111 |

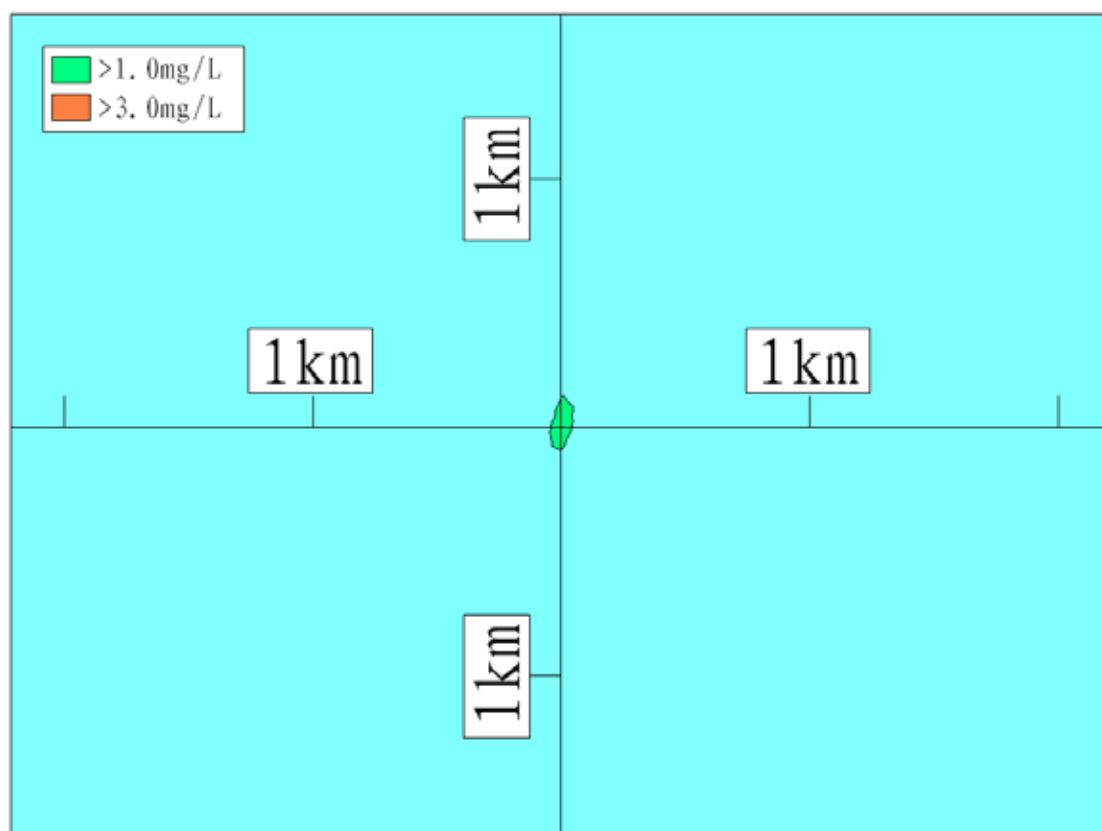


Figure 7.4-14 Envelope line of impacts under normal discharge of BOD after phase III project (partial zone of B<sub>3</sub>)

According to Figure 7.4-14 and Table 7.4-8, impact of BOD on the water environment is only limited to partial zone, which is near discharge outlet B<sub>3</sub>. Maximum influence distance of water body with BOD concentration >1mg/L is 110m and doesn't directly affect protection targets of the water environment.

#### 7.4.2.4 Forecast of impacts of AOX contained in waste water on water environment

According to engineering analysis, discharged volume of AOX is 0.94t/d when waste water isn't treated and is less than 0.38t/d after waste water treatment. For forecast calculation, we adopt 0.94t/d and 0.38t/d as the source strength and pollutant diffusion equation to calculate the AOX diffusion in 10 successive tide cycles at the discharge outlet of this project. Calculation results for the forecast are shown in Table 7.4-9 and Figure 7.4-15 and Figure 7.4-17.

According to Figure 7.4-15, Figure 7.4-17 and Table 7.4-9, influence area of water environment impacted by AOX under normal condition is the sea area on the downstream direction of discharge outlet B<sub>3</sub>, while maximum influence distance of water body with concentration increment of AOX >0.01mg/L is about 1000m. Under accident conditions, maximum influence distance of water body with concentration increment of AOX >0.1mg/L is about 500m. Maximum influence distance of water body with concentration increment of AOX >0.01mg/L is about 3.12km.

**Table 7.4-9**

**Analysis of water environmental impacts by AOX contained**

**in discharged waste water**

| Discharge volume | Maximum possible affected area under different concentrations (km <sup>2</sup> ) |           |           |
|------------------|----------------------------------------------------------------------------------|-----------|-----------|
|                  | >0.10mg/L                                                                        | >0.05mg/L | >0.01mg/L |
| 0.94t/d          | 0.0483                                                                           | 0.2093    | 31.1147   |
| 0.38t/d          | 0.0040                                                                           | — —       | 0.8904    |

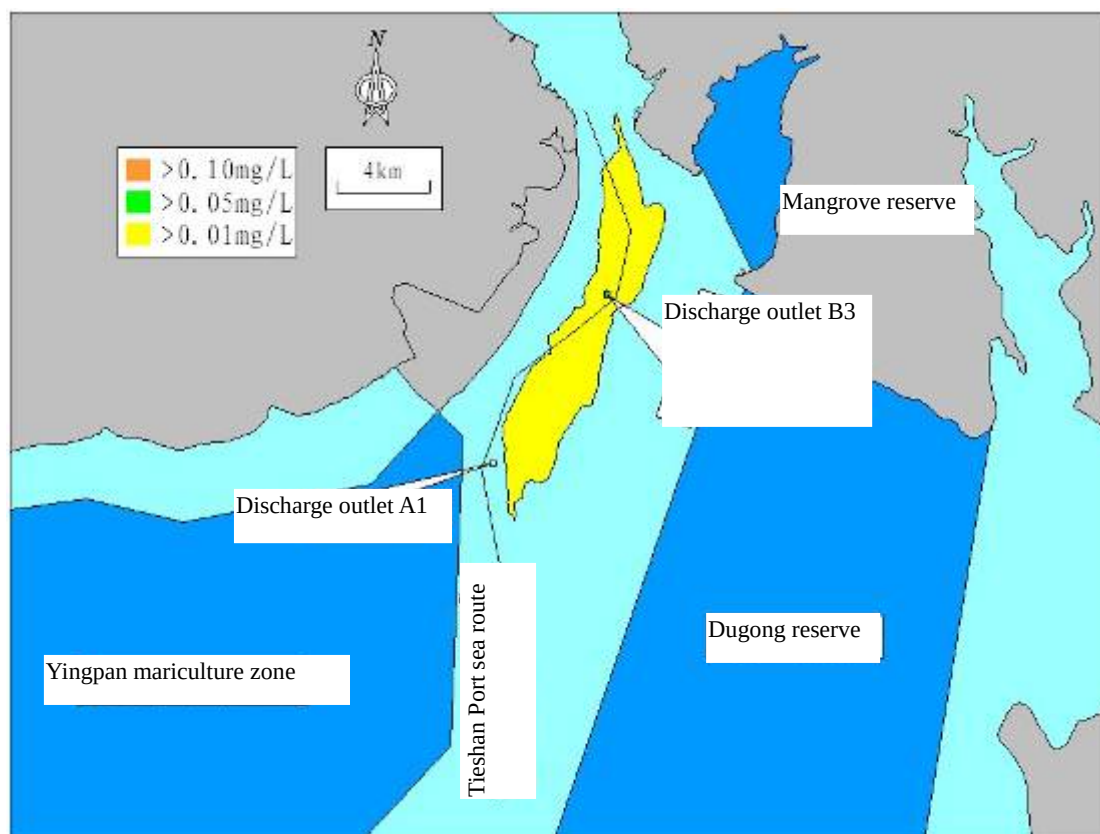


Figure 7.4-15 Envelope line of AOX impacts on water environment when discharge volume is 0.94t/d



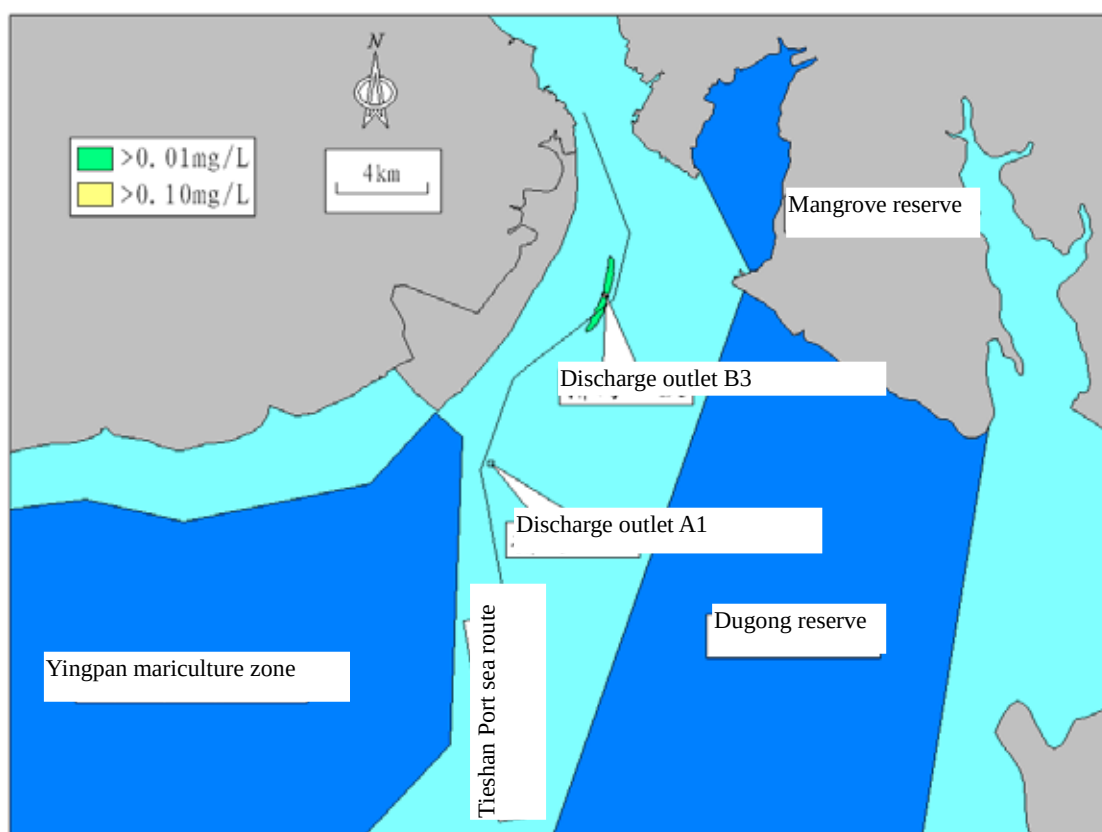


Figure 7.4-16 Envelope line of AOX impacts on water environment when the discharge volume is 0.38t/d

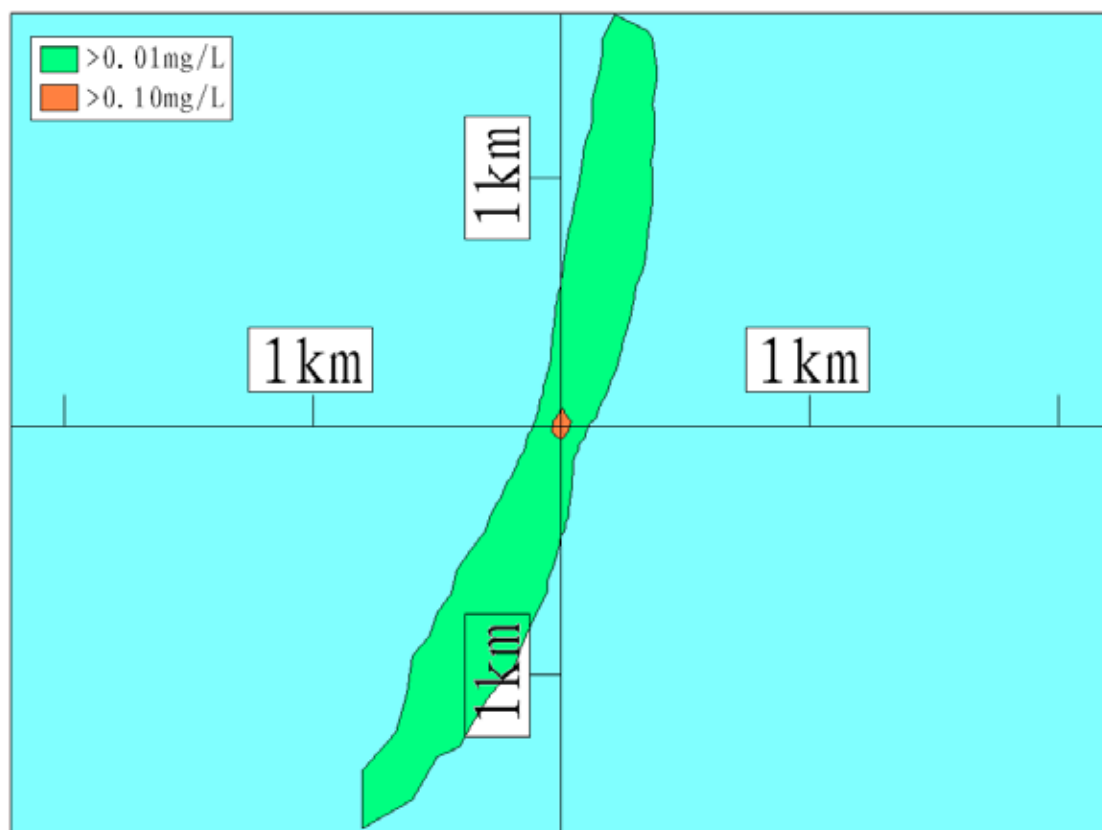


Figure 7.4-17 Envelope line of AOX impacts on water environment when the discharge volume is 0.38t/d (partial)

**7.4.2.5 Forecast of impacts on water environment by dioxins contained in waste water**  
According to engineering analysis, discharged volumes of dioxins are similar after completion of phase I, II and III. It is about  $(4.72 \times 10^8 \text{pgTEQ/d})$ . Therefore, only this value can be used as the source strength in pollutant diffusion equation to calculate the diffusion of dioxins in 10 successive tide cycles at the discharge outlet of this project.

Calculation results for the forecast of impacts on water environment by increment of dioxins contained in the waste water are listed in Table 7.4-10 and figure 7.4-18~7.4-19.

**Table 7.4-10                      Analysis of impacts on water environment by discharged dioxins contained in waste water (planned coastline)**

| Maximum possible affected area under different concentrations (km <sup>2</sup> ) |              |
|----------------------------------------------------------------------------------|--------------|
| >0.10pgTEQ/L                                                                     | >0.01pgTEQ/L |
| 0.0065                                                                           | 1.4970       |

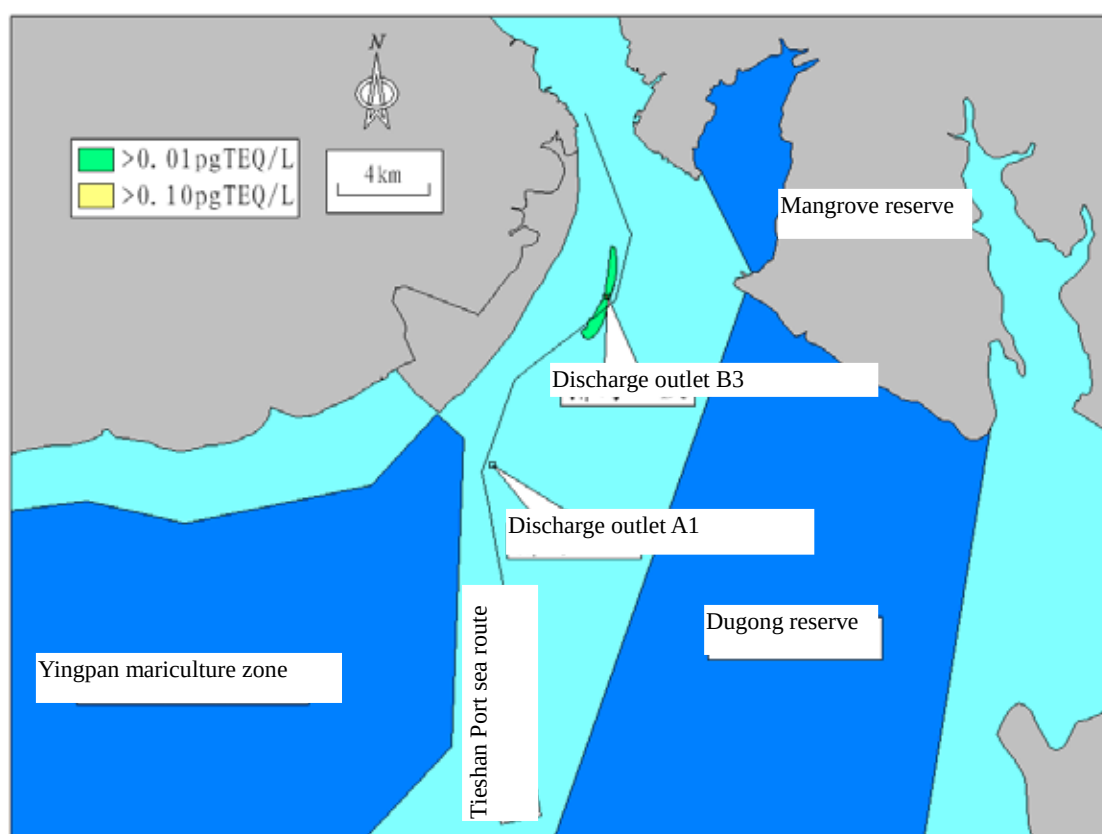


**Figure 7.4-18 Envelope line of impacts on water enviroment increment by dioxin contained in waste water**

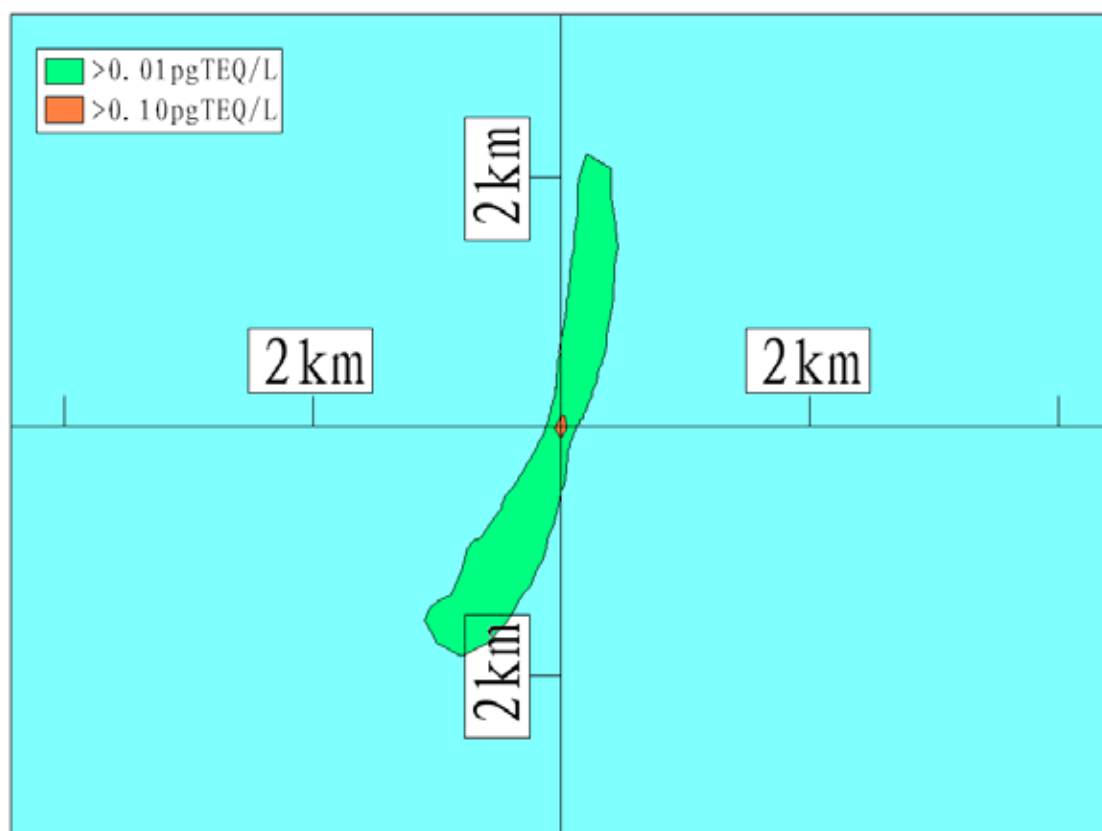


Figure 7.4-19 Envelope line of impacts on water environment increment by dioxin contained in waste water (partial zone of B<sub>3</sub>)

According to Figure 7.4-18, Figure 7.4-19 and Table 7.4-10, influence area of water environment impacted by dioxins is the sea area on the downstream direction of discharge outlet B<sub>3</sub>, while maximum influence distance of water body with concentration increment of TEQ/L > 0.01 pg is about 2.2 km.

#### 7.4.2.6 Forecast of impacts on water environment by SS contained in waste water

As only SS increment is considered in the quality standard of water environment, discharge load at planned outlet A is not taken into account when forecasting impacts by SS contained in discharged waste water to deep water during this project and adopt pollutant diffusion equation to calculate the SS diffusion value at the discharge outlet of the project for 10 successive tide cycles.

#### (1) Forecast of impacts on water environment by waste water discharged into sea after phase I project

According to the forecast calculation by 2 discharge concentrations, the discharge volume is 76260 m<sup>3</sup>/d, discharge concentrations are respectively 50 and 504 mg/L (from low to high) and discharged volume of SS contained in waste water are 3.82 and 38.4 t/d

t/d in turn. The calculation results are used as the source strength for the forecast and listed in Table 7.4-11 and figure 7.4-20.

**Table 7.4-11** Analysis of impacts on water environment by SS contained in waste water after phase I project

| Discharge volume<br>(mg/L) | Maximum possible affected area under different concentrations (km <sup>2</sup> ) |        |        |          |
|----------------------------|----------------------------------------------------------------------------------|--------|--------|----------|
|                            | >10mg/L                                                                          | >5mg/L | >1mg/L | 0.1 mg/L |
| 504                        | 0.0046                                                                           | 0.0261 | 0.8763 | — —      |
| 50                         | Local                                                                            | — —    | 0.0034 | 0.9097   |

## (2) Forecast of impacts on water environment by waste water discharged into sea after phase I project

According to the forecast calculation by 2 discharge concentrations, the discharge volume is 93938m<sup>3</sup>/d, discharge concentrations are respectively 30 and 715mg/L (from low to high) and discharged volume of SS contained in waste water are 2.82 and 67.2t/d in turn. The calculation results are used as the source strength for the forecast and listed in Table 7.4-12 and figure 7.4-21

**Table 7.4-12** Analysis of impacts on water environment by SS contained in waste water after phase II project

| Discharge volume<br>(mg/L) | Maximum possible affected area under different concentrations (km <sup>2</sup> ) |        |        |          |
|----------------------------|----------------------------------------------------------------------------------|--------|--------|----------|
|                            | >10mg/L                                                                          | >5mg/L | >1mg/L | 0.1 mg/L |
| 715                        | 0.0187                                                                           | 0.1019 | 4.8202 | — —      |
| 30                         | Local                                                                            | — —    | 0.0014 | 0.4298   |

## (3)Forecast of impacts on water environment by waste water discharged into sea after phase III project

According to the forecast calculation by 2 discharge concentrations, the discharge volume is 109158m<sup>3</sup>/d, discharge concentrations are respectively 50 and 942mg/L (from low to high) and discharged volume of SS contained in waste water are 3.82 and 67.2t/d in turn. The calculation results are used as the source strength for the forecast and listed in Table 7.4-13 and figure 7.4-22

**Table 7.4-13** Analysis of impacts on water environment by SS contained in waste water after phase III project

| Discharge volume<br>(mg/L) | Maximum possible affected area under different concentrations (km <sup>2</sup> ) |        |         |          |
|----------------------------|----------------------------------------------------------------------------------|--------|---------|----------|
|                            | >10mg/L                                                                          | >5mg/L | >1mg/L  | 0.1 mg/L |
| 942                        | 0.0550                                                                           | 0.2388 | 37.8913 | — —      |
| 30                         | Local                                                                            | — —    | 0.0024  | 0.6239   |

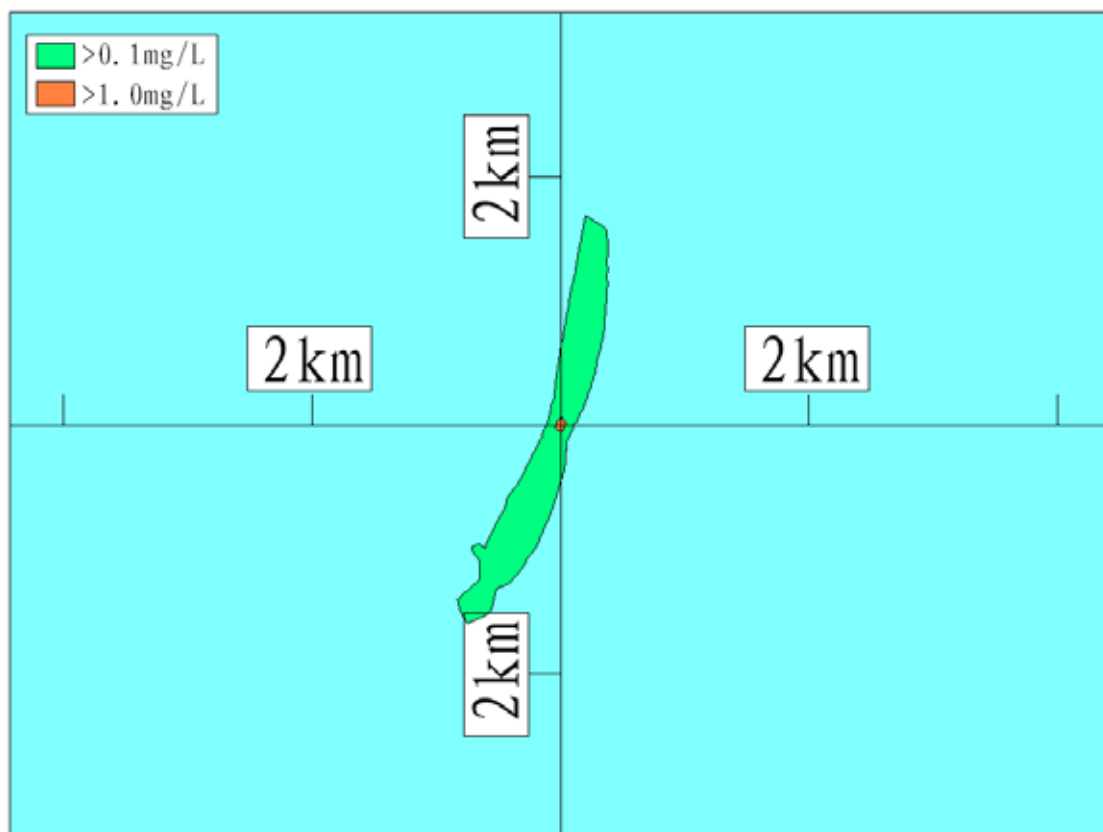


Figure 7.4-20 Envelope line of impacts when the discharge concentration of SS is 50mg/L after phase I project (Partial)

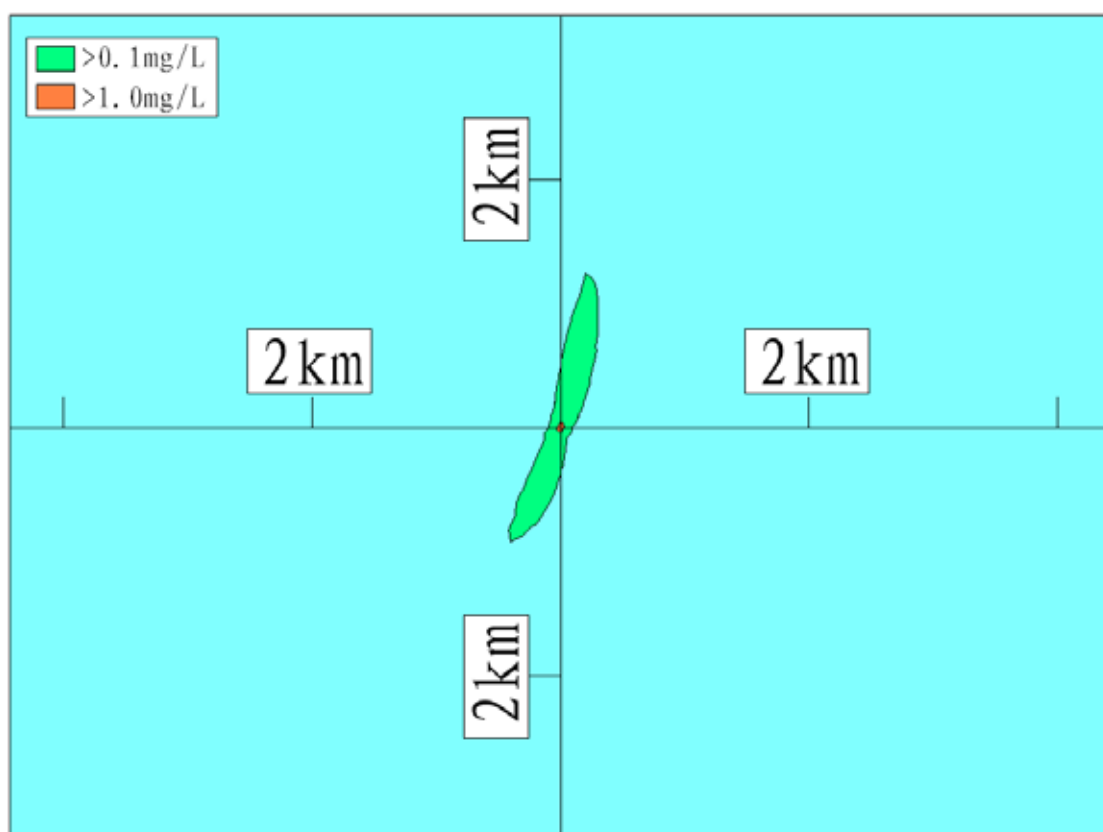


Figure 7.4-21 Envelope line of impacts when the discharge concentration of SS is 30mg/L after phase II project (Partial)

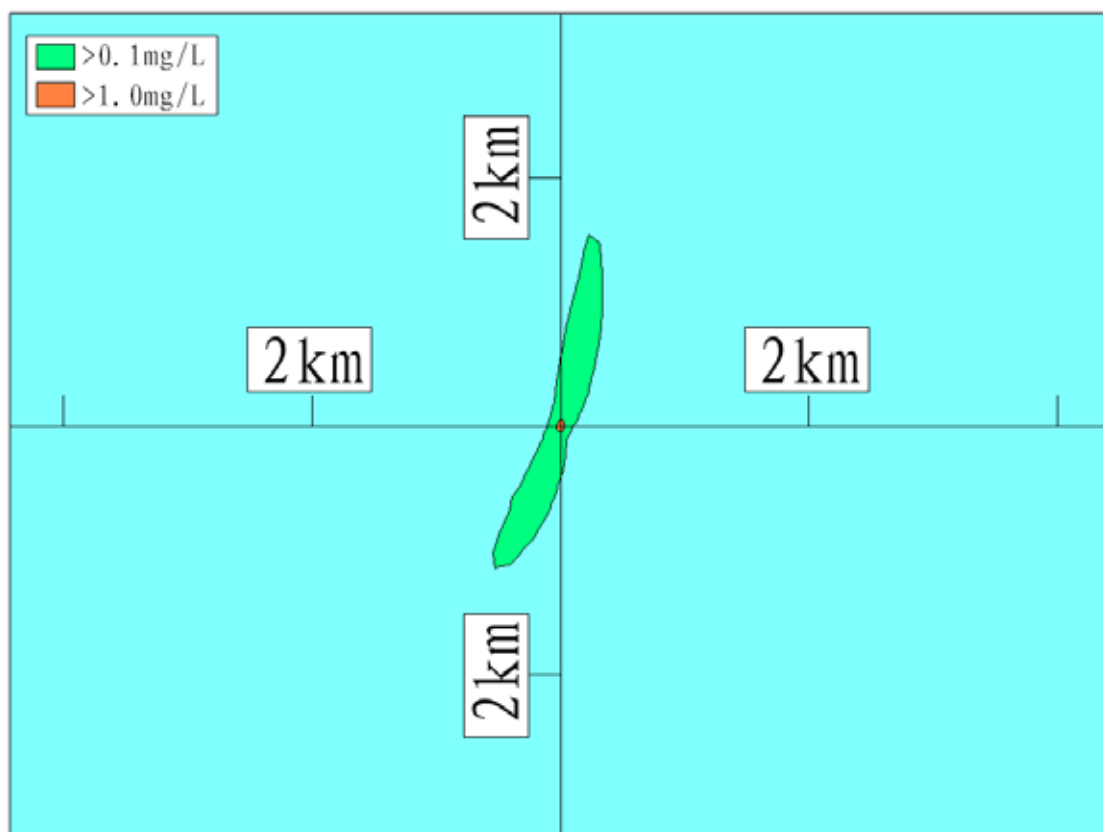


Figure 7.4-22 Envelope line of impacts when the discharge concentration of SS is 30mg/L after phase III project (Partial)

#### (4) Summary

According to calculation results, influence scopes of class I and II sea water quality with higher than standard limit are very small (shown in), which demonstrates that SS has little impact on the water environment and certainly doesn't directly affect mariculture region in Yingpan mariculture zone , Dugong reserve and Mangrove reserve.

#### 7.4.2.7 Forecast of impacts of ammonia nitrogen contained in waste water on water environment

To conduct forecast calculation for ammonia nitrogen in the waste water discharged into the deep water of the project, we adopt pollutant diffusion equation to calculate diffusion of ammonia nitrogen, which is discharged from the discharge outlet, in 10 consecutive tidal cycles and superimpose calculated result with background value (According to latest data, average actuality value of inorganic nitrogen near discharge outlet B<sub>3</sub> is about 0.16mg/L. Ammonia nitrogen is a component of inorganic nitrogen).

#### (1) Forecast of impacts on water environment by ammonia nitrogen contained in waste water after completion of phase I project

After completion of phase I project, discharge volume of ammonia nitrogen is 0.46t/d and used as the source strength for the forecast. The calculation results are listed in local enlarged view of figure 7.4-23 and Table 7.4-14 for discharge outlet B<sub>3</sub> (partial).

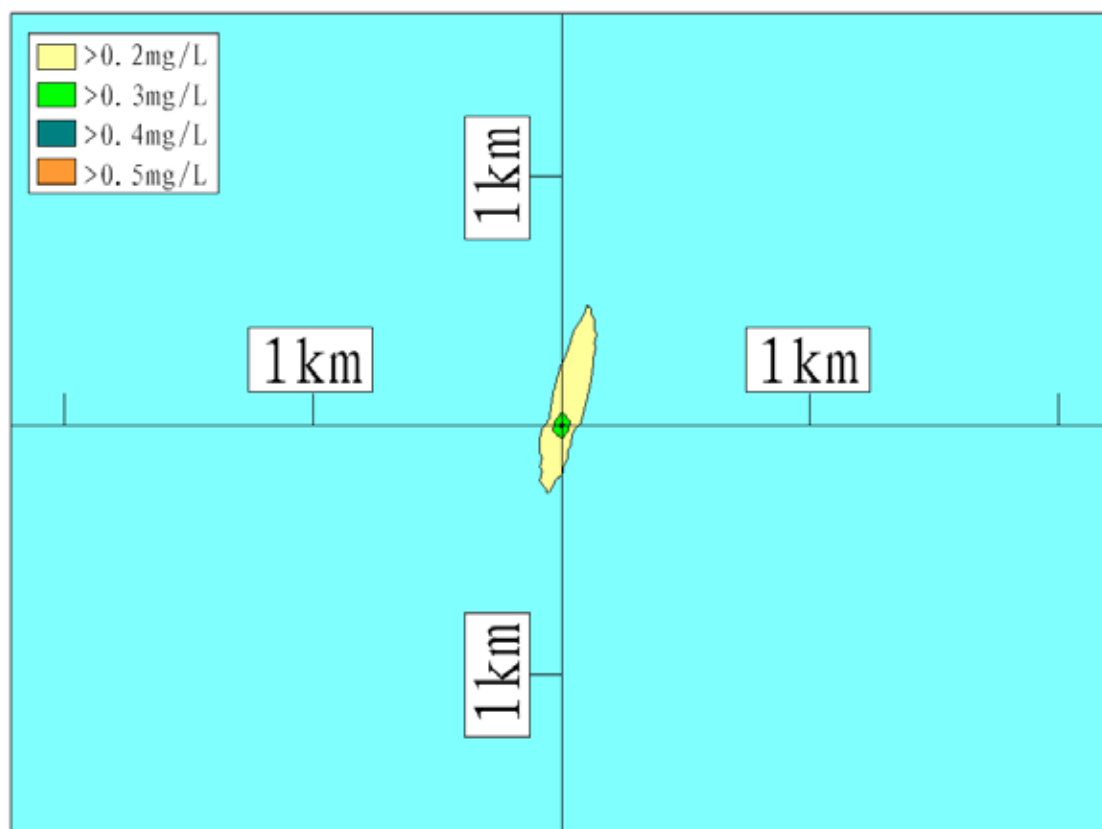


Figure 7.4-23 Envelope line of impacts under inorganic nitrogen when ammonia nitrogen is normally discharged after phase I project (partial zone of B<sub>3</sub>)

**Table 7.4-14 Analysis of impacts on water environment by discharged inorganic nitrogen contained in waste water after phase I project**

| Maximum possible affected area under different concentrations (km <sup>2</sup> ) |          |          |          |
|----------------------------------------------------------------------------------|----------|----------|----------|
| >0.5mg/L                                                                         | >0.4mg/L | >0.3mg/L | >0.2mg/L |
| Local                                                                            | 0.0001   | 0.0032   | 0.0711   |

According to the table, impact on water environment by inorganic nitrogen is only limited to partial zone, which is near discharge outlet B<sub>3</sub>. Maximum influence distance of water body with inorganic nitrogen concentration>0.3mg/L is 50m, while maximum influence distance of water body with inorganic nitrogen concentration>0.2mg/L is 500m and doesn't directly affect protection targets of the water environment.

(2) Forecast of impacts of ammonia nitrogen contained in waste water on water environment after completion of phase II project

After completion of phase II project, discharge volume of ammonia nitrogen is 0.56t/d and used as the source strength for the forecast. The calculation results are listed in the local enlarged view of figure 7.4-24 and Table 7.4-15.

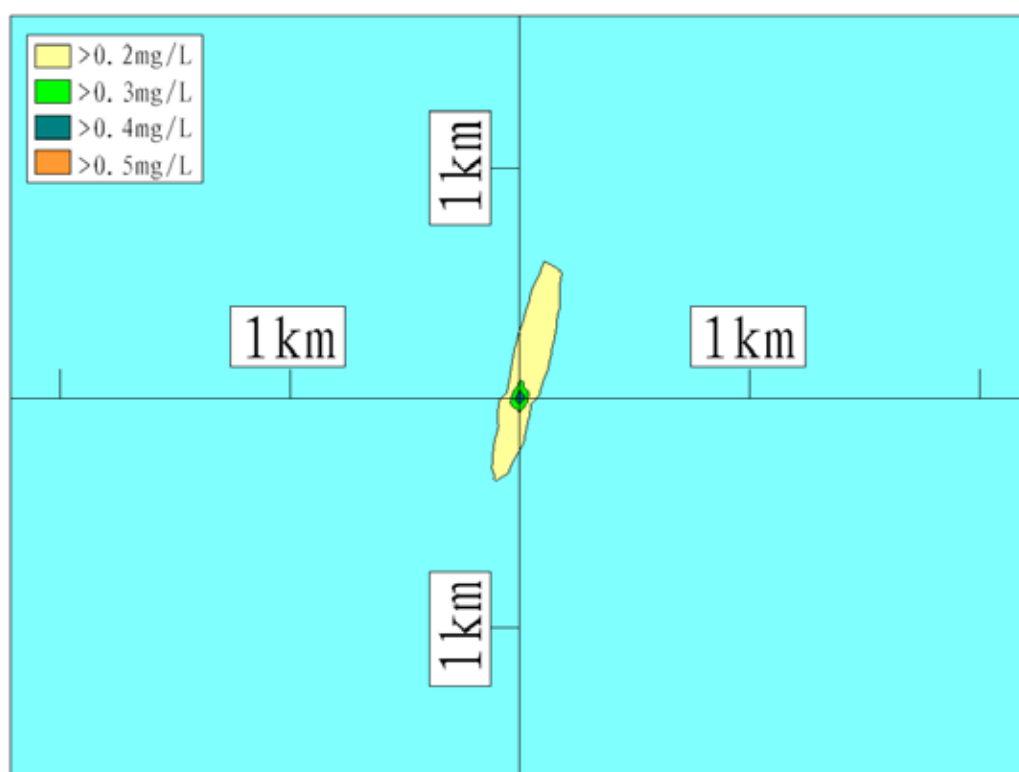


Figure 7.4-24 Envelope line of impacts on water environment under normal discharge of ammonia nitrogen after completion of phase II project (partial zone of B<sub>3</sub>)



**Table 7.4-15 Analysis of impacts on water environment by discharged inorganic nitrogen contained in waste water after phase II project**

| Maximum possible affected area under different concentrations (km <sup>2</sup> ) |          |          |          |
|----------------------------------------------------------------------------------|----------|----------|----------|
| >0.5mg/L                                                                         | >0.4mg/L | >0.3mg/L | >0.2mg/L |
| Local                                                                            | 0.0009   | 0.0047   | 0.1121   |

According to the table, impact of inorganic nitrogen on the water environment is only limited to partial zone, which is near discharge outlet B<sub>3</sub>. Maximum influence distance of water body with inorganic nitrogen concentration>0.3mg/L is 80m, while maximum influence distance of water body with inorganic nitrogen concentration>0.2mg/L is 600m and doesn't directly affect protection targets of the water environment.

(3) Forecast of impacts of ammonia nitrogen contained in waste water on water environment after completion phase III project

After completion of phase III project, discharge volume of ammonia nitrogen is 0.65t/d and used as the source strength for the forecast. The calculation results are listed in the local enlarged view of figure 7.4-25 and Table 7.4-16 for discharge outlet B<sub>3</sub> (partial).

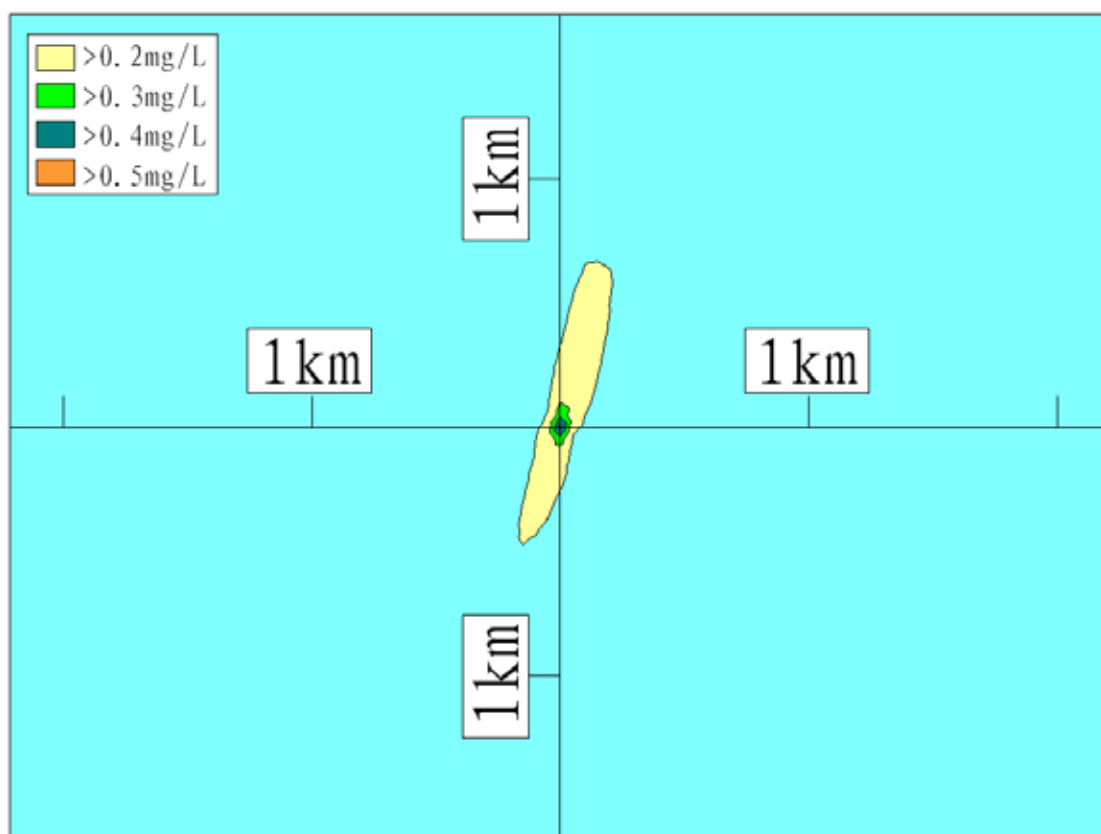


**Figure 7.4-25 Envelope line of impacts on water environment under normal discharge of ammonia nitrogen after completion of phase III project (partial zone of B<sub>3</sub>)**

**Table 7.4-16 Analysis of impacts on water environment by discharged inorganic nitrogen contained in waste water after phase III project**

| Maximum possible affected area under different concentrations (km <sup>2</sup> ) |          |          |          |
|----------------------------------------------------------------------------------|----------|----------|----------|
| >0.5mg/L                                                                         | >0.4mg/L | >0.3mg/L | >0.2mg/L |
| Local                                                                            | 0.0014   | 0.0065   | 0.1542   |

According to the table, impact of inorganic nitrogen on the water environment is only limited to partial zone, which is near discharge outlet B<sub>3</sub>. Maximum influence distance of water body with inorganic nitrogen concentration>0.3mg/L is 110m, while maximum influence distance of water body with inorganic nitrogen concentration>0.2mg/L is 700m and doesn't directly affect protection targets of the water environment.

#### 7.4.2.8 Forecast of impacts of total nitrogen contained in waste water on water environment

(1) Forecast of impacts on water environment by total nitrogen contained in waste water after phase I project

After completion of phase I project, discharge volume of total nitrogen is 0.61t/d and used as the source strength for the forecast. The calculation results are listed in the local enlarged view of figure 7.4-26 and Table 7.4-17 for discharge outlet B<sub>3</sub> (partial).

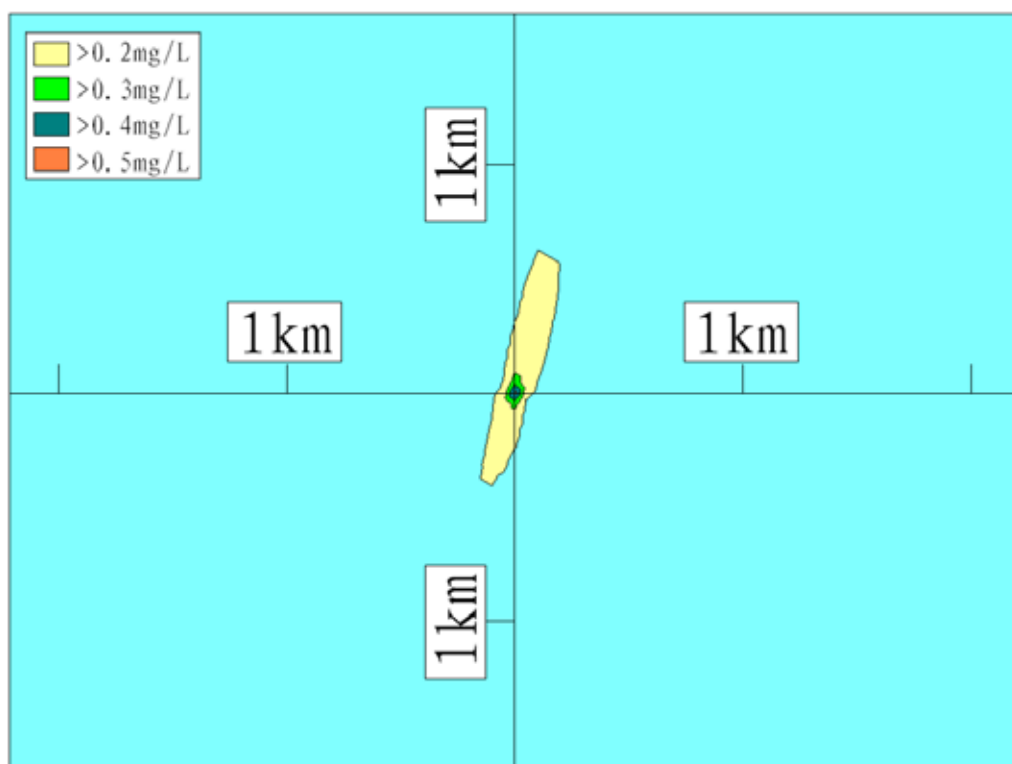


**Figure 7.4-26 Envelope line of impacts under normal discharge of total nitrogen after completion of phase I project (partial zone of B<sub>3</sub>)**

**Table 7.4-17 Analysis of impacts on water environment by discharged total nitrogen contained in waste water after phase I project**

| Maximum possible affected area under different concentrations (km <sup>2</sup> ) |          |          |          |
|----------------------------------------------------------------------------------|----------|----------|----------|
| >0.5mg/L                                                                         | >0.4mg/L | >0.3mg/L | >0.2mg/L |
| local                                                                            | 0.0014   | 0.0054   | 0.1318   |

According to the table, impact of total nitrogen on the water environment is only limited to partial zone, which is near discharge outlet B<sub>3</sub>. Maximum influence distance of water body with total nitrogen concentration>0.3mg/L is 100m, while maximum influence distance of water body with total nitrogen concentration>0.2mg/L is 700m and doesn't directly affect protection targets of the water environment.

(2) Forecast of impacts of total nitrogen contained in waste water on water environment after completion of phase II project

After completion of phase II project, discharge volume of total nitrogen is 0.75t/d and used as the source strength for the forecast. The calculation results are listed in the local enlarged view of Figure 7.4-27 and Table 7.4-18.

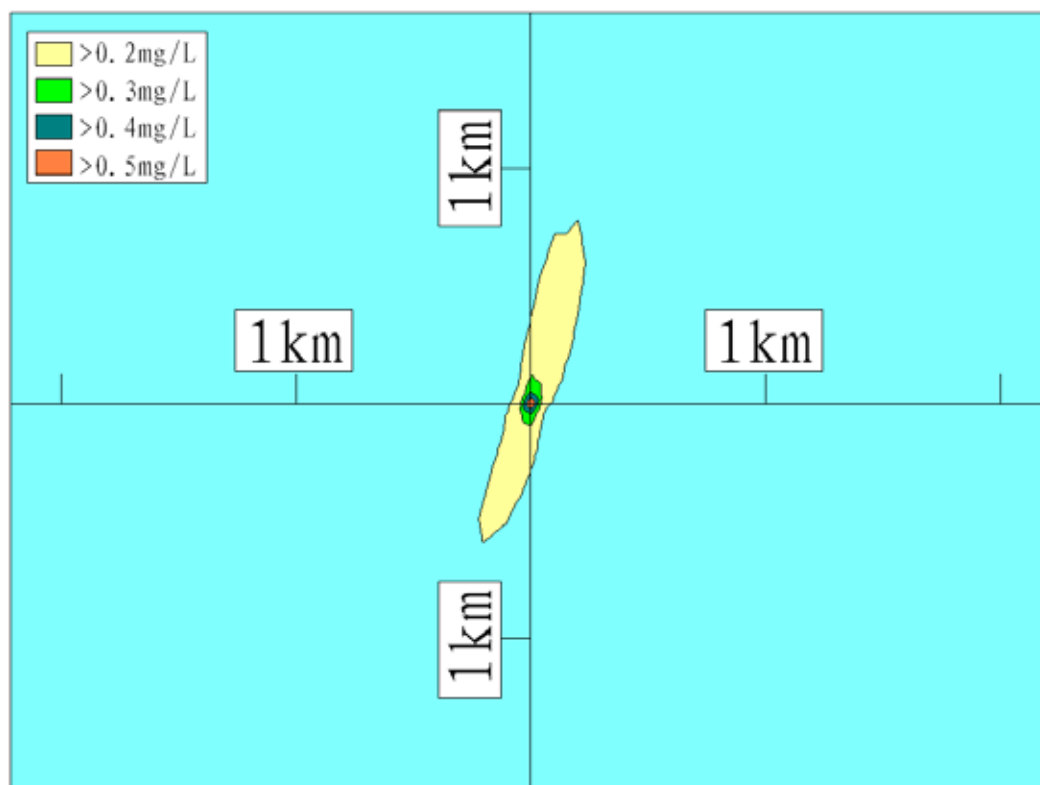


Figure 7.4-27 Envelope line of impacts under normal discharge of total nitrogen after phase II project (partial zone of B<sub>3</sub>)

**Table 7.4-18 Analysis of impacts on water environment by discharged total nitrogen contained in waste water after phase II project**

| Maximum possible affected area under different concentrations (km <sup>2</sup> ) |          |          |          |
|----------------------------------------------------------------------------------|----------|----------|----------|
| >0.5mg/L                                                                         | >0.4mg/L | >0.3mg/L | >0.2mg/L |
| 0.0006                                                                           | 0.0026   | 0.0093   | 0.2028   |

According to the table, impact of total nitrogen on the water environment is only limited to partial zone, which is near discharge outlet B<sub>3</sub>. Maximum influence distance of water body with total nitrogen concentration>0.3mg/L is 120m, while maximum influence distance of water body with total nitrogen concentration>0.2mg/L is 800m and doesn't directly affect protection targets of the water environment.

(3) Forecast of impacts of total nitrogen contained in waste water on water environment after phase III project

After completion of phase III project, discharge volume of total nitrogen is 0.87t/d and used as the source strength for the forecast. The calculation results are listed in the local enlarged view of Figure 7.4-28 and Table 7.4-19.

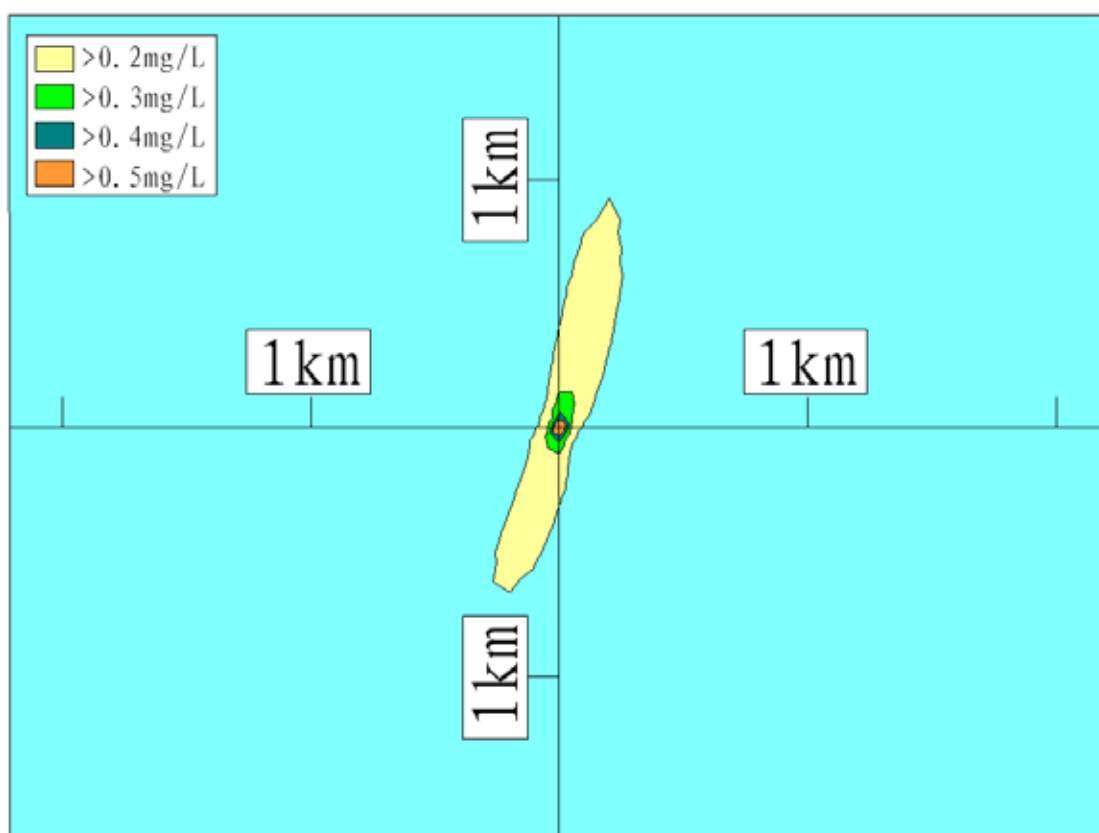


**Figure 7.4-28 Envelope line of impacts under normal discharge of total nitrogen after phase III project (partial zone of B<sub>3</sub>)**

**Table 7.4-19 Analysis of impacts on water environment by discharged total nitrogen contained in waste water after phase III project**

| Maximum possible affected area under different concentrations (km <sup>2</sup> ) |          |          |          |
|----------------------------------------------------------------------------------|----------|----------|----------|
| >0.5mg/L                                                                         | >0.4mg/L | >0.3mg/L | >0.2mg/L |
| 0.0014                                                                           | 0.0033   | 0.0145   | 0.2647   |

According to the table, impact of total nitrogen on the water environment is only limited to partial zone, which is near discharge outlet B<sub>3</sub>. Maximum influence distance of water body with total nitrogen concentration>0.3mg/L is 170m, while maximum influence distance of water body with total nitrogen concentration>0.2mg/L is 950m and doesn't directly affect protection targets of the water environment.

#### 7.4.2.9 Forecast of impacts of total phosphorus contained in waste water on water environment

##### (1) Forecast of impacts of total phosphorus contained in waste water on water environment after phase I project

After completion of phase I project, discharge volume of total phosphorus is 0.06t/d and used as the source strength for the forecast. The calculation results are listed in enlarged figure 7.4-29 and Table 7.4-20 for discharge outlet B<sub>3</sub> (partial).

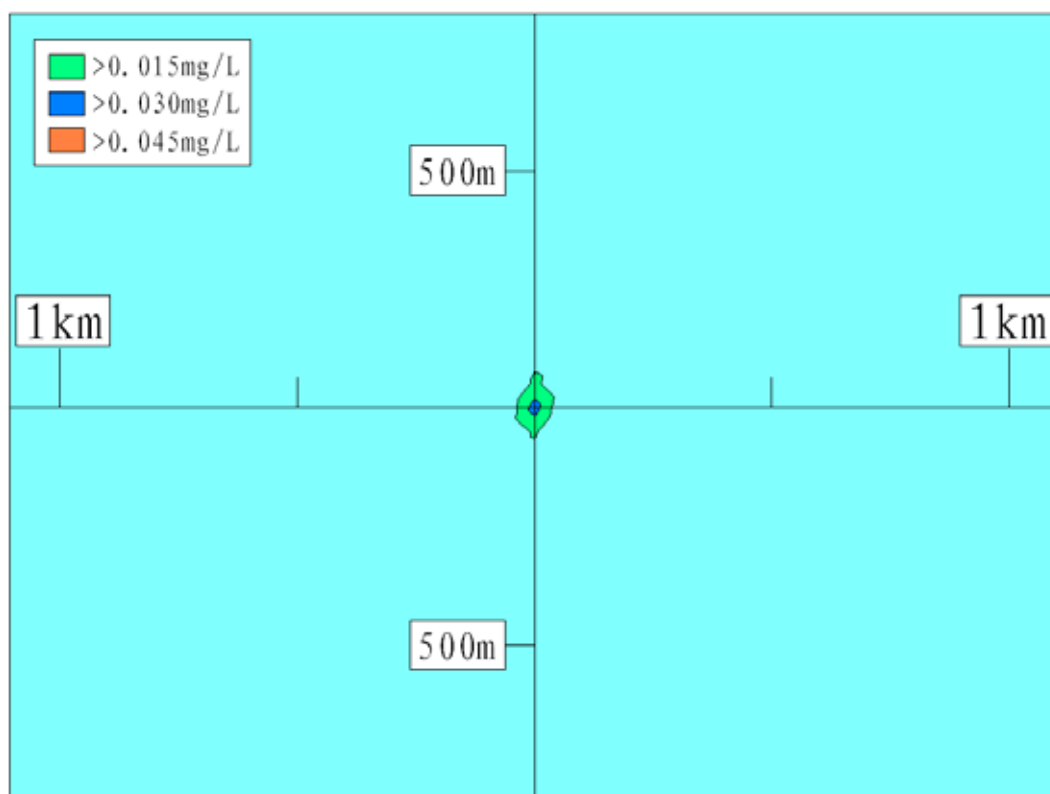


**Figure 7.4-29 Envelope line of impacts on total phosphorus under normal discharge after phase I project (partial zone of B<sub>3</sub>)**

**Table 7.4-20 Analysis of impacts on water environment by discharged total phosphorus contained in waste water after phase I project**

| Maximum possible affected area under different concentrations (km <sup>2</sup> ) |            |            |
|----------------------------------------------------------------------------------|------------|------------|
| >0.045mg/L                                                                       | >0.030mg/L | >0.015mg/L |
| Local                                                                            | 0.0004     | 0.0056     |

According to the table, impact of total phosphorus on the water environment is only limited to partial zone, which is near discharge outlet B<sub>3</sub>. Maximum influence distance of water body with total phosphorus concentration>0.015mg/L is 80m and doesn't directly affect protection targets of the water environment.

(2) Forecast of impacts of total phosphorus contained in waste water on water environment after phase II project

After completion of phase II project, discharge volume of total phosphorus is 0.08t/d and used as the source strength for the forecast. The calculation results are listed in partial enlarged Figure 7.4-30 and Table 7.4-21.

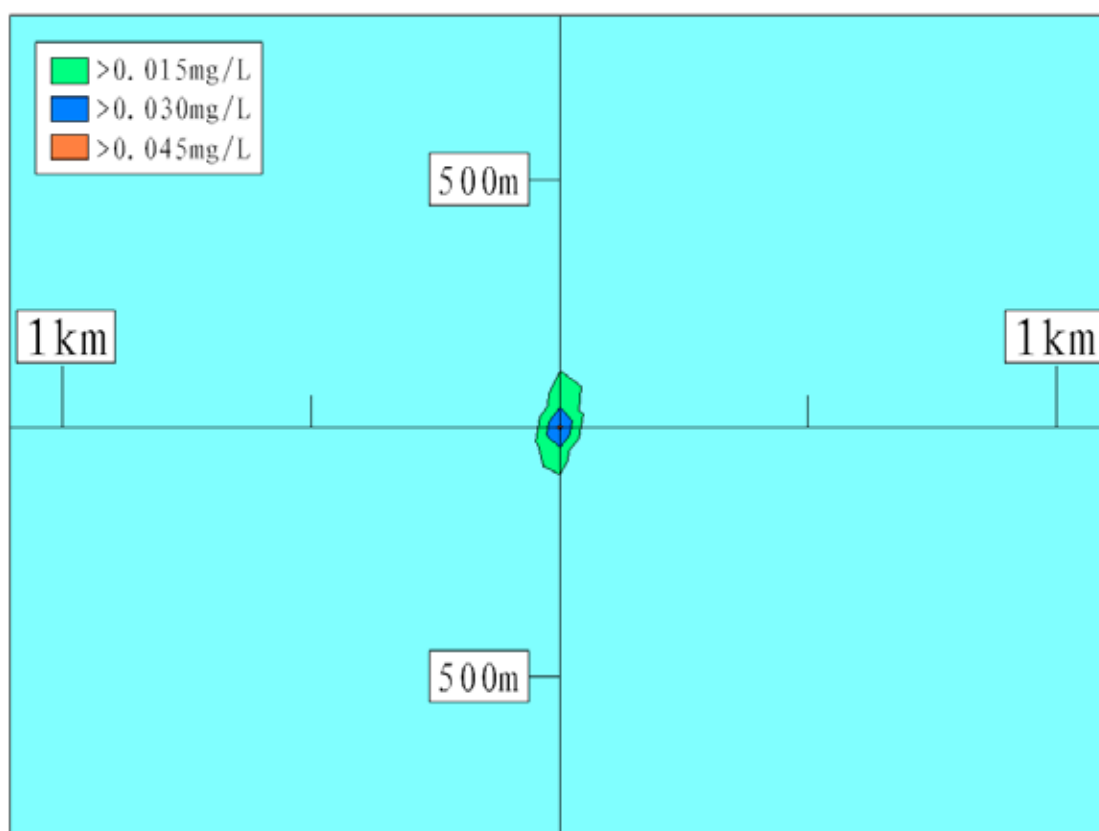


**Figure 7.4-30 Envelope line of impacts on increment under normal discharge of total phosphorus after phase II project (partial zone of B<sub>3</sub>)**

**Table 7.4-21 Analysis of impacts on water environment by discharged total phosphorus contained in waste water after phase II project**

| Maximum possible affected area under different concentrations (km <sup>2</sup> ) |            |            |
|----------------------------------------------------------------------------------|------------|------------|
| >0.045mg/L                                                                       | >0.030mg/L | >0.015mg/L |
| Local                                                                            | 0.0021     | 0.0111     |

According to the table, impact of total phosphorus on the water environment is only limited to partial zone, which is near discharge outlet B<sub>3</sub>. Maximum influence distance of water body with total phosphorus concentration>0.015mg/L is 110m and doesn't directly affect protection targets of the water environment.

(3) Forecast of impacts of total phosphorus contained in waste water on water environment after phase III project

After completion of phase III project, discharge volume of total nitrogen is 0.09t/d and used as the source strength for the forecast. The calculation results are listed in partial enlarged Figure 7.4-31 and Table 7.4-22.

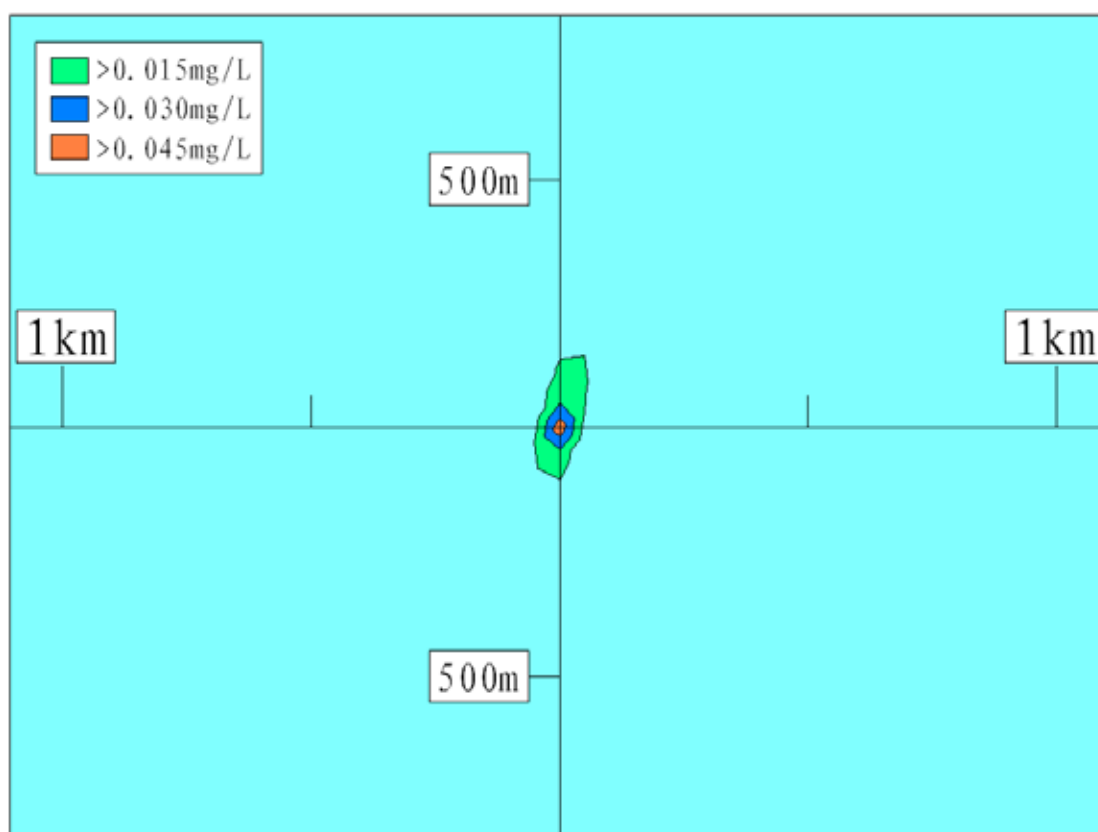


**Figure 7.4-31 Envelope line of impacts on increment under normal discharge of total phosphorus after phase III project (partial zone of B<sub>3</sub>)**

**Table 7.4-22 Analysis of impacts on water environment by discharged total phosphorus contained in waste water after phase III project**

| Maximum possible affected area under different concentrations (km <sup>2</sup> ) |            |            |
|----------------------------------------------------------------------------------|------------|------------|
| >0.045mg/L                                                                       | >0.030mg/L | >0.015mg/L |
| 0.0004                                                                           | 0.0029     | 0.0156     |

According to the table, impact of total phosphorus on the water environment is only limited to partial zone, which is near discharge outlet B<sub>3</sub>. Maximum influence distance of water body with inorganic nitrogen concentration>0.015mg/L is 150m and doesn't directly affect protection targets of the water environment.

#### 7.4.2.10 Forecast of impacts on water environment by color contained in waste water

(1) Forecast of impacts on water environment by color contained in waste water after phase I project

After completion of phase I project, discharge volume of waste water is 76260t/d, while chroma in waste water is 50 (as a non-dimensional product) and used as the source strength for the forecast. The calculation results are listed in the local enlarged view of figure 7.4-32 and Table 7.4-23 for discharge outlet B<sub>3</sub>.

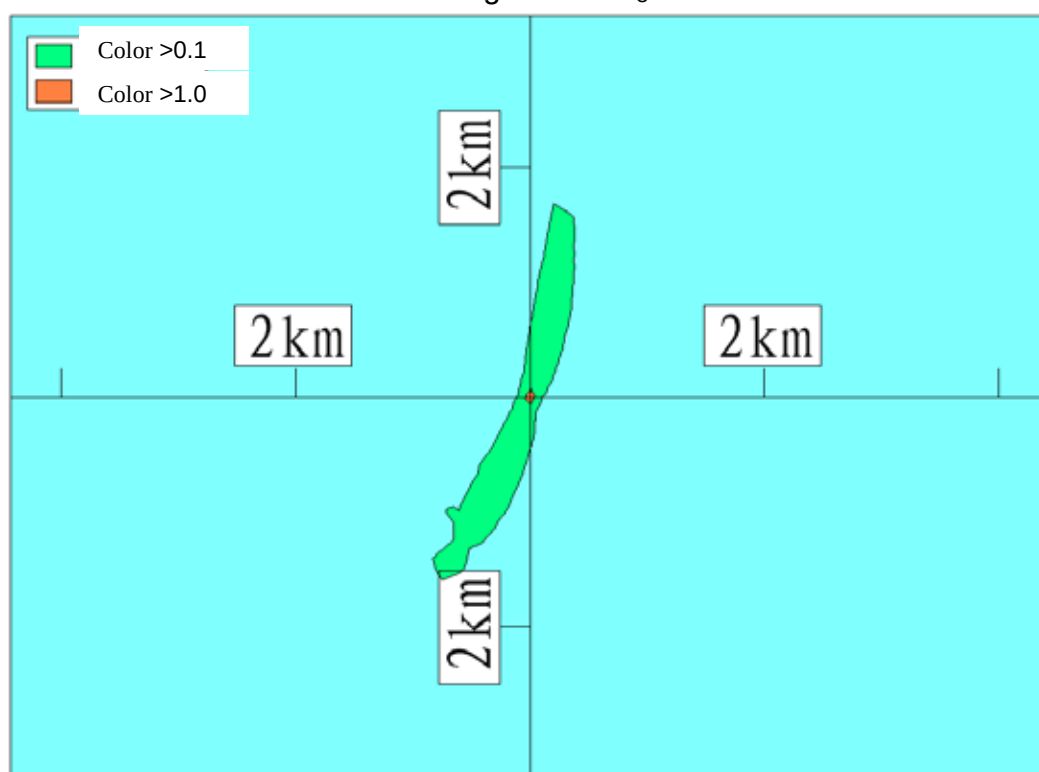


Figure 7.4-32 Envelope line of impacts on color increment under normal discharge after phase I project (partial zone of B<sub>3</sub>)



**Table 7.4-23 Analysis of impacts on water environment by color in discharged waste water after phase I project**

| Maximum area potentially affected by various increments of chroma (km <sup>2</sup> ) |                         |
|--------------------------------------------------------------------------------------|-------------------------|
| Increment of color>1.0                                                               | Increment of color >0.1 |
| 0.0034                                                                               | 0.9097                  |

According to the table, impact of increment of chroma in water environment is only limited to partial zone , which is near discharge outlet B<sub>3</sub>. Maximum influence distance of water body with increment of color >1.0 is 70m.

(2) Forecast of impacts of color contained in waste water on water environment after phase II project

After completion of phase II project, discharge volume of waste water is 93938t/d, while chroma in waste water is 50 (as a non-dimensional product) and used as the source strength for the forecast. The calculation results are listed in the local enlarged view of figure 7.4-33 and Table 7.4-24.

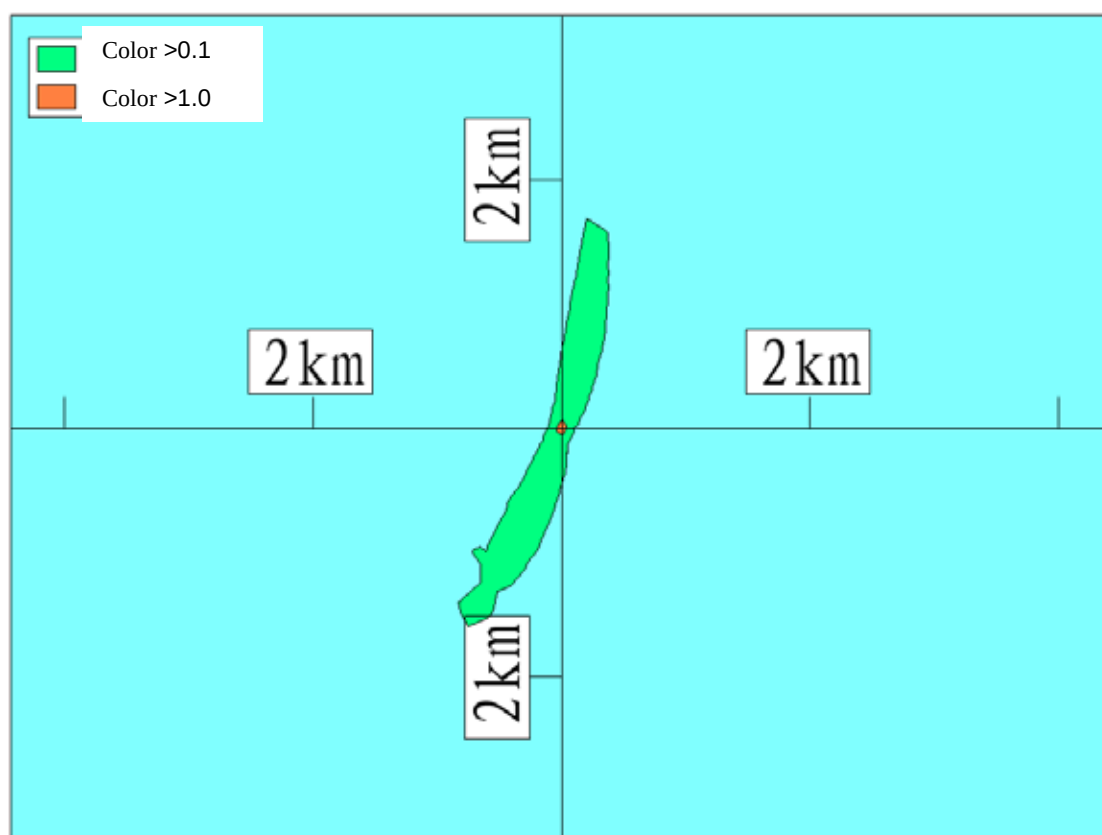


**Figure 7.4-33 Envelope line of impacts on color increment under normal discharge after phase II project (partial zone of B<sub>3</sub>)**

**Table 7.4—24 Analysis of impacts on water environment by color in discharged waste water after phase II project**

| Maximum area potentially affected by various increments of chroma (km <sup>2</sup> ) |                         |
|--------------------------------------------------------------------------------------|-------------------------|
| Increment of color >1.0                                                              | Increment of color >0.1 |
| 0.0059                                                                               | 1.4746                  |

According to the table, impact of increment of color on the water environment is only limited to partial zone, which is near discharge outlet B<sub>3</sub>. Maximum influence distance of water body with increment of chroma >1.0 is 90m.

(3) Forecast of impacts of color contained in waste water on water environment after phase III project

After completion of phase III project, discharge volume of waste water is 109158t/d, while chroma in waste water is 50 (as a non-dimensional product) and used as the source strength for the forecast. The calculation results are listed in figure 7.4-34, and Table 7.4-25, and the enlarged view of influence scope is listed in figure 7.4-35 for discharge outlet B<sub>3</sub>.

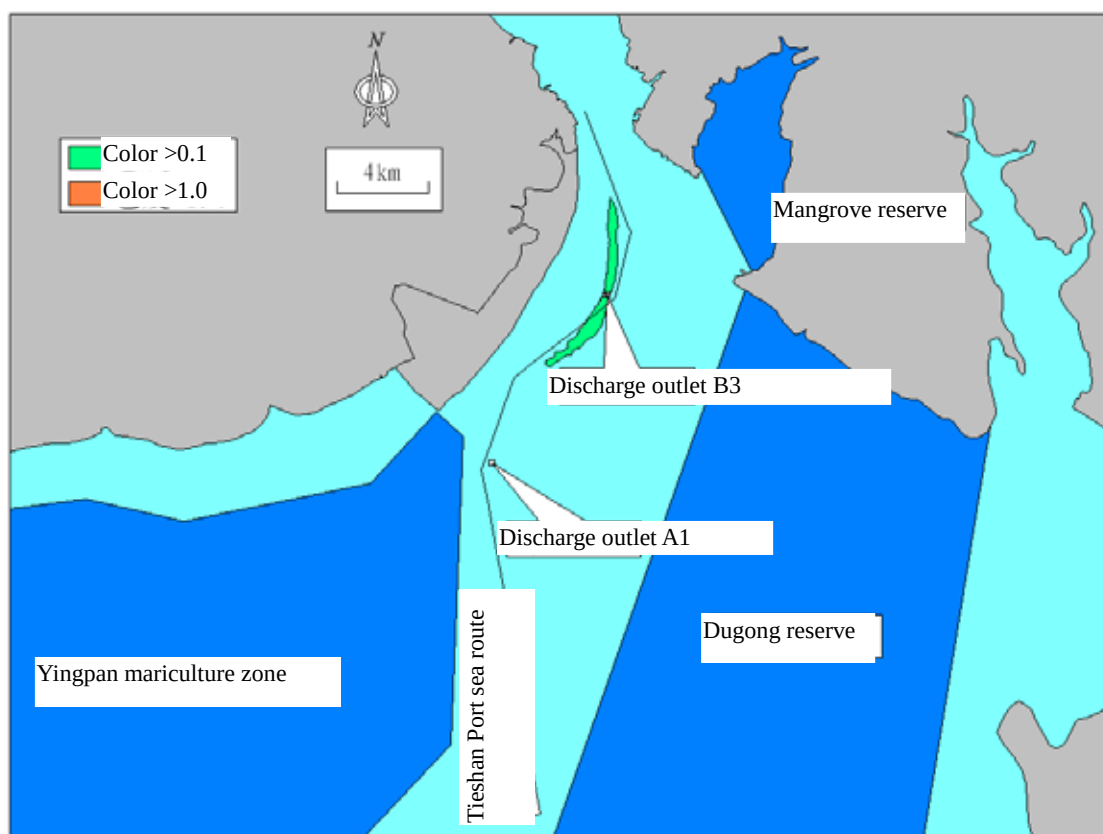


**Figure 7.4-34 Envelope line of impacts on color increment under normal discharge after phase III project**

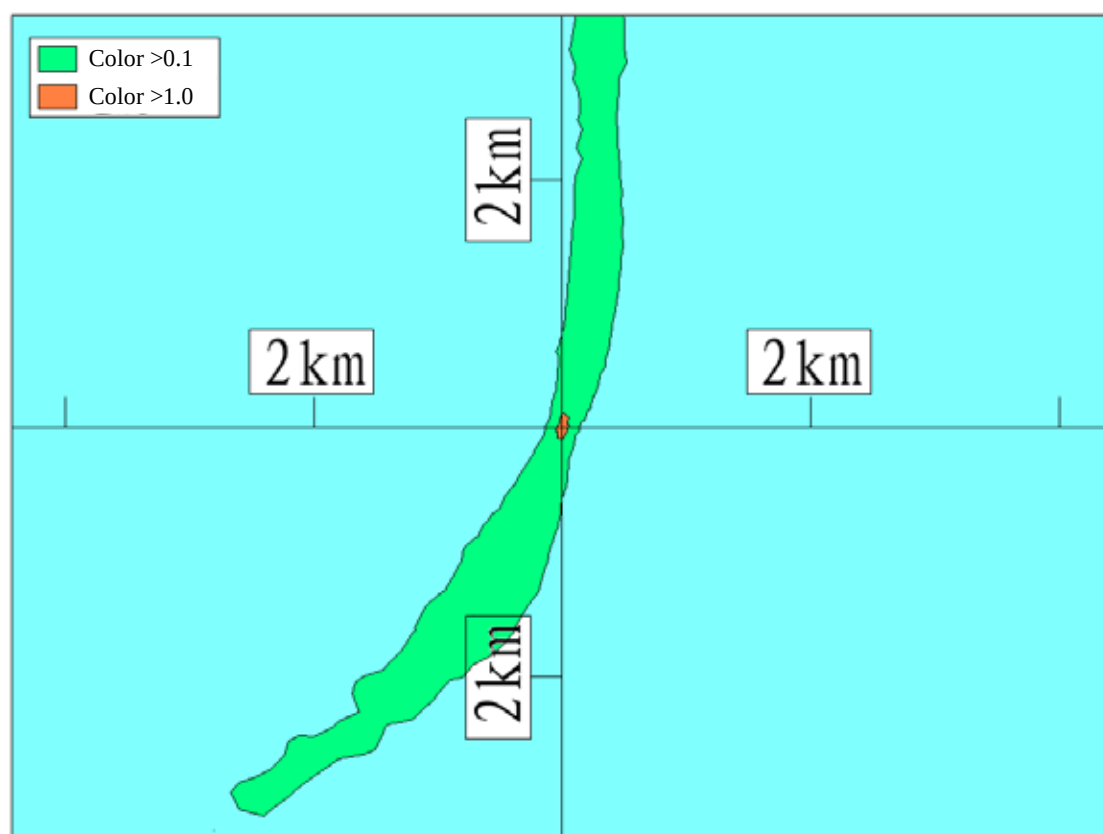


Figure 7.4-35 Envelope line of impacts on color increment under normal discharge after phase III project (partial zone of B<sub>3</sub>)

**Table 7.4—25 Analysis of impacts on water environment by color in discharged waste water after phase II project**

| Maximum area potentially affected by various increments of chroma (km <sup>2</sup> ) |                         |
|--------------------------------------------------------------------------------------|-------------------------|
| Increment of color >1.0                                                              | Increment of color >0.1 |
| 0.0091                                                                               | 2.9193                  |

According to the table, impact of increment of color on the water environment is only limited to partial zone, which is near discharge outlet B<sub>3</sub>. Maximum influence distance of water body with increment of color >1.0 is 120m.

### 7.4.3 Impacts on environment-sensitive targets by discharged waste water

#### 7.4.3.1 Analysis of impacts by COD contained in waste water on environment-sensitive targets

The possible impact degree of waste water on environment-sensitive targets (Mangrove

reserve, dugong reserve and Yingpan mariculture zone) is illustrated by redrawing with COD concentration increments (0.01mg/L and 0.1mg/L) on the basis of data estimated by model in the early stage.

(1) Impacts on environment-sensitive targets by COD contained in waste water after phase I project

We only list concentration increments of COD (0.01mg/L and 0.1mg/L) that reach environment-sensitive targets according to calculation results of the COD mathematical diffusion model. Refer to table 7.4-26 and figure 7.4-36 and 7.4-37 for forecast results.

**Table 7.4-26 Analysis of impacts on environment-sensitive targets by COD contained in discharged waste water after phase I project**

| Discharge concentration (mg/L) | Maximum concentration increment of CODs reaching environment-sensitive objects (mg/L) |                |                  |
|--------------------------------|---------------------------------------------------------------------------------------|----------------|------------------|
|                                | Yingpan mariculture zone                                                              | Dugong reserve | Mangrove reserve |
| 1410                           | 0.003                                                                                 | 0.027          | 0.246            |
| 250                            | 0.003                                                                                 | 0.005          | 0.044            |
| 100                            | 0.001                                                                                 | 0.002          | 0.017            |

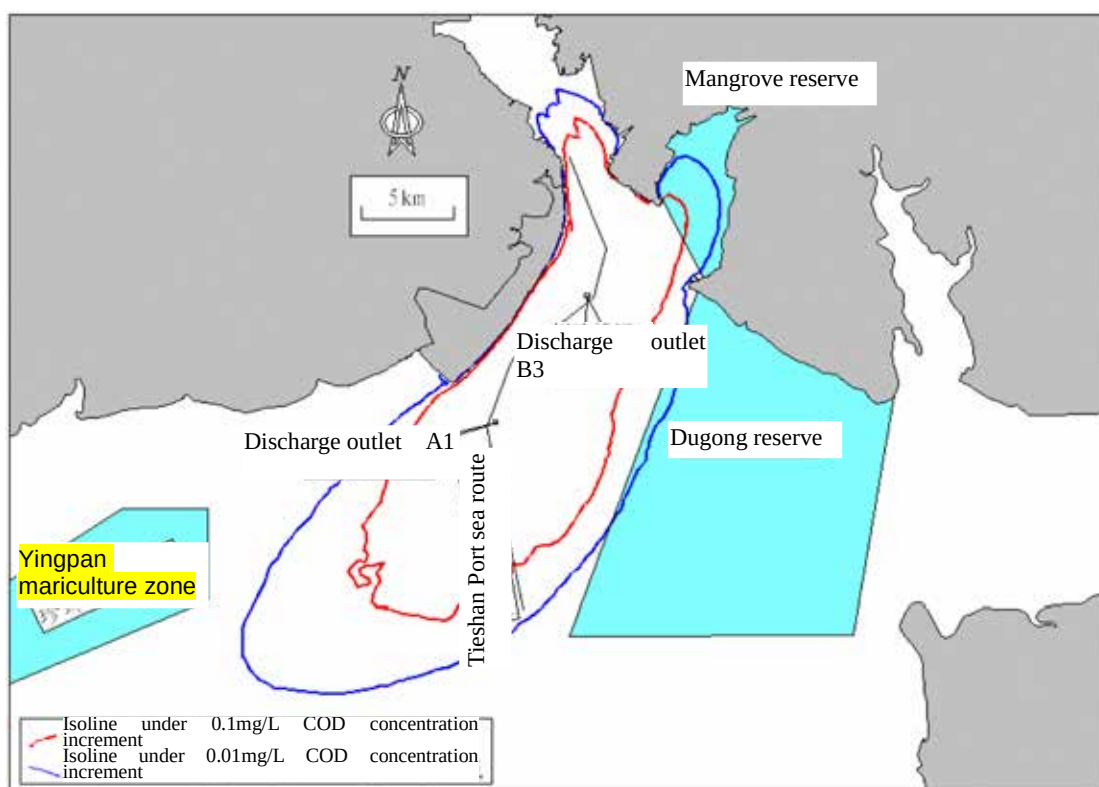


**Figure 7.4-36 Envelope line of concentration increment under 1410mg/L COD concentration after phase I project**

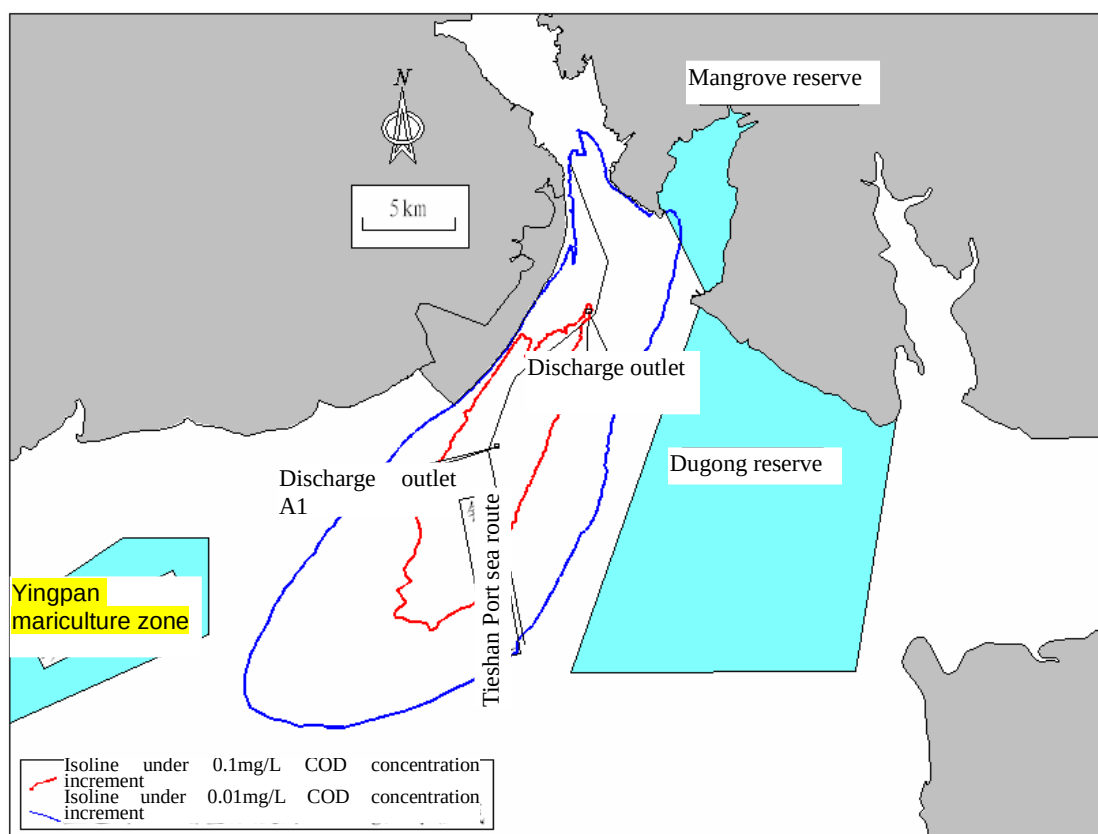


Figure 7.4-37 Envelope line of concentration increment under 100mg/L COD concentration after phase I project.

## (2) Impacts on environment-sensitive objects by COD contained in waste water after phase II project

We only list concentration increments of COD (0.01mg/L and 0.1mg/L) that reach environment-sensitive targets according to calculation results of the COD mathematical diffusion model. Refer to table 7.4-27 and figure 7.4-38 and 7.4-39 for forecast results.

**Table 7.4-27 Analysis of impacts on environment-sensitive objects by COD contained in discharged waste water after phase II project**

| Discharge concentration (mg/L) | Maximum concentration increment of CODs reaching environment-sensitive objects (mg/L) |                |                  |
|--------------------------------|---------------------------------------------------------------------------------------|----------------|------------------|
|                                | Yingpan mariculture zone                                                              | Dugong reserve | Mangrove reserve |
| 1250                           | 0.449                                                                                 | 0.029          | 0.269            |
| 90                             | 0.210                                                                                 | 0.002          | 0.019            |

## (3) Impacts on environment-sensitive objects by COD contained in waste water after phase III project

Only concentration increments of CODs (0.01mg/L and 0.1mg/L) that reach environment-

sensitive objects are listed according to calculation results of the COD mathematical diffusion model. Refer to table 7.4-28 and figure 7.4-40 and 7.4-41 for forecast results.

**Table 7.4-28 Analysis of impacts on environment-sensitive objects by COD contained in discharged waste water after phase III project**

| Discharge concentration<br>(mg/L) | Maximum concentration increment of CODs reaching environment-sensitive objects (mg/L) |                |                  |
|-----------------------------------|---------------------------------------------------------------------------------------|----------------|------------------|
|                                   | Yingpan mariculture zone                                                              | Dugong Reserve | Mangrove Reserve |
| 1136                              | 0.465                                                                                 | 0.031          | 0.284            |
| 90                                | 0.211                                                                                 | 0.002          | 0.022            |

#### (4) Summary

According to forecast results of impacts on environment-sensitive objects by COD contained in discharged waste water during the project, the current concentration of COD is 1.5mg/L in nearby water area. Superposing this value reaching maximum concentration of COD of environment-sensitive targets, the result isn't larger than the COD concentration (2mg/L) of Tier 1 sea water quality standard. It is obvious that COD contained in discharged waste water only have slight impacts on Yingpan mariculture zone, dugong nature reserve and mangrove nature reserve.

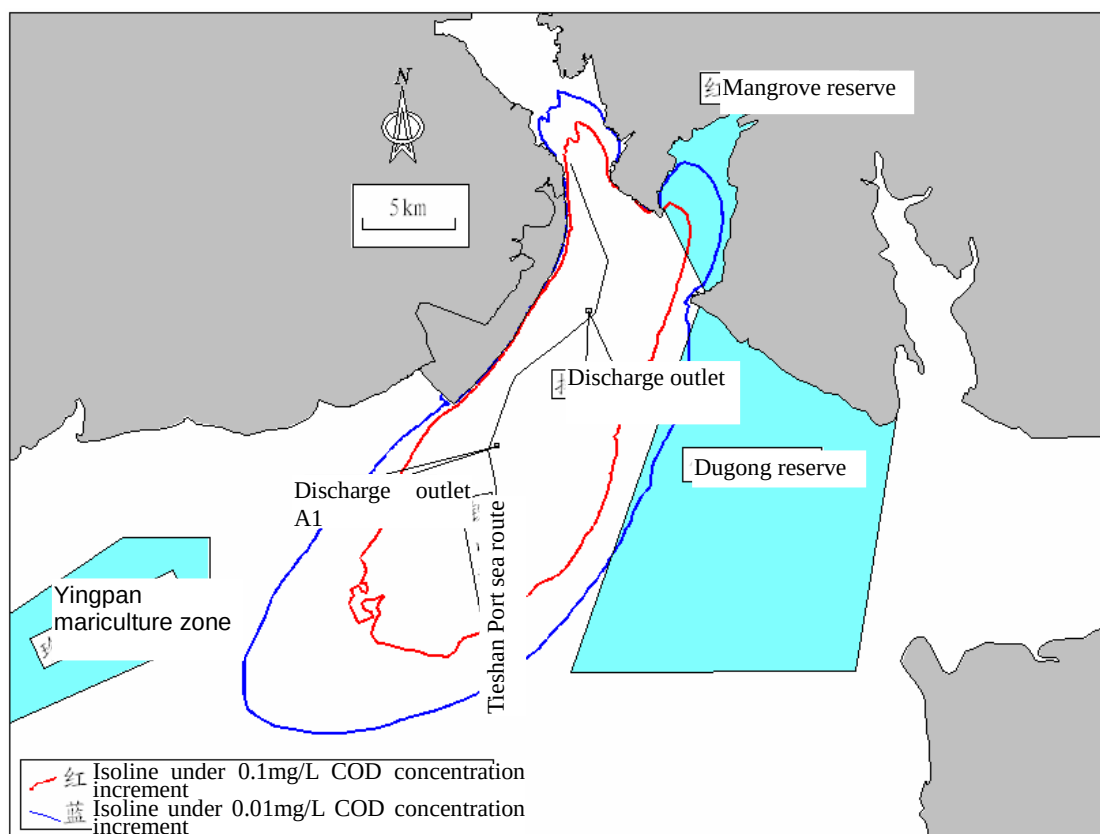


Figure 7.4-38 Envelope line of concentration increment under 1250mg/L COD concentration after phase II project

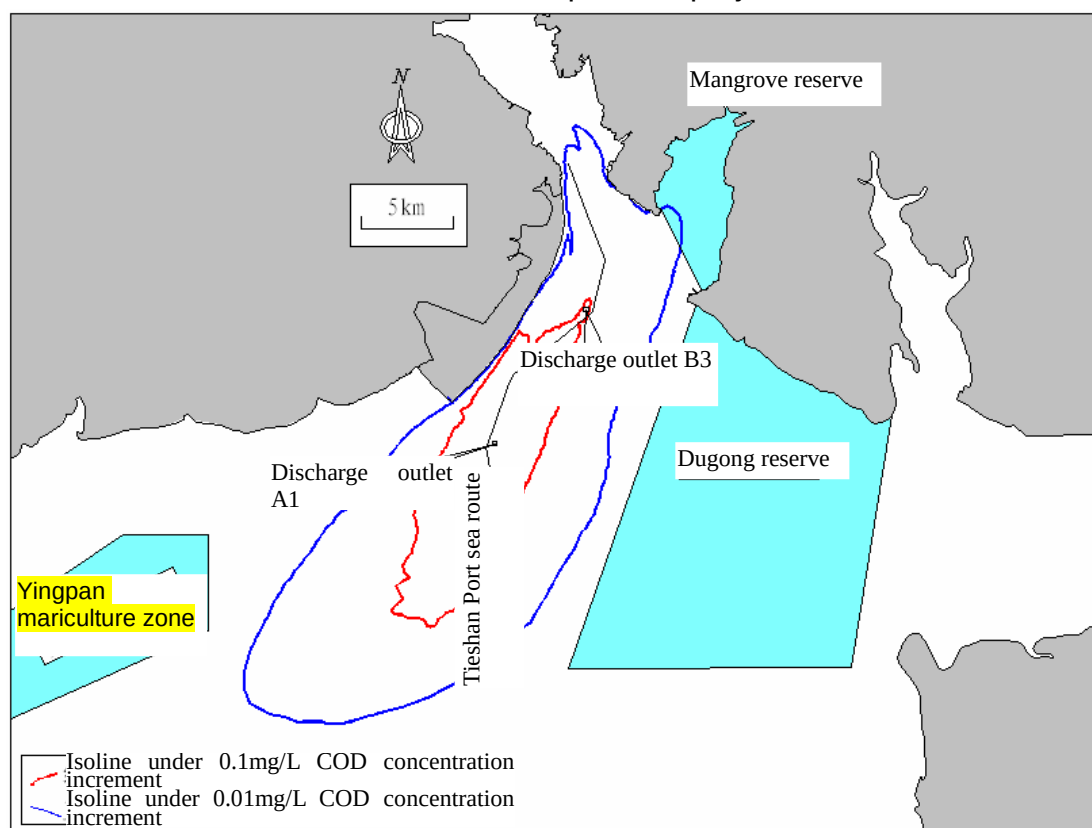


Figure 7.4-39 Envelope line of concentration increment under 90mg/L COD concentration after phase II project

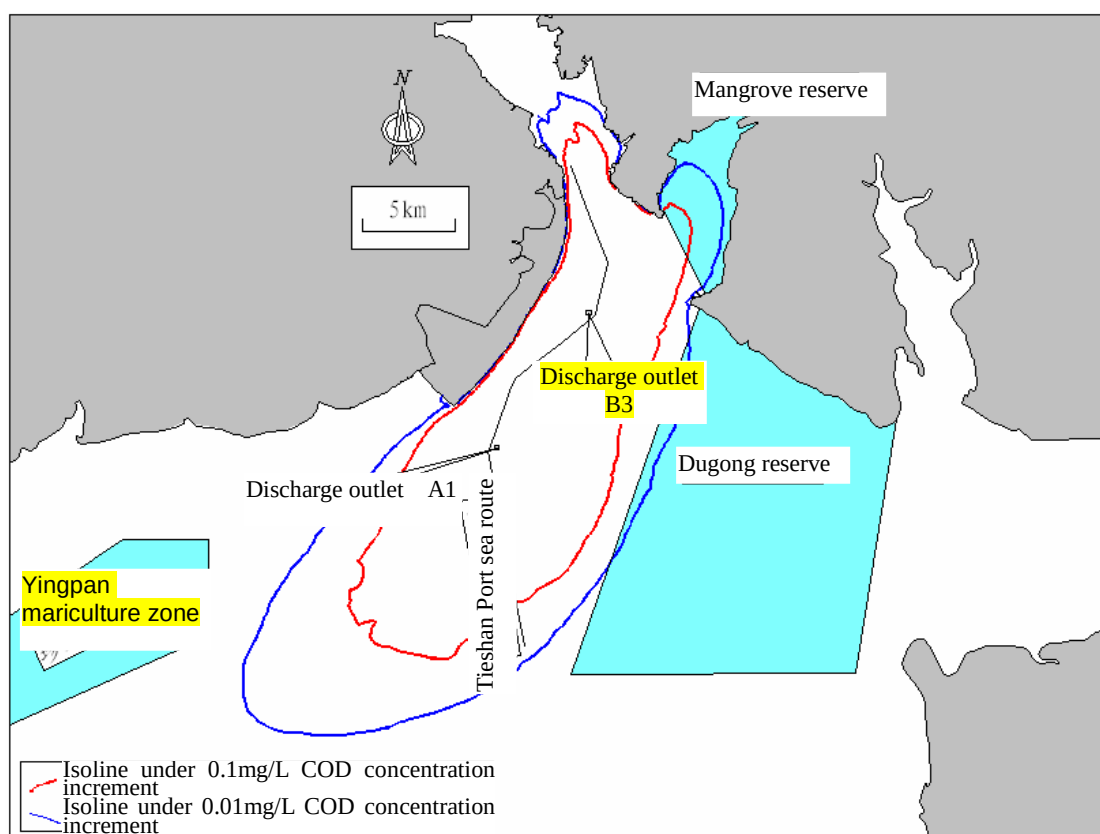


Figure 7.4-40 Envelope line of concentration increment under 1136mg/L COD concentration after phase III project

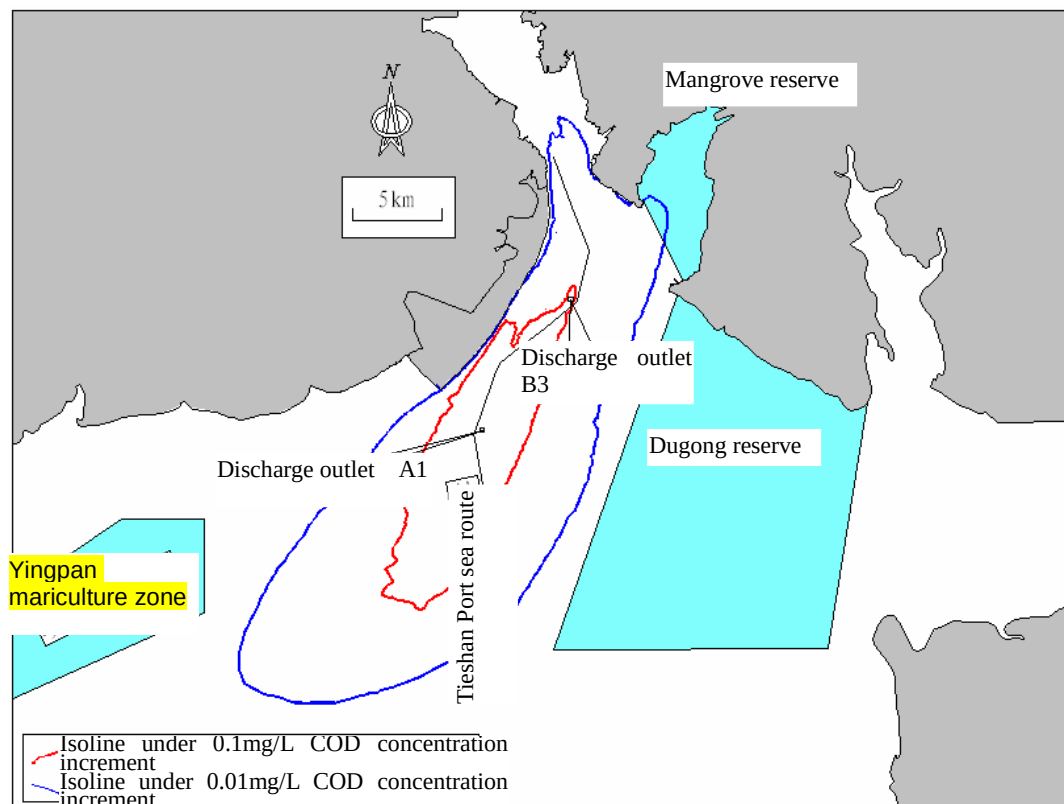


Figure 7.4-41 Envelope line of concentration increment under 100mg/L COD concentration after phase III project



#### 7.4.3.2 Analysis of impacts by BOD contained in waste water on environment-sensitive objects

We list concentration increments of BOD (0.01mg/L and 0.1mg/L) that reach environment-sensitive targets according to calculation results of the BOD mathematical diffusion model. Refer to table 7.4-29.

**Table 7.4-29 Analysis of impacts on environment-sensitive objects by BOD contained in discharged waste water after phase I project**

| Stage            | Maximum concentration increment of SS reaching environment-sensitive objects (mg/L) |                |                  |
|------------------|-------------------------------------------------------------------------------------|----------------|------------------|
|                  | <u>Yingpan mariculture zone</u>                                                     | Dugong reserve | Mangrove reserve |
| <u>Phase I</u>   | <u>0.013</u>                                                                        | <u>0.001</u>   | <u>0.009</u>     |
| <u>Phase II</u>  | <u>0.016</u>                                                                        | <u>0.001</u>   | <u>0.011</u>     |
| <u>Phase III</u> | <u>0.019</u>                                                                        | <u>0.001</u>   | <u>0.012</u>     |

#### 7.4.3.3 Impacts on environment-sensitive objects by SS contained in waste water of each outlet address selection scheme

Degrees of possible impacts by waste water on environment-sensitive objects(Mangrove reserve, Dugong reserve and Yingpan mariculture zone) are illustrated by redrawing with SS concentration increments (0.001mg/L and 0.005mg/L) on the basis of data estimated by model in the early stage.

We only list concentration increments of SS (0.01mg/L and 0.1mg/L) that reach environment-sensitive targets according to calculation results of the COD mathematical diffusion model .Refer to table 7.4-30 and figure 7.4-42 for alculatation results.

**Table 7.4-30 Impacts on environment-sensitive objects by AOX of each discharge outlet selection scheme**

| Discharge volume (mg/L) | Maximum concentration increment of AOX reaching the object sensitive to environment (mg/L) |                |                  |
|-------------------------|--------------------------------------------------------------------------------------------|----------------|------------------|
|                         | Yingpan mariculture zone                                                                   | Dugong reserve | Mangrove reserve |
| 504                     | 0.398                                                                                      | 0.024          | 0.220            |
| 50                      | 0.033                                                                                      | 0.002          | 0.022            |

#### (2) Impacts on environment-sensitive objects by SS contained in Waste Water after phase

## II project

Only concentration increments of SS (0.01mg/L and 0.1mg/L) that reach environment-sensitive objects are listed according to calculation results of the SS mathematical diffusion model. Refer to table 7.4-31 and figure 7.4-43.

**Table 7.4-31 Analysis of impacts on environment-sensitive objects by SS contained in discharged waste water after phase II project**

| Discharge concentration (mg/L) | Maximum concentration increment of SS reaching environment-sensitive objects (mg/L) |                |                  |
|--------------------------------|-------------------------------------------------------------------------------------|----------------|------------------|
|                                | Yingpan mariculture zone                                                            | Dugong reserve | Mangrove reserve |
| 715                            | 0.607                                                                               | 0.041          | 0.385            |
| 30                             | 0.024                                                                               | 0.002          | 0.016            |

### (3) Impacts on environment-sensitive objects by SS contained in waste water after phase III project

Only concentration increments of SS (0.01mg/L and 0.1mg/L) that reach environment-sensitive objects are listed according to calculation results of the SS mathematical diffusion model. Refer to table 7.4-32 and figure 7.4-44.

**Table 7.4-32 Analysis of impacts on environment-sensitive objects by SS contained in discharged waste water after phase III project**

| Discharge concentration (mg/L) | Maximum concentration increment of SS reaching environment-sensitive objects (mg/L) |                |                  |
|--------------------------------|-------------------------------------------------------------------------------------|----------------|------------------|
|                                | Yingpan mariculture zone                                                            | Dugong reserve | Mangrove reserve |
| 942                            | 0.003                                                                               | 0.063          | 0.589            |
| 30                             | 0.028                                                                               | 0.002          | 0.019            |

### (4) Summary

According to forecast and analysis, impacts on environment-sensitive objects by SS contained in discharged waste water during the project won't exceed the SS concentration (10mg/L) of Tier 1 sea water quality standards. It is obvious that SS contained in discharged waste water only have slight impacts on Yingpan mariculture zone, dugong nature reserve and mangrove nature reserve.

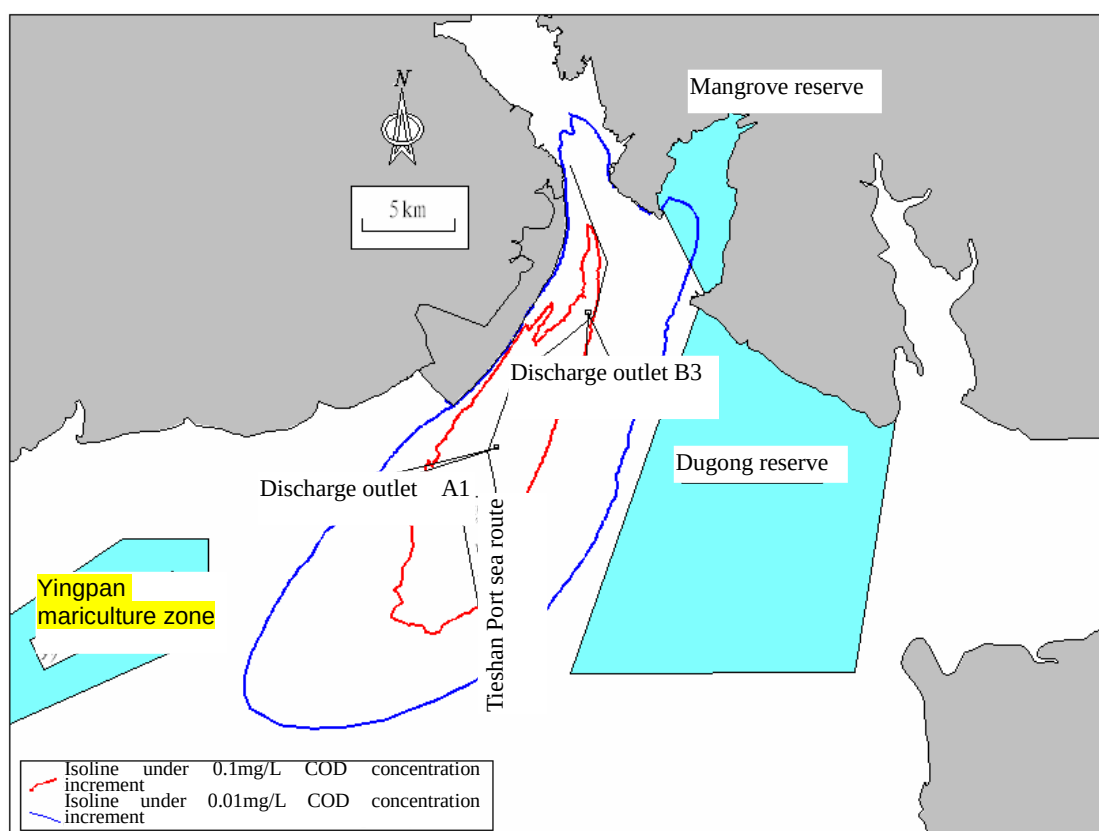


Figure 7.4-42 Envelope line of impacts under 50mg/L SS concentration after phase I project

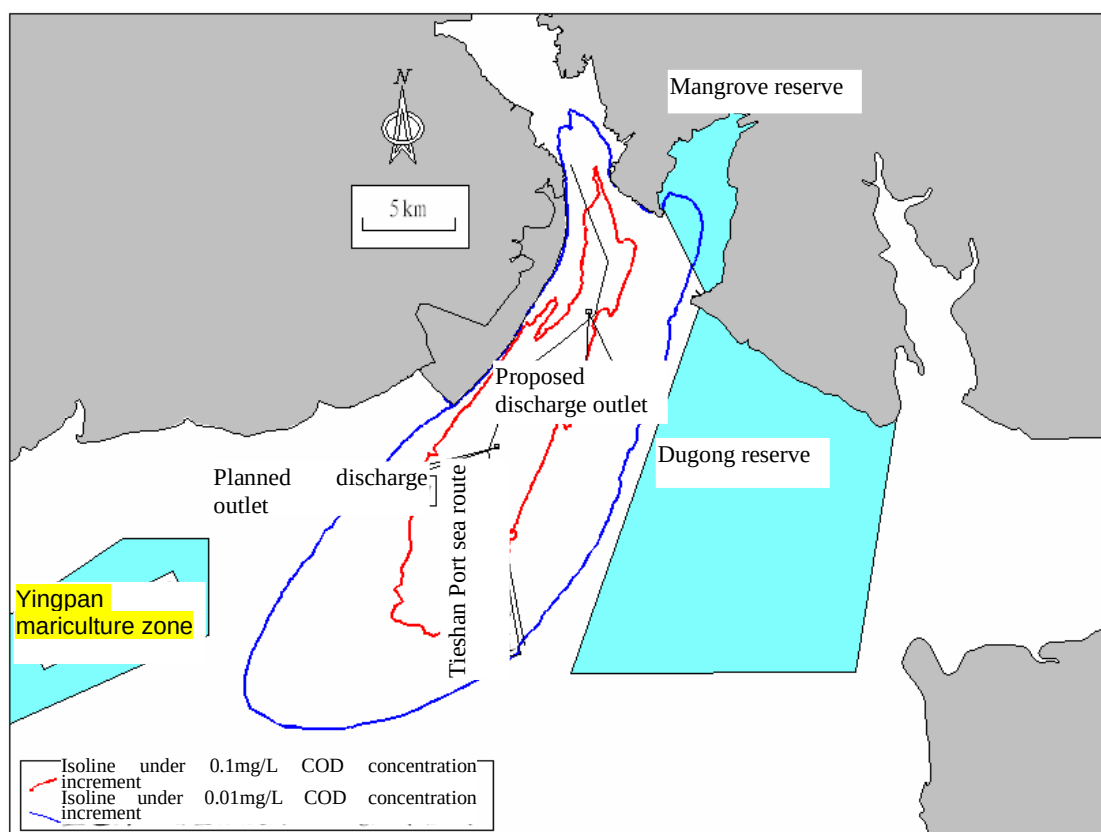


Figure 7.4-43 Envelope line of impacts under 30mg/L SS concentration after phase II project

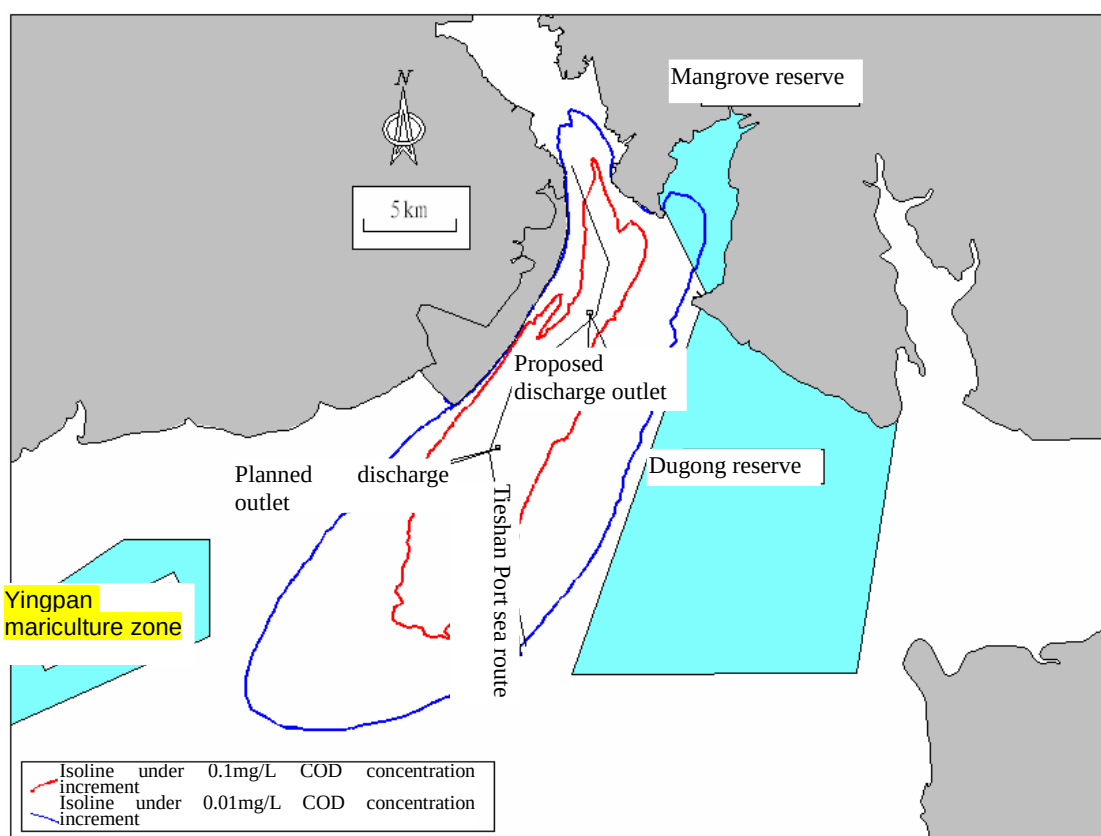


Figure 7.4-44 Envelope line of impacts under 30mg/L SS concentration after phase III project

#### 7.4.3.4 Impacts on environment-sensitive objects by AOX contained in waste water

Degrees of possible impacts by waste water on environment-sensitive objects (Mangrove reserve, Dugong reserve and Yingpan mariculture zone) are illustrated by redrawing with AOX concentration increments (0.001mg/L and 0.005mg/L) on the basis of data estimated by model in the early stage. Refer to table 7.4-33 and figure 7.4-45, 7.4-46 for maximum AOX concentration increment of each object.

**Table 7.4-33 Impacts on environment-sensitive objects by AOX contained in waste water**

| Discharge volume | Maximum concentration increment of AOX reaching the environmental-sensitive object (mg/L) |                |                  |
|------------------|-------------------------------------------------------------------------------------------|----------------|------------------|
|                  | Yingpan mariculture zone                                                                  | Dugong reserve | Mangrove reserve |
| 0.94t/d          | 0.008                                                                                     | 0.001          | 0.005            |
| 0.38t/d          | 0.003                                                                                     | <0.001         | 0.002            |

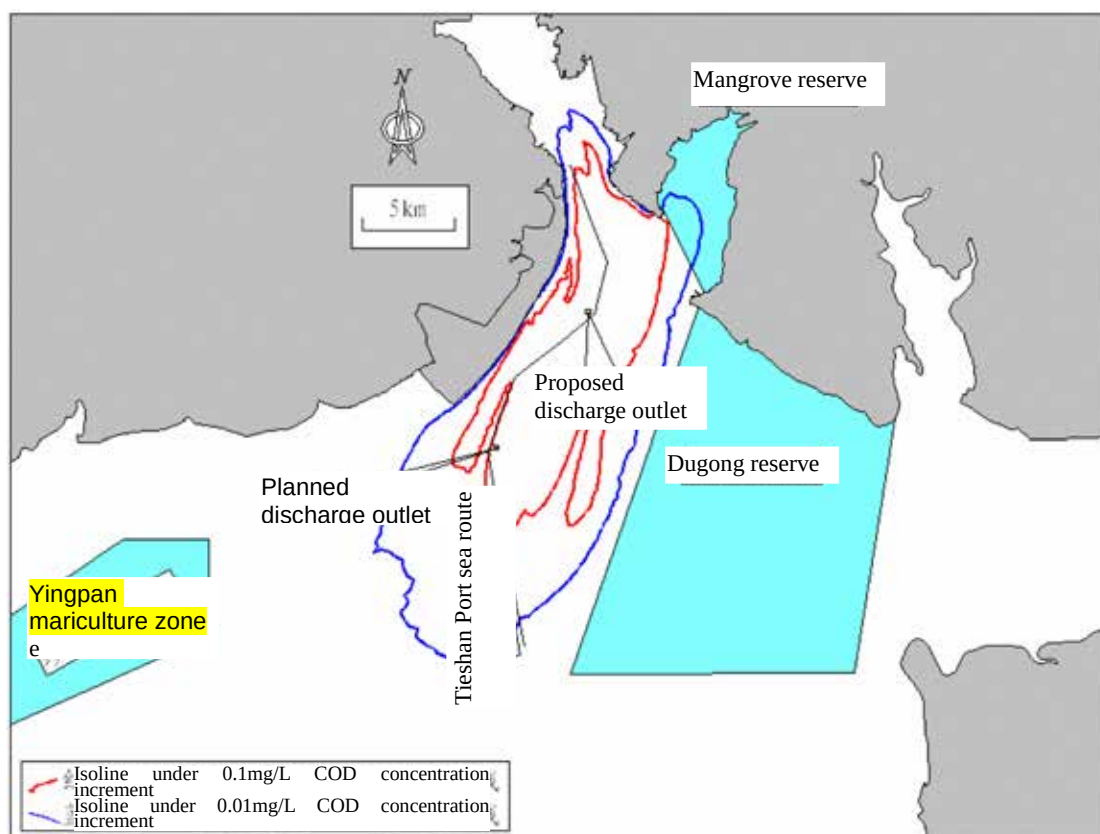
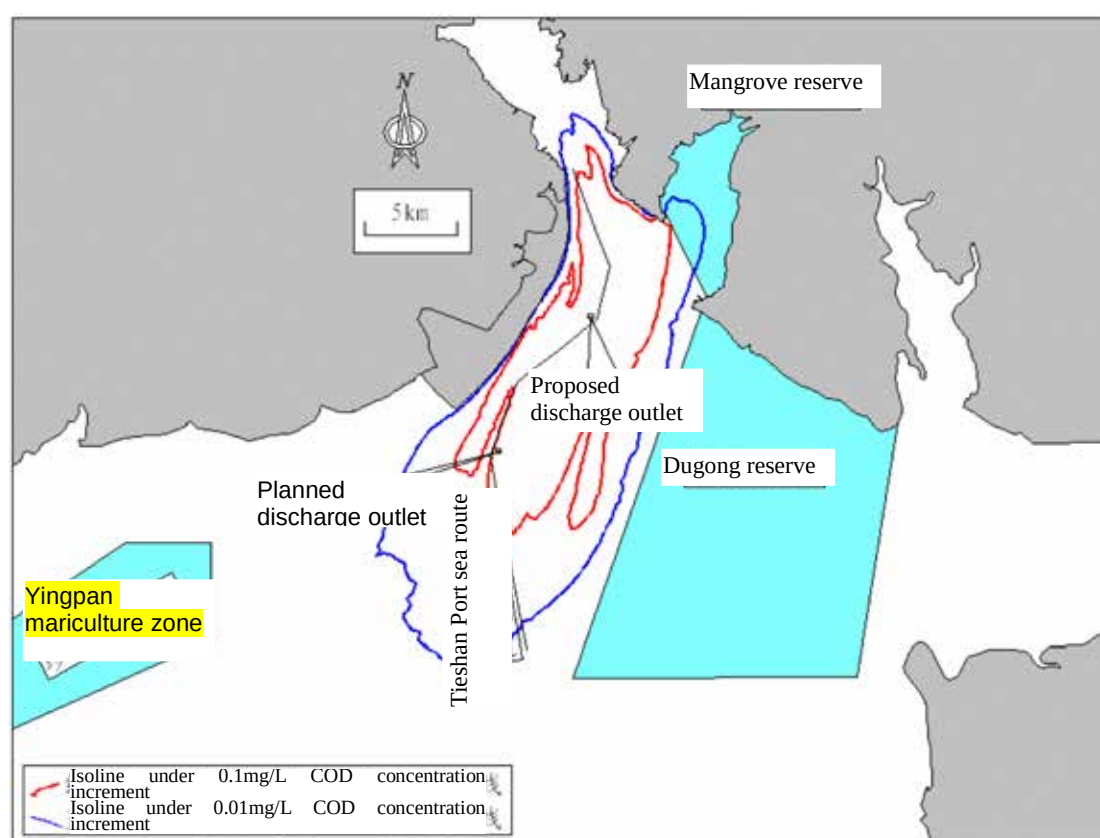


Figure 7.4-45 Envelope line of impacts on water environment by AOX when the discharge volume is 0.94t/d



#### 7.4.3.5 Impacts on environment-sensitive objects by dioxins contained in waste water

Only concentration increments of dioxins that reach environment-sensitive objects are

listed according to calculation results of the dioxins mathematical diffusion model. Refer to table 7.4-47 and figure 7.5-34 for forecast results.

**Table 7.4-34 Analysis of impacts on environment-sensitive objects by dioxins contained in discharged waste water**

| Maximum concentration increment of dioxins reaching the environment-sensitive object (pgTEQ/L) |                |                  |
|------------------------------------------------------------------------------------------------|----------------|------------------|
| Yingpan mariculture zone                                                                       | Dugong Reserve | Mangrove Reserve |
| 0.004                                                                                          | <0.001         | 0.003            |

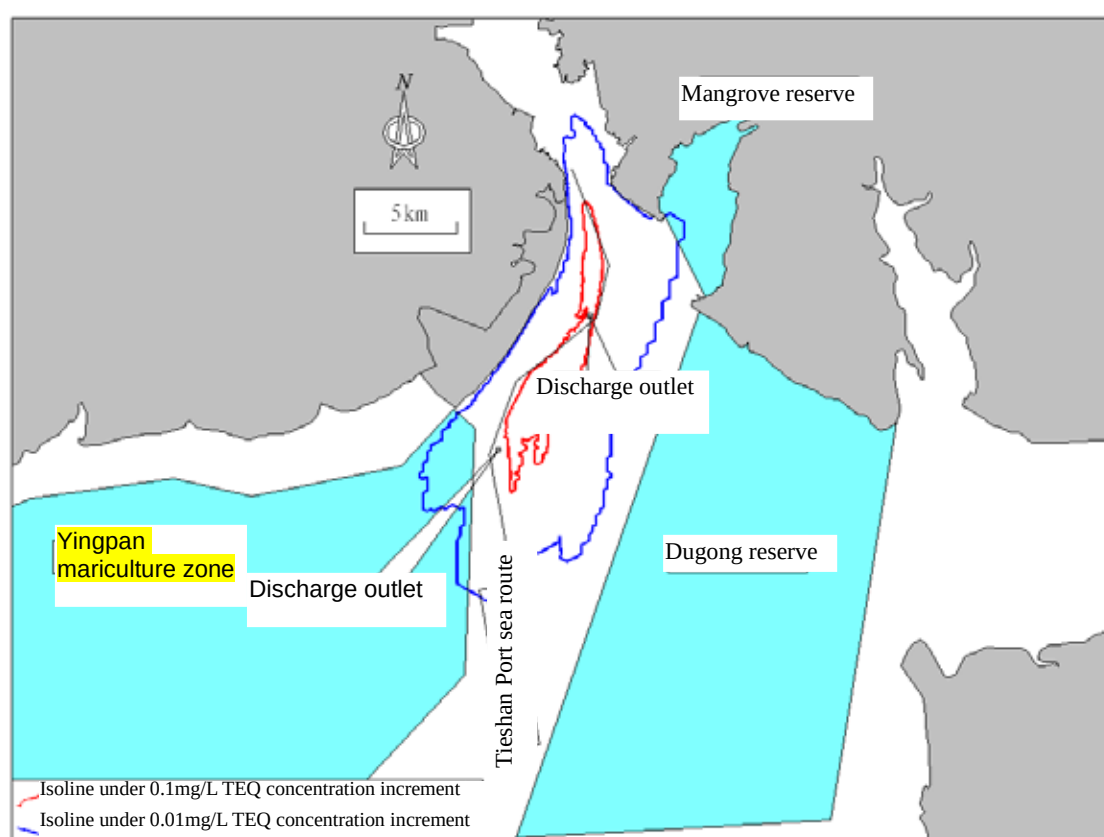


**Figure 7.4-47 Envelope line of increment concentration of dioxin when the discharge volume is 0.38t/d ( $B_3$ )**

#### 7.4.3.6 Impacts on environment-sensitive objects by ammonia nitrogen contained in waste water

Only concentration increments of ammonia nitrogen that reach environment-sensitive objects are listed according to calculation results of the ammonia nitrogen mathematical diffusion model. Refer to table 7.4-35.

**Table 7.4-35 Analysis of impacts on environment-sensitive objects by ammonia nitrogen contained in discharged waste water**

| Stage     | Maximum concentration increment of ammonia nitrogen reaching the environmental-sensitive object (mg/L) |                |                  |
|-----------|--------------------------------------------------------------------------------------------------------|----------------|------------------|
|           | Yingpan mariculture zone                                                                               | Dugong reserve | Mangrove reserve |
| Phase I   | 0.004                                                                                                  | <0.001         | 0.002            |
| Phase II  | 0.005                                                                                                  | <0.001         | 0.002            |
| Phase III | 0.006                                                                                                  | <0.001         | 0.003            |

#### 7.4.3.7 Impacts on environment-sensitive objects by total nitrogen contained in waste water

Concentration increments of total nitrogen that reach environment-sensitive objects are listed according to calculation results of the total nitrogen mathematical diffusion model. Refer to Figure 7.4-47~Figure 7.4-49 and Table 7.4-36.

**Table 7.4-36 Analysis of impacts on environment-sensitive objects by total nitrogen contained in discharged waste water**

| Stage     | Maximum concentration increment of total nitrogen reaching the environmental-sensitive object (mg/L) |                |                  |
|-----------|------------------------------------------------------------------------------------------------------|----------------|------------------|
|           | Yingpan mariculture zone                                                                             | Dugong reserve | Mangrove reserve |
| Phase I   | 0.003                                                                                                | <0.001         | 0.001            |
| Phase II  | 0.004                                                                                                | <0.001         | 0.002            |
| Phase III | 0.004                                                                                                | <0.001         | 0.002            |

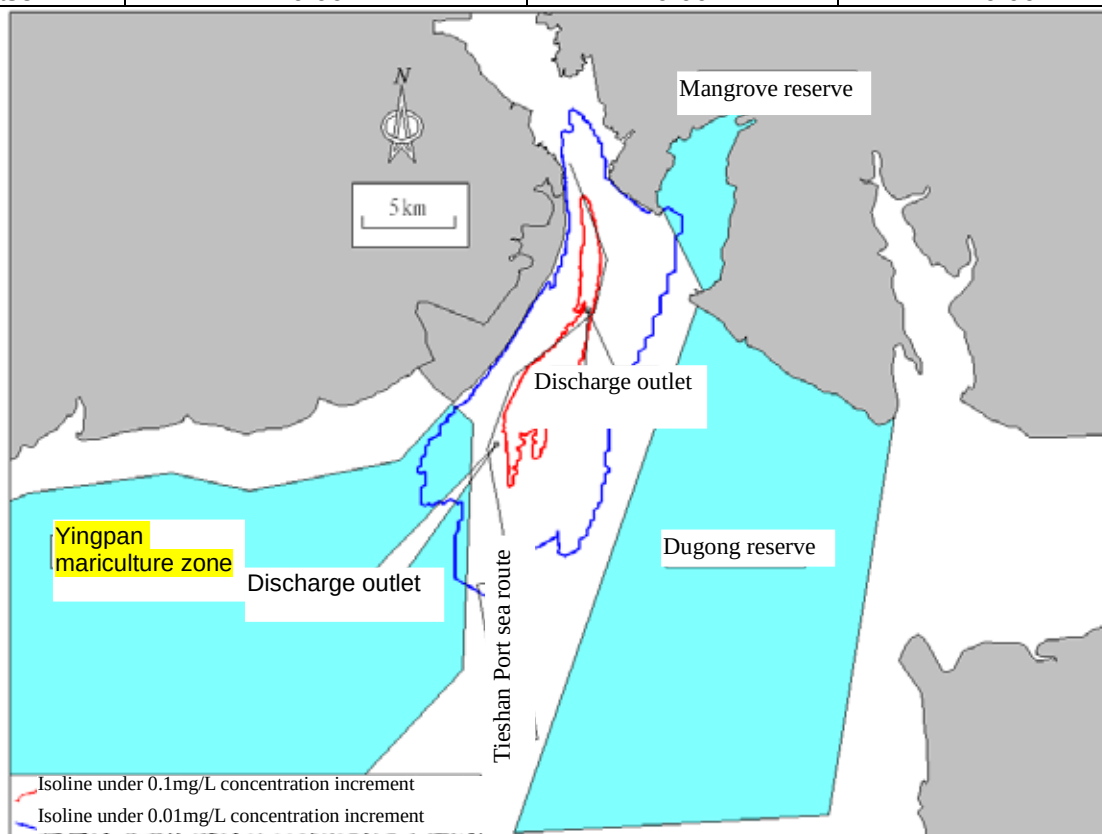


**Figure 7.4-47 Envelope line of increment concentration of total nitrogen after phase I project**

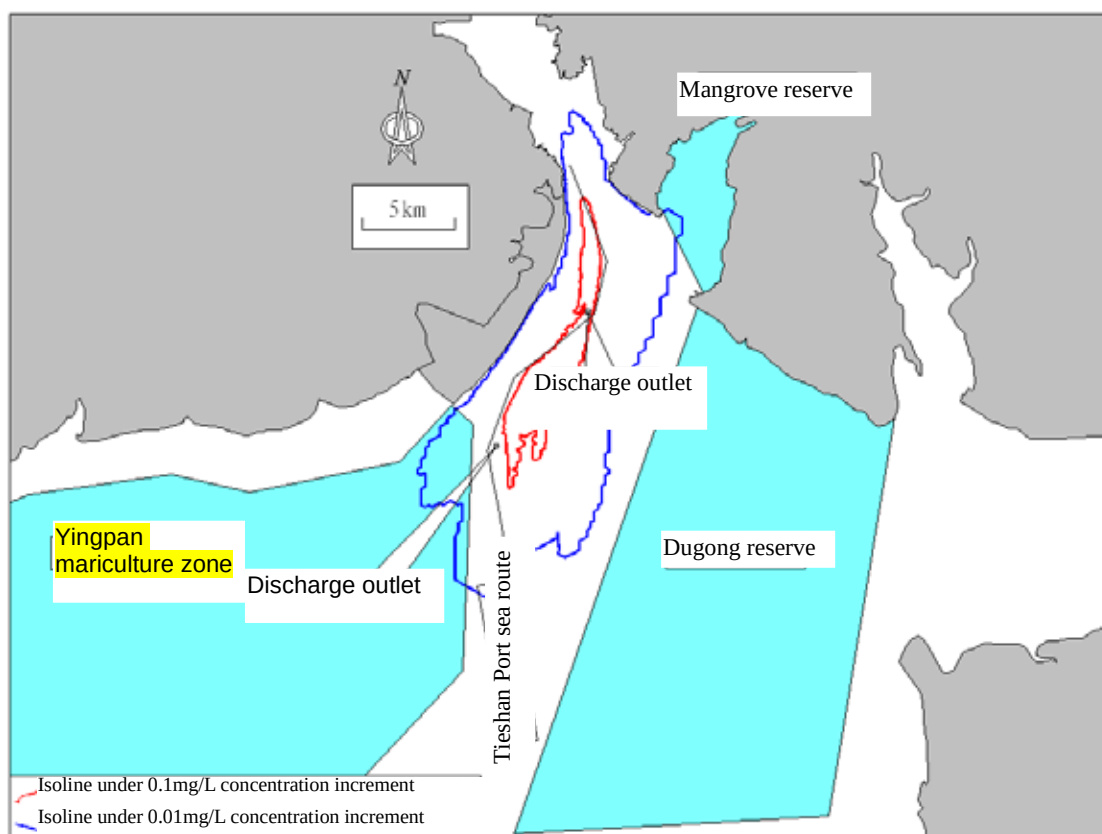


Figure 7.4-48 Envelope line of increment concentration of total nitrogen after phase II project

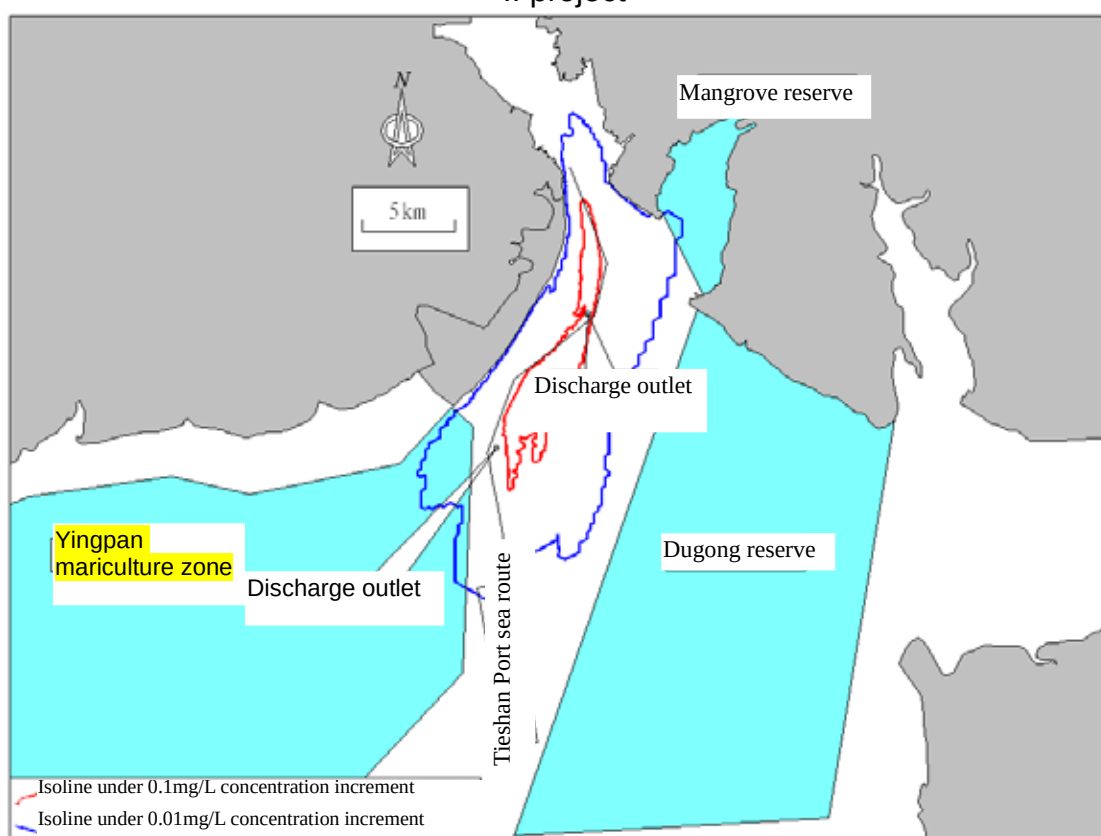


Figure 7.4-49 Envelope line of increment concentration of total nitrogen after phase III project



#### 7.4.3.8 Impacts on environment-sensitive objects by total phosphorus contained in waste water

Only concentration increments of total phosphorus that reach environment-sensitive objects are listed according to calculation results of the total phosphorus mathematical diffusion model. Refer to table 7.4-37 and figure 7.4-50-7.4-52.

**Table 7.4-37 Analysis of impacts on environment-sensitive objects by total phosphorus contained in discharged waste water under planned coastal line**

| Stage     | Maximum concentration increment of total phosphorus reaching the environment-sensitive object (pgTEQ/L) |                |                  |
|-----------|---------------------------------------------------------------------------------------------------------|----------------|------------------|
|           | Yingpan mariculture zone                                                                                | Dugong reserve | Mangrove reserve |
| Phase I   | 0.001                                                                                                   | <0.001         | 0.001            |
| Phase II  | 0.001                                                                                                   | <0.001         | 0.001            |
| Phase III | 0.001                                                                                                   | <0.001         | 0.001            |

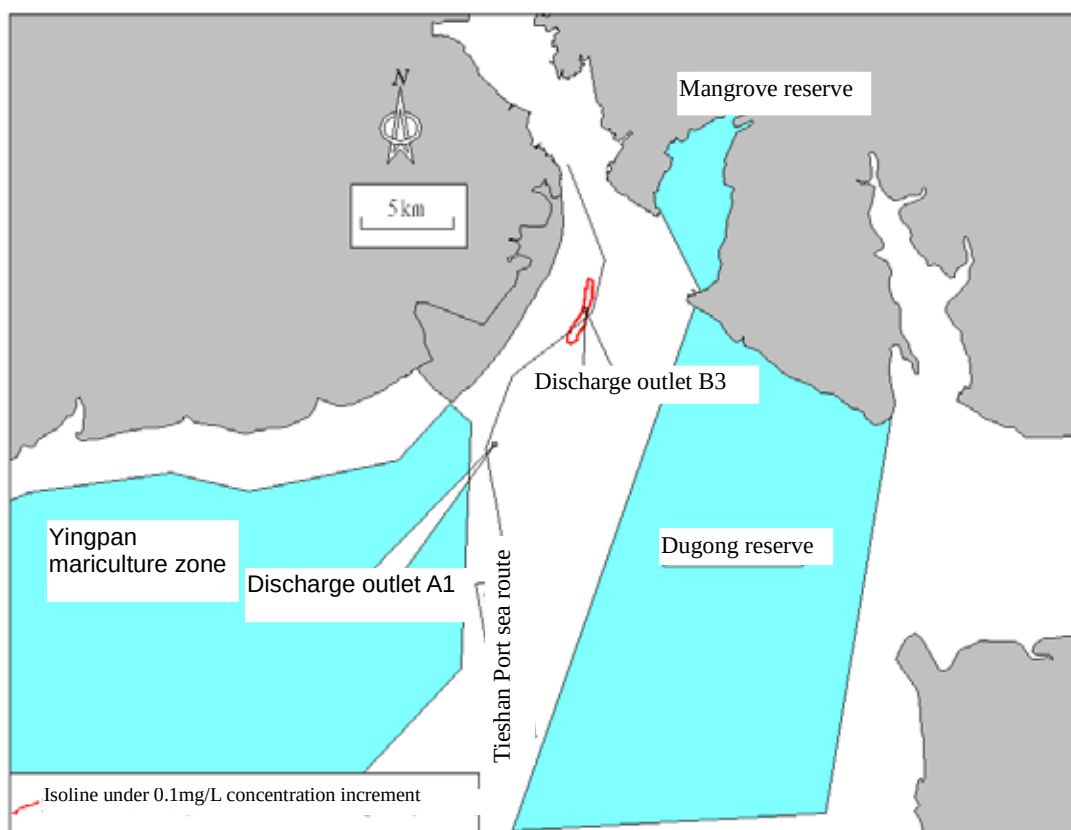


**Figure 7.4-50 Envelope line of increment concentration of total phosphorus under planned coastal line after phase I project (B<sub>3</sub>)**

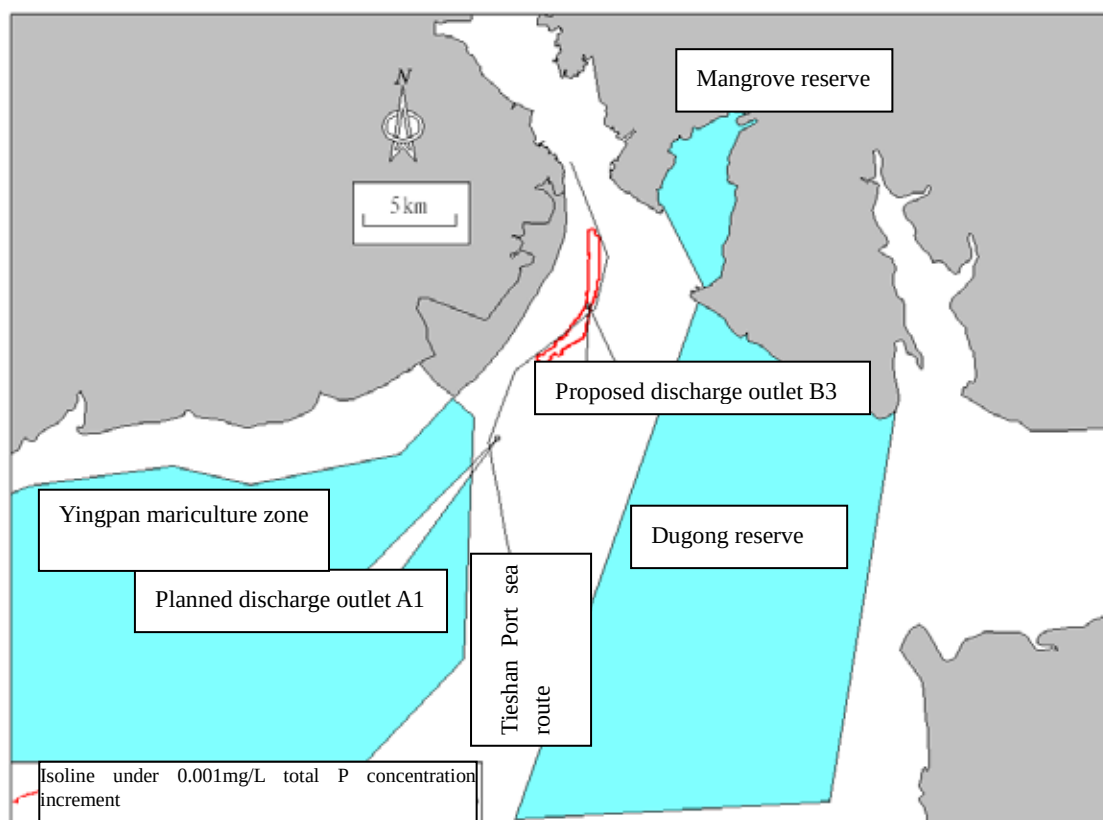


Figure 7.4—51 Envelope isoline of total phosphor increment concentration after phase II  
planned coastal line project

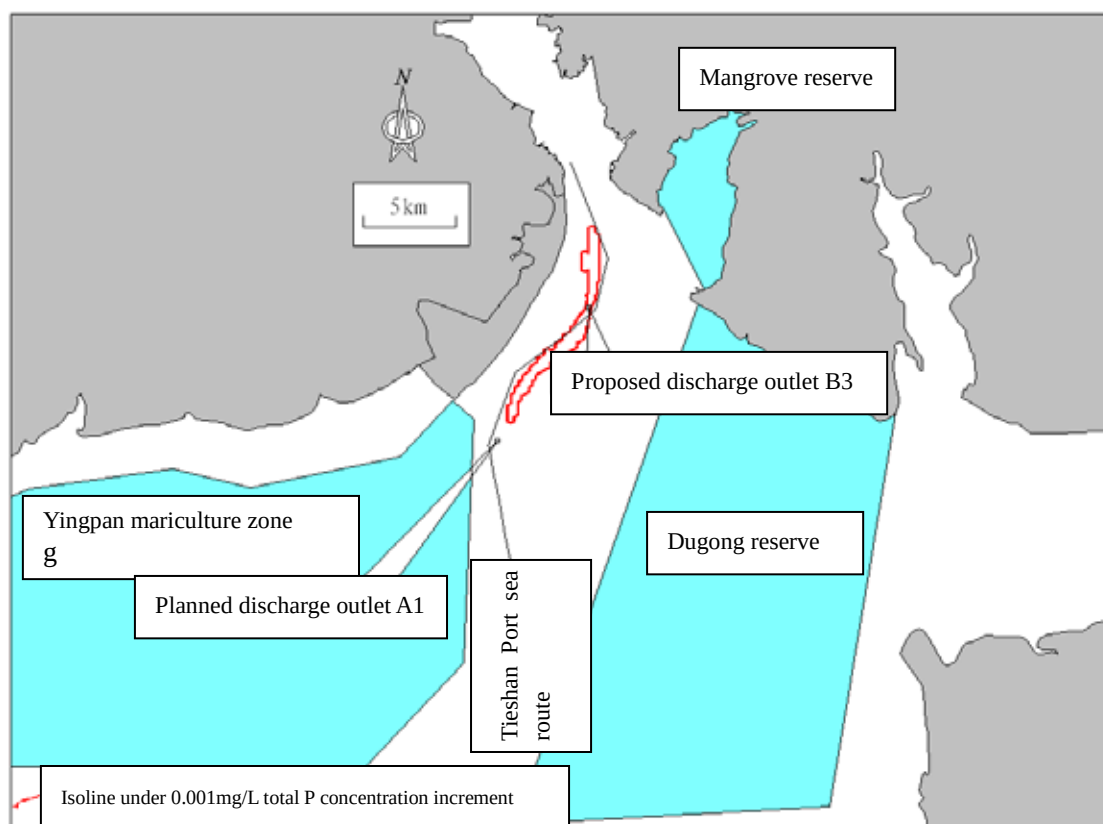


Figure 7.4—52 Envelope isoline of total phosphor increment concentration after phase III  
planned coastal line project

#### 7.4.3.9 Impacts on environment-sensitive objects by color contained in waste water

According to the calculation results of color diffusion mathematical model in waste water, we lists the chroma concentration increment that reach the environment-sensitive objects. The predict calculation results refer to Table 7.4-38.

**Table 7.4-38 Analysis of impacts on environment sensitive objects by color contained in discharged waste water after the implementation of the planned coastal line**

| Construction period | The maximal concentration increment that reach the environment-sensitive objects (mg/L) |                |                  |
|---------------------|-----------------------------------------------------------------------------------------|----------------|------------------|
|                     | Yinpan sea water breeding                                                               | Dugong reserve | Mangrove reserve |
| Phase I             | 0.033                                                                                   | 0.002          | 0.015            |
| Phase II            | 0.040                                                                                   | 0.002          | 0.019            |
| Phase III           | 0.047                                                                                   | 0.003          | 0.022            |

### 7.5 Environmental Impacts of Discharge Outlet of the Project without Implementation of Coastline Plan (Port development)

*Section removed, the port development in the Tieshangang Industrial area is taking place making section 7.4 the relevant description for the conditions of the discharge long term*

### 7.6 Summary

(1) Under normal construction situations, COD only partially impacts the water environment and maximum possible areas, where the concentration is above 2.0mg/L, are respectively 0.02(km<sup>2</sup>), 0.03(km<sup>2</sup>) and 0.04(km<sup>2</sup>) during Phase I, II and II, almost without any superposition with impacts by COD contained in the discharged waste water from the planned outlet A1; Dugong reserve, mangrove reserve and Yingpan mariculture zone will not be directly impacted. In accident discharge, due to large impact range of COD contained in the waste water, further strict management and prevention facilities should be built to prevent and avoid accident discharge of waste water.

(2) According to the calculation results, impact ranges of SS in all construction situations are slight when exceeding higher than limits of Tier 1 and 2 sea water quality standards. SS neither impacts environment nor directly influences Yingpan mariculture zone, dugong reserve and mangrove reserve.

(3) Discharged quantities of AOX are respectively 0.38t/d and 0.94t/d in different construction situations. Adopt pollutant diffusion equation to calculate the AOX diffusion in 10 successive tide cycles at the discharge outlet of this project, the calculation results show that: when the concentration is higher than 0.05mg/L, maximum possible affected area is 0.01 (km<sup>2</sup>). Impacts caused by AOX are relatively lower on water environment

and slight on, dugong reserve, mangrove reserve and Yingpan mariculture zone.

(4) The impact on the evaluated sea area by the pollutant such as dioxin, total phosphorus,  $\text{NH}_2\text{-N}$  and total nitrogen under various discharge condition is limited in the sea area close to the discharge outlet, and the impact on the main ocean environment protection objects is slight.

## 8. Prediction and Evaluation of Atmospheric Environmental Effects

### 8.1 Analysis of Meteorological Conditions for Pollution

#### 8.1.1 Comparison of Wind Field between Plant zone and Meteorological Station

The plant zone is located northeast of the meteorological station, 40km in linear distance. Both locations are identical in the light of geographic environment and atmospheric circulation system effect, but probably with a certain degree of difference between them in terms of surface wind direction and wind speed due to the difference of a small scale of topographic condition. This evaluation makes use of the air pollution meteorology observation data obtained in their respective plant zones (not far from the intended location of this project, 6.5km southwest and 4.0km northeast from Beihai Power Plant and Oil Refinery Plant respectively) in early 2005 and August of 2005 respectively during the environmental evaluations of the reconstruction project of Beihai Oil Refinery Plant in another region and the Beihai Power Plant project at second phase to conduct essential meteorological factors correlation analysis of the intended location of the project and Beihai Meteorological station..

The statistical results of surface wind data at the same stage and at the same time for the district near the plant zone and Beihai meteorological station during observation are given in Table 8.1-1. We can see from the table:

- 1) The prevailing wind of plant zone and meteorological station are basically conformable, but only one azimuth bias in the most wind direction. Three wind directions: S, SNE, SSW, of surface wind are dominant at the plant zone, with the most predominant direction of S-SW, ENE, SSE-SE; three wind directions: SW, ENE, SE, are dominant at the meteorological station with the most predominant direction of S-SW, ENE, SSE, .SE; three wind directions: SW, ENE, SE, are dominant at the meteorological station with the most predominant direction of S-SW, ENE, SE.
- 2) The frequency of static wind is 10.1%, 3% higher than that at the meteorological station.
- 3) The average wind speed is close to 2.7m/s and 2.8m/s at plant zone and meteorological station respectively.

In order to verify the representativeness of observed data in the area near the plant zone and meteorological station during the summer investigation (August 14-28, 2005) was conducted. The statistical results have indicated that the wind directions of both sites are well correlated, the occurrence frequency of having the same wind direction or

one azimuth bias is 64%. The wind speeds of both sites are also well correlated. A comparison of wind speed on daily base for both sites observed during the observations given in Fig. 8.1-1, indicates that the tendency of daily variation of wind speed at both sites is in good consistency. In accordance with the proposal of Technical guidelines on evaluation of environmental effect (HJ/T 2.2-93) issued by State's Environmental Protection Administration, the correlative coefficient of wind speed components in X and Y directions at the plant zone and meteorological station based on the component regression method was calculated with the results of  $r_x=0.65$  and  $r_y=0.68$ . The significance test of the regression formula with  $\alpha=0.05$  has shown that it was far higher than that of evaluation project for class I with  $r>0.45$ , indicating that the observed data obtained from the plant zone have good representativeness. The calculated results by component regression method are given in Table 8.1-2.

**Table 8.1-1 Statistical table of Comparison of surface wind between the plant zone and meteorological station during the investigation**

| Wind direction | Winter                       |                        |                          |                        | Summer                       |                        |                          |                        |
|----------------|------------------------------|------------------------|--------------------------|------------------------|------------------------------|------------------------|--------------------------|------------------------|
|                | Wind direction frequency (%) |                        | Average wind speed (m/s) |                        | Wind direction frequency (%) |                        | Average wind speed (m/s) |                        |
|                | Plant Zone                   | Meteorological station | Plant Zone               | Meteorological station | Plant Zone                   | Meteorological station | Plant Zone               | Meteorological station |
| N              | 2.0                          | 3.0                    | 1.5                      | 2.3                    | 1                            | 18                     | 4.0                      | 3.1                    |
| NNE            | 5.1                          | 5.1                    | 1.8                      | 1.5                    | 2                            | 12                     | 3.5                      | 2.1                    |
| NE             | 8.1                          | 6.1                    | 2.2                      | 2.1                    | 12                           | 6                      | 2.9                      | 1.6                    |
| ENE            | 14.1                         | 13.1                   | 2.7                      | 2.2                    | 10                           | 6                      | 4.2                      | 1.4                    |
| E              | 3.0                          | 3.0                    | 2.3                      | 2.0                    | 40                           | 7                      | 4.7                      | 2.3                    |
| ESE            | 2.0                          | 2.0                    | 4.0                      | 3.1                    | 6                            | 16                     | 4.7                      | 3.1                    |
| SE             | 7.1                          | 13.1                   | 2.6                      | 2.8                    | 6                            | 6                      | 3.0                      | 3.2                    |
| SSE            | 9.1                          | 3.0                    | 3.3                      | 4.1                    | 1                            | 6                      | 3.0                      | 2.0                    |
| S              | 16.2                         | 8.2                    | 3.8                      | 3.4                    | 1                            | 3                      | 4.0                      | 2.5                    |
| SSW            | 12.1                         | 18.2                   | 4.2                      | 4.0                    | 3                            | 5                      | 1.7                      | 1.5                    |
| SW             | 6.1                          | 9.1                    | 2.5                      | 3.8                    | 2                            | 3                      | 3.0                      | 2.9                    |
| WSW            | 3.0                          | 4.0                    | 2.0                      | 2.8                    | 1                            | 3                      | 2.0                      | 3.7                    |
| W              | 1.0                          | 1.0                    | 1.0                      | 2.6                    | 2                            | 4                      | 3.0                      | 1.2                    |
| WNW            | 0.0                          | 1.0                    | 0.0                      | 2.5                    | 1                            | 0                      | 3.0                      | 0.0                    |
| NW             | 1.0                          | 3.0                    | 2.0                      | 2.5                    | 5                            | 1                      | 2.6                      | 2.2                    |
| NNW            | 0.0                          | 0.0                    | 0.0                      | 0.0                    | 0                            | 4                      | 0.0                      | 1.0                    |
| C              | 10.1                         | 7.1                    | 0.0                      | 0.0                    | 7                            | 0                      |                          |                        |
| Sum or average | 100.0                        | 100.0                  | 2.7                      | 2.8                    | 100                          | 100                    | 3.6                      | 2.4                    |

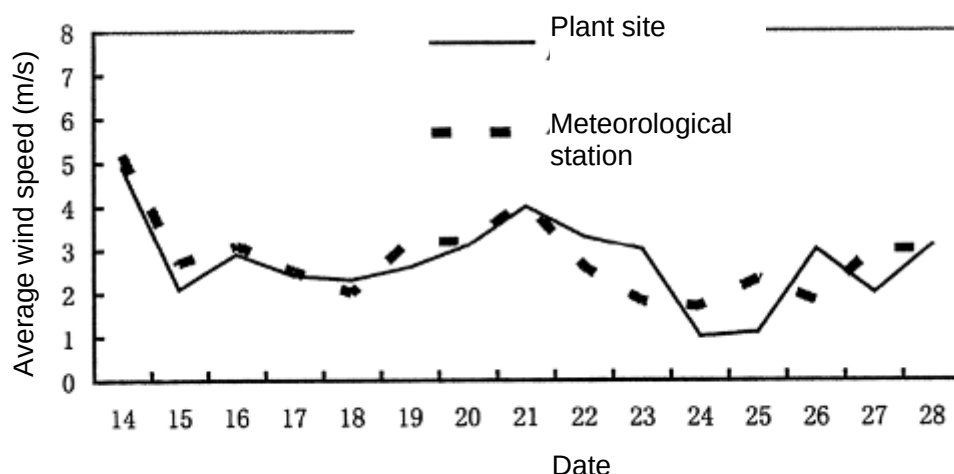


Fig. 8.1-1 Comparison of wind speed on daily base between plant site and weather stand in Beihai City (August 14-28, 2005)

Table 8.1-2 Calculated results by component regression method

| Direction | Regression Coefficient |        | Regression formula  | Number of samples | Correlative Coefficient | Significance level |
|-----------|------------------------|--------|---------------------|-------------------|-------------------------|--------------------|
|           | a                      | b      |                     |                   |                         |                    |
| X         | 0.4800                 | 0.5418 | $X=0.4800+0.5418x$  | 105               | 0.065                   | 0.05               |
| Y         | -0.3893                | 0.7207 | $Y=-0.3893+0.7207y$ | 105               | 0.68                    | 0.05               |

Note: X, Y-plant zone value, x, y- meteorological station value

The analyses above have shown that the similar distribution features of surface wind direction and speed at both plant zone and meteorological station in Beihai City have been found, indicating that the modification for wind speed and direction is not needed while the surface wind data kept in archives of Beihai meteorological station could be directly used for analysis of air pollution meteorology at a low altitude for the intended plant zone.

Therefore, the meteorological analysis of pollution is mainly based on the statistical analysis of observation data of conventional ground meteorological conditions at Beihai Meteorological station with the help of analysis on the basis of observed data on site meteorological examination during the observation for projects of technical renovation of Beihai Power Plant and renovation of refinery plant in another region.

### 8.1.2 Features of wind field at boundary layer

The plant zone is at a low latitude, belonging to a subtropical monsoon climate which is featured by higher temperature, moderate precipitation and longer sunshine time; less precipitation, dryness and warmth in late autumn, winter and early spring; a rainy season with high temperature and very hot in summer, frequently appearing circulation current of sea breeze and land breeze. The average annual temperature of Beihai City is 23.0℃, average annual precipitation 1803.5mm, average annual evaporation

1901.8mm, average relative humidity 80%, and average sunshine time 1885.2h. The most familiar meteorological disaster is typhoon which is very common in summer and autumn, usually 2-4 times a year. Each would last for about 24h. The statistical weather data at Beihai Meteorological station is given in Table 8.1-3.

### 8.1.3 Wind direction and wind speed of surface wind

#### a) Wind direction

Based on statistical analysis of wind direction data over the last five years (2000-2004) at Beihai meteorological station, a wind rose of Beihai City has been obtained as shown in Fig. 8.1-2. The wind direction frequency on seasonal and yearly bases in Beihai City is given in Table 8.1-4.

It is rendered in the city with two prevailing wind directions a year, one wind by north dominant with N and NNE wind with a total frequency of 26.0%, the other wind by south, dominant with SE and S wind with joint frequency of 20.2%. The power plant has longer time for wind by north prevailing and short for wind by south prevailing, with low static wind frequency, only 7.8% a year.

**Table 8.1-3 Statistical weather data of Beihai City (in the period of 1995-2004)**

| Month<br>Item                           | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | year   |
|-----------------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Average<br>barometric<br>pressure (hpa) | 1017.3 | 1016.4 | 1012.2 | 1009.3 | 1006.2 | 1003.3 | 1002.2 | 1003.1 | 1007.0 | 1012.1 | 1015.4 | 1018.6 | 1010.3 |
| Average<br>temperature<br>°C            | 15.1   | 16.1   | 19.3   | 24.0   | 26.7   | 28.6   | 28.9   | 28.4   | 27.0   | 24.9   | 20.8   | 16.5   | 23.0   |
| Max.<br>temperature<br>(°C)             | 27.9   | 29.3   | 30.5   | 32.9   | 35.7   | 36.2   | 36.2   | 35.4   | 35.4   | 34.7   | 31.4   | 28.8   | 36.2   |
| Min.<br>temperature<br>(°C)             | 3.3    | 2.6    | 7.1    | 9.6    | 17.5   | 20.4   | 22.6   | 16.1   | 16.1   | 14.7   | 8.9    | 2.6    | 2.6    |
| Relative<br>humidity<br>(%)             | 79     | 82     | 84     | 84     | 82     | 83     | 83     | 85     | 82     | 77     | 73     | 72     | 80     |
| precipitation<br>(mm)                   | 25.2   | 35.6   | 52.5   | 70.1   | 149.7  | 319.8  | 375.0  | 424.8  | 216.2  | 74.2   | 36.2   | 24.1   | 1803.5 |
| evaporation<br>(mm)                     | 107.6  | 94.5   | 116.6  | 149.0  | 186.5  | 183.3  | 205.3  | 173.9  | 187.2  | 212.1  | 169.6  | 136.7  | 1901.8 |
| Precipitation<br>days (d)               | 12.3   | 13.8   | 16.5   | 15.0   | 15.7   | 16.8   | 18.5   | 19.2   | 15.5   | 8.4    | 7.8    | 9.1    | 168.6  |
| Days of<br>torrential rain<br>(d)       | 0.0    | 0.1    | 0.0    | 0.2    | 0.5    | 1.4    | 2.4    | 2.6    | 0.7    | 0.3    | 0.1    | 0.0    | 8.3    |
| Windy days<br>(d)                       | 0.6    | 0.5    | 0.8    | 0.6    | 0.2    | 0.0    | 1.4    | 1.0    | 0.5    | 0.4    | 0.4    | 1.0    | 7.4    |



**Table 8.1-4 Seasonal and yearly wind Frequency in Beihai City (Unit: %)**

| season<br>frequency<br>wind<br>direction | Spring<br>(3~5 M's) | Summer<br>(6~8 M's) | Autumn<br>(9~11 M's) | Winter<br>(12~2 M's) | Yearly |
|------------------------------------------|---------------------|---------------------|----------------------|----------------------|--------|
| N                                        | 11.8                | 3.8                 | 19.7                 | 27.0                 | 15.5   |
| NNE                                      | 9.3                 | 3.3                 | 13.8                 | 15.8                 | 10.5   |
| NE                                       | 5.2                 | 5.9                 | 10.3                 | 5.0                  | 6.6    |
| ENE                                      | 2.9                 | 3.4                 | 4.7                  | 3.1                  | 3.5    |
| E                                        | 6.5                 | 6.3                 | 5.9                  | 7.4                  | 6.5    |
| ESE                                      | 9.7                 | 3.4                 | 3.6                  | 9.1                  | 6.4    |
| SE                                       | 13.7                | 11.4                | 11.4                 | 10.5                 | 11.8   |
| SSE                                      | 5.5                 | 4.4                 | 1.6                  | 2.5                  | 3.5    |
| S                                        | 8.6                 | 17.8                | 4.5                  | 2.7                  | 8.4    |
| SSE                                      | 3.5                 | 7.3                 | 0.6                  | 0.8                  | 3.1    |
| SW                                       | 4.1                 | 12.1                | 2.1                  | 0.7                  | 4.8    |
| WSW                                      | 2.3                 | 3.3                 | 1.3                  | 0.5                  | 1.9    |
| W                                        | 1.8                 | 5.6                 | 2.0                  | 0.4                  | 2.5    |
| WNW                                      | 0.4                 | 1.3                 | 1.2                  | 0.4                  | 0.8    |
| NW                                       | 1.3                 | 1.8                 | 1.4                  | 0.8                  | 1.3    |
| NNW                                      | 7.3                 | 2.1                 | 4.8                  | 5.9                  | 5.0    |
| C                                        | 5.9                 | 6.8                 | 11.1                 | 7.3                  | 7.8    |

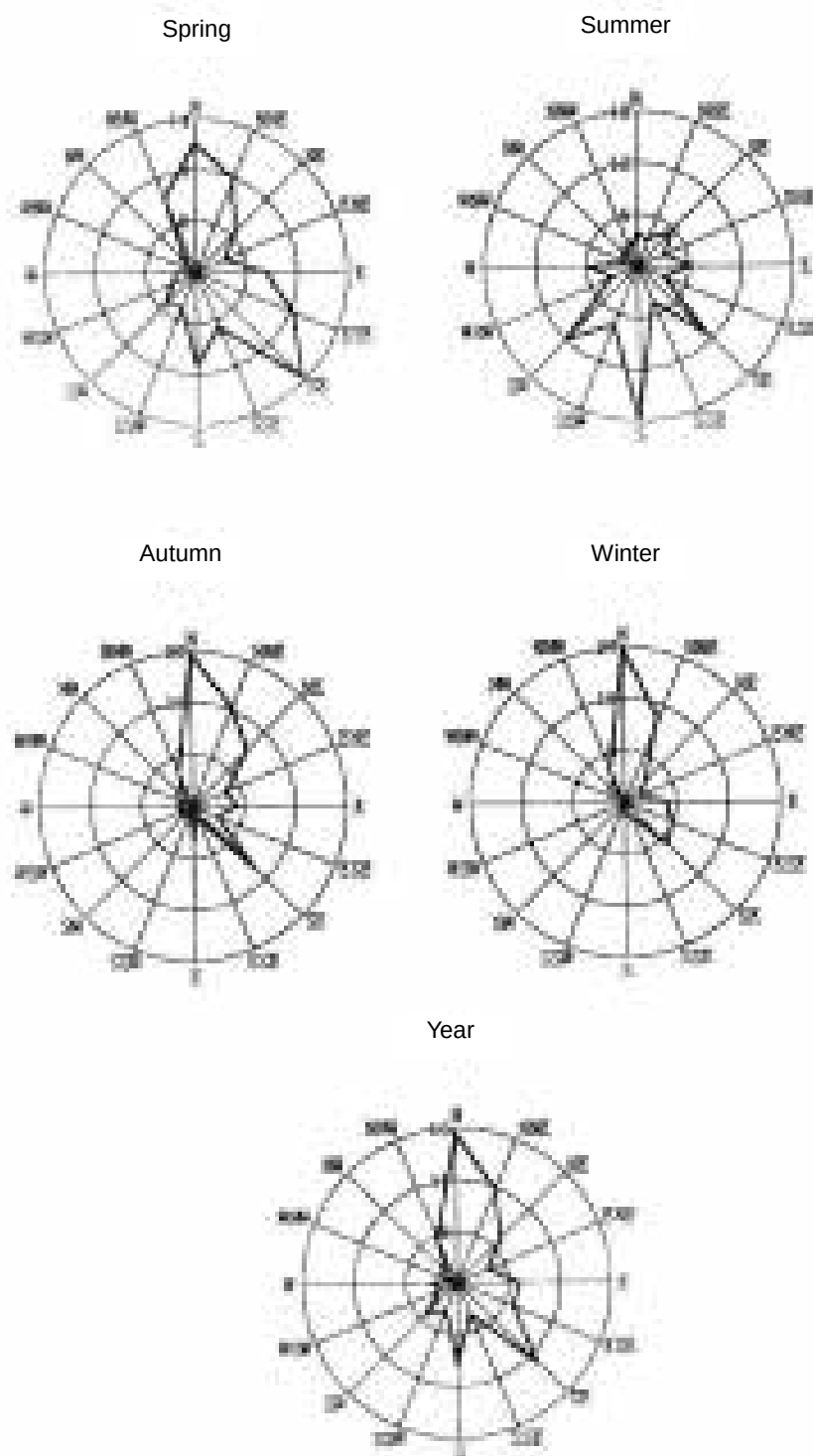


Fig. 8.1-2 Wind rose of seasonal and yearly wind in Beihai City

## b) Wind speed

## 1) Average wind speed and seasonal variation

The average annual wind speed in the city is 3.6m/s, one of the largest in Guangxi. The seasonal wind speed distribution features are: largest in winter followed by spring, autumn and summer. The average annual wind speed in each month is given in Table 8.1-5.

**Table 8.1-5 Average wind speed in Beihai City Unit: m/s**

| month              | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | year |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| Average wind speed | 4.1 | 4.1 | 3.9 | 3.5 | 3.7 | 3.5 | 3.7 | 2.9 | 3.3 | 3.4 | 3.7 | 4.0 | 3.6  |

## 2) Average wind speed of each wind direction

A big difference of average wind speed of each direction all the year round in Beihai City exists in which the maximum wind speed is 4.0-6.3 m/s of NNW-NNE wind with N wind as an axis center, followed by 4.1-4.2 m/s of ESE, SE wind.

It is indicated with frequency distribution data of each wind direction that the four wind directions of high frequency, N, NNE, SE and S, are well consistent to the wind direction having higher wind speed, indicating that the horizontal transportation capability of prevailing wind direction in Beihai City is stronger.

**Table 8.1-6 Average speed of each wind direction in Beihai City (m/s) (2000-2004)**

| season<br>frequency<br>wind<br>direction | Spring<br>(3~5 M's) | Summer<br>(6~8 M's) | Autumn<br>(9~11 M's) | Winter<br>(12~2 M's) | Yearly |
|------------------------------------------|---------------------|---------------------|----------------------|----------------------|--------|
| N                                        | 5.3                 | 4.1                 | 5.1                  | 5.6                  | 5.3    |
| NNE                                      | 3.7                 | 3.3                 | 3.9                  | 4.3                  | 4.0    |
| NE                                       | 2.9                 | 2.8                 | 3.0                  | 2.7                  | 2.9    |
| ENE                                      | 2.8                 | 3.3                 | 3.3                  | 2.4                  | 3.0    |
| E                                        | 3.8                 | 3.6                 | 3.5                  | 3.7                  | 3.6    |
| ESE                                      | 4.1                 | 3.5                 | 4.0                  | 4.4                  | 4.1    |
| SE                                       | 4.3                 | 4.0                 | 4.1                  | 4.4                  | 4.2    |
| SSE                                      | 3.5                 | 3.5                 | 2.7                  | 3.6                  | 3.4    |
| S                                        | 3.4                 | 3.7                 | 3.0                  | 3.1                  | 3.5    |
| SSE                                      | 3.2                 | 3.8                 | 2.5                  | 2.5                  | 3.5    |
| SW                                       | 2.9                 | 4.0                 | 2.3                  | 2.2                  | 3.5    |

| season<br>frequency<br>wind<br>direction | Spring<br>(3~5 M's) | Summer<br>(6~8 M's) | Autumn<br>(9~11 M's) | Winter<br>(12~2 M's) | Yearly |
|------------------------------------------|---------------------|---------------------|----------------------|----------------------|--------|
| WSW                                      | 2.6                 | 3.0                 | 2.4                  | 1.6                  | 2.7    |
| W                                        | 2.7                 | 3.0                 | 2.4                  | 1.8                  | 2.8    |
| WNW                                      | 2.4                 | 3.5                 | 2.5                  | 2.0                  | 2.8    |
| NW                                       | 3.0                 | 2.9                 | 3.6                  | 2.8                  | 3.1    |
| NNW                                      | 4.0                 | 3.9                 | 4.4                  | 4.4                  | 4.2    |

### 3) Wind Speed Frequency Distribution

Based on the statistical data of wind speed frequency of the city, the maximum wind speed frequency at plant zone at 1.5-3.0 m/s yearly is 38%. See Table 8.1-7 for detail.

**Table 8.1-7 Seasonal and yearly wind speed frequency in Beihai City (%)**

| Season<br>wind speed scale | Spring<br>(3~5 M's) | Summer<br>(6~8 M's) | Autumn<br>(9~11 M's) | Winter<br>(12~2 M's) | Yearly |
|----------------------------|---------------------|---------------------|----------------------|----------------------|--------|
| ≤0.4                       | 5.9                 | 6.8                 | 11.1                 | 7.3                  | 7.8    |
| 0.5~1.4                    | 5.2                 | 7.6                 | 5.7                  | 3.7                  | 5.5    |
| 1.5~3.0                    | 40.1                | 43.3                | 36.9                 | 31.5                 | 38.0   |
| 3.1~5.0                    | 32.9                | 29.8                | 30.6                 | 31.9                 | 31.3   |
| 5.1~7.0                    | 12.9                | 9.7                 | 11.4                 | 17.7                 | 12.9   |
| 7.1~9.0                    | 2.4                 | 2.1                 | 3.7                  | 6.9                  | 3.8    |
| ≥9.1                       | 0.5                 | 0.7                 | 0.5                  | 1.1                  | 0.7    |

#### 8.1.4 Stability of atmospheric stratification

Occurrence frequency of stability over the last three years (2002-2004) at the city's meteorological station is given in Table 8.1-8, which indicates that:

a) The yearly and seasonal stability is dominated by a neutral D type with its yearly occurrence frequency of 67.6% observed, in which the highest one is in winter and spring with the frequency of 74.5% and 74.2% respectively, while 66.9% and 54.6% in summer and autumn respectively.

b) The yearly stability type (E, F) is more than the instability type (A-C). The yearly occurrence frequency of A, B, C types are 0.3%, 5.3% and 6.8% respectively, totaling 12.4%. The occurrence frequency of E, F types are 9.9% and 10.0% respectively, totaling 19.9%.

**Table 8.1-8 Seasonal and yearly Occurrence frequency of various types of stability in Beihai City (%)**

| Season<br>type of stability | Spring<br>(3~5 M's) | Summer<br>(6~8 M's) | Autumn<br>(9~11 M's) | Winter<br>(12~2 M's) | Yearly |
|-----------------------------|---------------------|---------------------|----------------------|----------------------|--------|
| A                           | 0.5                 | 0.3                 | 0.4                  | 0.3                  | 0.3    |
| B                           | 3.9                 | 5.4                 | 8.8                  | 3.1                  | 5.3    |
| C                           | 6.5                 | 9.7                 | 7.5                  | 3.6                  | 6.8    |
| D                           | 74.2                | 66.9                | 54.6                 | 74.5                 | 67.6   |
| E                           | 6.3                 | 10.6                | 13.8                 | 8.9                  | 9.9    |
| F                           | 8.7                 | 7.1                 | 14.9                 | 9.5                  | 10.0   |

### 8.1.5 Air Pollution Meteorology examination at boundary layer

Two phases of air pollution meteorology observation at boundary layer were conducted by Guangxi Meteorological Science and Technology Information Service Center in the area near Tieshan Port in the spring and summer of 2005 respectively during the evaluation of atmospheric environmental effect for the reconstruction project of Beihai Oil refinery plant in another region and Beihai Power Plant Phase II expansion. The results of observation are now used to analyze the features of air pollution meteorology at boundary layer.

#### a) Daily variation of wind speed

The daily variation of wind speed refers to the variation of wind speed at near-ground layer on daily basis which is obtained through continuous observation of surface wind in the area of Tieshan Port with an EL electric registering weather vane wind gauge. The statistical analysis results of average wind speed in time sequence in the Tieshan Port area based on the observed data are shown in Table 8.1-10 and Fig. 8.1-3 and Fig. 8.1-4.

**Table 8.1-9 Average wind speed in time sequence in plant zone during observation (m/s)**

| Time sequence | 01  | 02  | 03  | 04  | 05  | 06  | 07  | 08  | 09  | 10  | 11  | 12  |
|---------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Spring        | 3.2 | 3.4 | 3.0 | 3.0 | 2.6 | 3.1 | 3.2 | 2.6 | 2.8 | 3.3 | 3.7 | 3.6 |
| Summer        | 1.6 | 1.6 | 2.0 | 1.8 | 1.7 | 1.7 | 1.8 | 1.7 | 2.4 | 3.3 | 2.6 | 2.6 |
| Time sequence | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  | 21  | 22  | 23  | 24  |
| Spring        | 3.2 | 2.7 | 2.7 | 2.8 | 2.4 | 2.4 | 1.9 | 2.6 | 2.5 | 2.8 | 4.1 | 3.7 |
| Summer        | 3.1 | 3.3 | 4.3 | 3.3 | 3.0 | 3.3 | 2.5 | 2.0 | 2.1 | 1.7 | 1.8 | 1.8 |

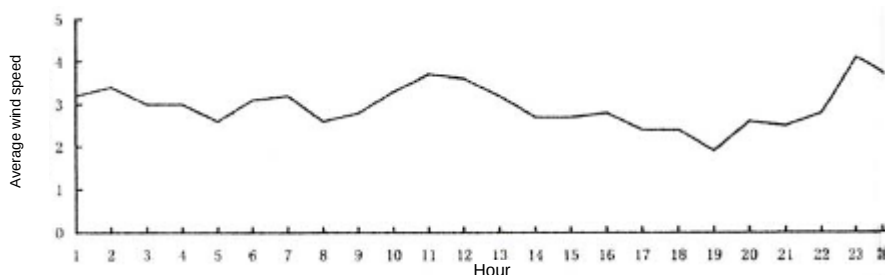


Fig. 8.1-3 Daily variation curve of average wind speed in Tieshan Port area during observation in spring

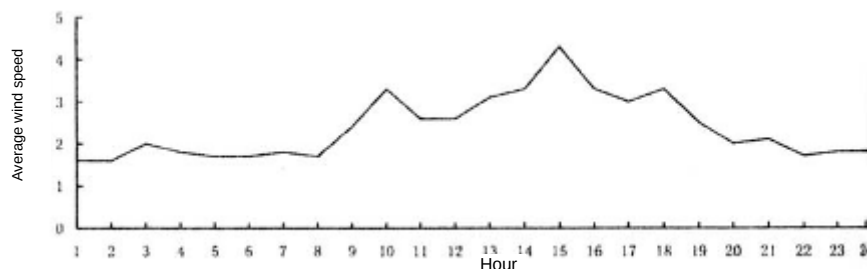


Fig. 8.1-4 Daily variation curve of average wind speed in Tieshan Port area during observation in summer

## b) variation of wind direction and wind speed at different altitudes

### 1) Variation of wind direction at different altitudes

Apparent Wind Direction Shear phenomenon exists at lower altitude in Tieshan Port area. The wind direction between the ground and a height of 1500m above is dominated with SSE-S-SSW, but with the tendency of one direction bias clockwise as the altitude increases, indicating that the atmospheric pollutants at various altitudes would be diffused mainly in NNW-N-NNE direction of the discharge source.

### 2) Variation of wind speed at different altitudes

The average wind speed between the ground and a height of 700m above increases apparently with the rise of altitude, as it increases from 2.2m/s to 3.9m/s at an increase rate of 1.7m/s×100m between the ground and 100m above, and an increase rate of 0.6 m/s×100m in a range of 100-400m above; and a slow increase rate of 0.1 m/s×100m in a range of 400-700m above, and a weak decrease tendency in it is observed in a range of 700-1500m above, in which it decreases at a rate of 0.7 m/s×100m in a range of 700-800m above, and decreases from 5.4m/s to 5.1m/s in a range of 900-1100m at an average decrease rate of 0.2 m/s×100m, then increases from 5.1m/s to 5.9m/s in a range of 1100-1200m above at an increase rate of 0.8 m/s×100m, and decreases from 5.9m/s to 5.0m/s in a range of 1300-1500m above at an average decrease rate of 0.5

m/s $\times$ 100m.

### 3) Wind speed profile under different stabilities

In order to understand the relationship between wind speed and altitude under different stabilities in the plant zone, the statistical analysis is carried out on the basis of anemometric samples which are classified into five categories: A-B, C, D, E, and F with P-S stability classification method in accordance with anemometric data obtained at a low altitude and ground observation data during observation. As shown in Fig. 8.1-5, the wind speed profile under conditions of atmospheric instability (upon statistical analysis of five types: A, B, C, D, E, F, and in atmospheric instability of A, B, C types as shown in Fig. 8.1-6) is similar to that at 11 and 14 o'clock in the day time and is quite steep, indicating that the variation of wind speed is small with the changing altitude; the wind speed profile under conditions of atmospheric stability is identical to that in time sequence at night which is quite smooth, indicating that the wind speed changes considerably with the changing altitude. The above information shows it is advantageous for momentum exchange between upper and lower atmospheric layers under instable conditions of atmospheric stratification with a small variation of wind speed, on the contrary, it results in inactive momentum exchange between upper and lower atmospheric layers under stable conditions with a big variation of wind speed.

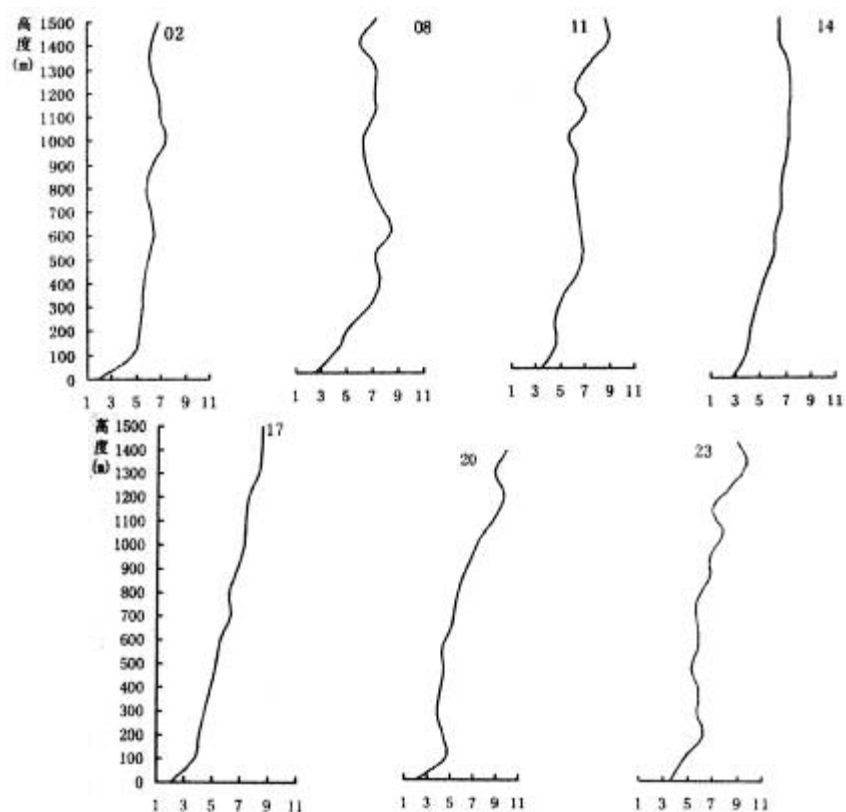


Fig. 8.1-5 Wind speed profile under various types of stability in plant zone during observation in spring

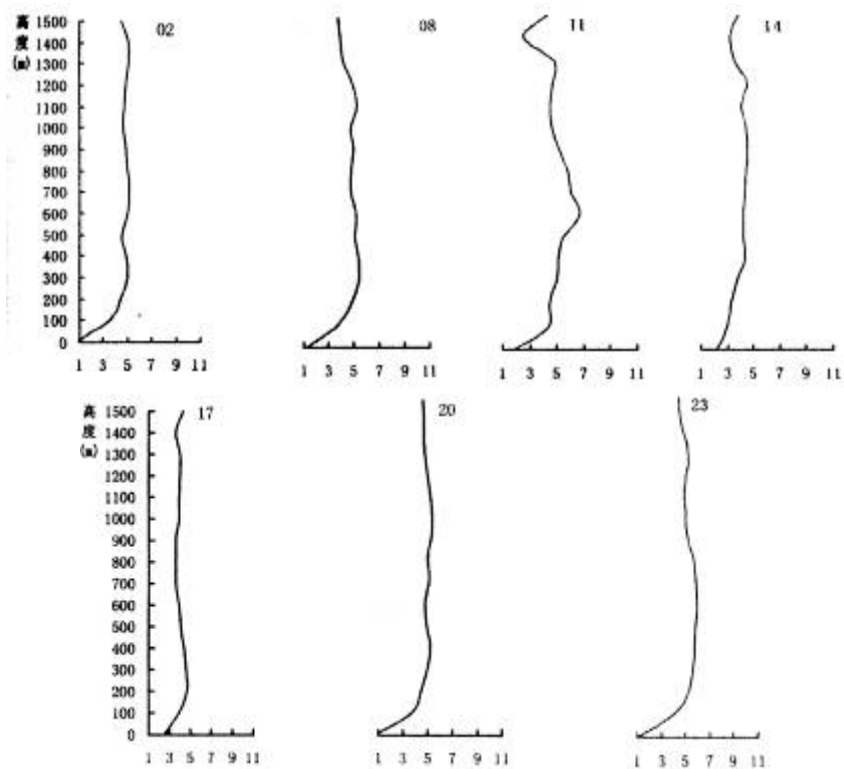


Fig. 8.1-6 Wind speed profile under various types of stability in plant zone during observation in summer



A simulated P value based on observed data in Plant zone and simulated P value recommended in National Standard are given in Table 8.1-10. As shown in the table, the P value of the plant zone of Beihai Power Plant Phase II Engineering Project under various types of stability is higher than the recommended value in National Standard, indicating that the wind speed at a low altitude in the plant zone under local geographical conditions generally increases fast with the increase of altitude. It is probably caused by a strong friction between low hill platform and surface air flow which results in an apparent decrease of ground wind speed.

**Table 8.1-10 P values under different stabilities in Tieshan Port area and its comparison with domestic P values**

| Stability Degree<br>Region  | A    | B    | C    | D    | E    | F    |
|-----------------------------|------|------|------|------|------|------|
| Tieshan Port                | 0.17 | 0.17 | 0.17 | 0.25 | 0.44 | 0.55 |
| International (countryside) | 0.07 | 0.07 | 0.10 | 0.15 | 0.25 | 0.25 |

#### c) Sea breeze and land breeze

Beihai is located along the coastal area at low latitude, its south facing Beibu Gulf. According to its geographical location, the in-shore wind (ESE-S-W) is defined as sea breeze, off-shore wind (NW-N-ENE) as land breeze, and days when conversion of wind direction between sea breeze and land breeze occurs day and night are defined as typical land breeze days. Based on the statistical analysis upon the observations in spring and summer, we find that the sea breeze and land breeze in Beihai have the following features: low occurrence frequency, strong sea breeze and weak land breeze, and an apparent seasonal difference between weather situations forming sea breeze and land breeze. Detailed information comes as follows:

#### 1) a low occurrence frequency

Annual average occurrence frequency of sea breeze and land breeze is merely 19.4% with maximum occurrence frequency in autumn of 26.8%, followed by winter of 19.1%, and spring and summer of 15.5% and 16.3% respectively.

**Table 8.1-11 Seasonal and Annual occurrence frequency of sea breeze and land breeze in Beihai City (%)**

| Spring (3—5) | Summer (6—8) | Autumn (9—11) | Winter (12—2) | yearly |
|--------------|--------------|---------------|---------------|--------|
| 15           | 16.3         | 26.8          | 19.1          | 19     |

#### 2) Intensity of sea breeze and land breeze

It can be seen from Table 8.1-12 that the rule of generation of sea breeze and land

breeze is that the sea breeze generally starts between 12-13 o'clock and ends between 20-23 o'clock lasting 7-10h, during which it is the strongest between 14-15 o'clock with an average speed of 3.1 m/s and the maximum speed reaching 7-8 m/s; the land breeze generally starts between 1-3 o'clock and ends between 6-9 o'clock lasting 7-9h, during which it is the strongest between 5-7 o'clock with an average speed of 2.4 m/s, and the maximum speed reaching 5-6 m/s. As can be seen, sea breeze is always stronger than land breeze in terms of both the average wind speed and the maximum wind speed.

**Table 8.1-12 Statistics of circulation of sea breeze and land breeze in Beihai City**

| Item<br>Type | Occurrence<br>time | Strongest<br>time | Ending<br>time | Time lasted<br>(h) | Average<br>wind speed<br>(m/s) | Maximum<br>wind speed<br>(m/s) |
|--------------|--------------------|-------------------|----------------|--------------------|--------------------------------|--------------------------------|
| Sea          | 12~13              | 14~15             | 20~23          | 07~10              | 3.1                            | 7~9                            |
| Land         | 02~04              | 05~07             | 09~10          | 07~09              | 2.4                            | 5~6                            |

### 3) Features of sea breeze and land breeze in Tieshan Port area during investigation

As analyzed upon the observation results (see Table 8.1-13), the average wind speed of sea breeze during controlling measurement in spring is 2.4 m/s, and 4 m/s for strongest surface wind; the thickness of sea breeze layer reaches 700-1000m, and the average wind speed of land breeze is only 1.1 m/s with its thickness of only 300-600m; the average wind speed of sea breeze during controlling measurement in summer is 2.9 m/s, and 5 m/s for strongest surface wind; the thickness of sea breeze layer is 600-800m; and the average wind speed of land breeze is only 1.8 m/s with its thickness of only 200-500m, featured by incontinuous sustaining time.

**Table 8.1-13 Statistics of circulation of sea breeze and land breeze in Tieshan Port area during investigation**

| Type \ Item | Item        | Occurrence time | Strongest time | Ending time | Average wind speed (m/s) | Max. wind speed (m/s) |
|-------------|-------------|-----------------|----------------|-------------|--------------------------|-----------------------|
| Spring      | Sea breeze  | 12~13           | 15~17          | 20~22       | 2.4                      | 700~1000              |
|             | Land breeze | 02~04           | 06~08          | 09~10       | 1.1                      | 300~600               |
| Summer      | Sea breeze  | 10~12           | 14~17          | 20~21       | 2.9                      | 600~800               |
|             | Land breeze | 23~01           | 04~06          | 07~09       | 1.8                      | 200~500               |

In sum, due to a strong background wind field at the site, weather conditions that really form the sea breeze and land breeze wind current day and night are rare with a low occurrence frequency of sea breeze and land breeze, moreover, the feature is apparent that sea breeze is stronger than land breeze and the land breeze is often covered by background wind field.

#### 8.1.6 Features of temperature inversion

##### a) Inversion layer

The atmospheric inversion at a low altitude in Tieshan Port area during observation is divided into ground temperature inversion and untouched temperature inversion below 300m, between 300-600m, and above 600m, with the results given in Table 8.1-15. During the regular observation time in spring investigation, it was found that the ground inversion only occurred at the time point of 23 o'clock with its thickness of inversion layer of 99m, the average inversion intensity of **1.2℃/100m, and occurrence** frequency of 6.7%. The ground temperature inversion was not detected during with all other time due to a stronger surface wind speed in Tieshan Port area resulting in little ground temperature inversion.

**Table 8.1-14 Statistical inversion at a low altitude in Beihai during observation in spring and summer**

|        | Type of inversion                    | Time item                    | 02   | 08   | 11   | 14   | 17   | 20   | 23   | average |
|--------|--------------------------------------|------------------------------|------|------|------|------|------|------|------|---------|
|        | Ground inversion                     | Occurrence frequency         |      |      |      |      |      |      | 6.7  | 6.7     |
| Spring | Ground inversion                     | Thickness                    |      |      |      |      |      |      | 99   | 99      |
|        |                                      | Intensity                    |      |      |      |      |      |      | 1.4  | 1.4     |
|        | Untouched inversion below 300m       | Occurrence frequency (%) (%) | 20.0 | 26.7 | 13.3 | 13.3 | 20.0 | 33.3 | 33.3 | 22.9    |
|        |                                      | Height below                 | 135  | 94   | 71   | 190  | 98   | 91   | 181  | 123     |
|        |                                      | Thickness                    | 78   | 135  | 70   | 120  | 52   | 49   | 52   | 76      |
|        |                                      | Intensity                    | 1.7  | 1.3  | 1.4  | 1.2  | 1.4  | 1.4  | 1.3  | 1.4     |
|        | Untouched inversion between 300-600m | Occurrence frequency         | 20.0 | 6.7  | 40.0 | 6.7  | 20.0 | 13.3 | 20.0 | 18.1    |
|        |                                      | Height below                 | 531  | 475  | 449  | 342  | 439  | 533  | 536  | 479     |
|        |                                      | Thickness                    | 124  | 250  | 23   | 208  | 83   | 138  | 106  | 127     |
|        |                                      | Intensity                    | 1.3  | 1.2  | 1.2  | 1.0  | 1.0  | 0.6  | 1.3  | 1.1     |
|        | Untouched inversion above 600m       | Occurrence frequency (%) (%) | 20.0 | 26.7 | 40.0 | 26.7 | 26.7 | 40.0 | 33.3 | 30.5    |
|        |                                      | Height below                 | 1017 | 1192 | 1088 | 1248 | 1070 | 995  | 1032 | 1086    |
|        |                                      | Thickness                    | 43   | 137  | 94   | 94   | 68   | 69   | 117  | 89      |
|        |                                      | Intensity                    | 1.5  | 1.1  | 1.3  | 1.1  | 1.2  | 1.3  | 1.2  | 1.2     |
| Autumn | Ground inversion                     | Occurrence frequency         |      |      |      |      | 6.7  |      |      | 6.7     |
|        |                                      | Thickness                    |      |      |      |      | 136  |      |      | 136     |
|        |                                      | Intensity                    |      |      |      |      | 0.4  |      |      | 0.4     |
|        | Untouched inversion below 300m       | Occurrence frequency (%) (%) |      | 13.3 | 13.3 | 13.3 | 6.7  | 6.7  | 6.7  | 10.0    |
|        |                                      | Height below                 |      | 116  | 158  | 150  | 270  | 272  | 224  | 179     |
|        |                                      | Thickness                    |      | 33   | 65   | 88   | 234  | 40   | 48   | 77      |
|        |                                      | Intensity                    |      | 1.7  | 1.6  | 1.1  | 0.7  | 1.8  | 1.2  | 1.4     |
|        | Untouched inversion between 300-600m | Occurrence frequency (%) (%) | 6.7  |      |      | 6.7  |      |      |      | 6.7     |
|        |                                      | Height below                 | 328  |      |      | 412  |      |      |      | 370     |
|        |                                      | Thickness                    | 32   |      |      | 121  |      |      |      | 77      |
|        |                                      | Intensity                    | 1.2  |      |      | 0.8  |      |      |      | 1.0     |
|        | Untouched inversion above 600m       | Occurrence frequency (%) (%) | 6.7  | 13.3 | 6.7  |      | 13.3 |      |      | 10.0    |
|        |                                      | Height below                 | 864  | 845  | 1000 |      | 1197 |      |      | 991     |
|        |                                      | Thickness                    | 76   | 41   | 73   |      | 148  |      |      | 88      |
|        |                                      | Intensity                    | 1.6  | 1.4  | 0.7  |      | 0.9  |      |      | 1.1     |

**b) Temperature boundary layer**

Temperature boundary layer usually comes into being near the shore which gradually thickens while being affected by ground heating in the process of in-land movement of

air. One of the features to determine the temperature boundary layer is a temperature inversion at a low altitude, namely the inversion layer base between superadiabatic atmospheric layer and lower adiabatic atmospheric layer in the sounding curve. Without a Lithuanian temperature layer between the two atmospheric layers, the temperature boundary layer does not exist.

Based on these features of temperature boundary layer, two conditions below are defined as conditions for temperature boundary layer:

- 1) Stable SW-S-SE surface wind in daytime, fine weather and strong ground radiation;
- 2) Temperature inversion at a low altitude appears simultaneously at three sounding points and auxiliary sounding point, moreover, the bottom of inversion layer at the auxiliary sounding point is higher than the sounding points. However, due to the excessive rainy days during observation in spring and summer, the typical temperature boundary layer days were not detected.

## 8.2 Prediction and evaluation of effect on air environment

### 8.2.1 Prediction mode of air quality

Adopt the ADMS diffusion model recommended by Environmental Impact Assessment Technical Guideline for Atmospheric Environment (draft) to predict. AMDS can simulate the instantaneous (several minutes), short-term (hourly average, daily average), long-term (annual average) of the concentration distribution of the pollutant discharged by point source, non-point source, line source and volume source.

#### (1) PDF mode

Under the unstable condition, for the plume with low buoyancy, adopt PDF mode of weil (1984) to calculate the ground-level concentration, i.e.:

$$C = \frac{C_Y}{\sqrt{2ps_Y}} \exp\left[-\frac{1}{2}\left(\frac{Y - Y_F}{s_t}\right)^2\right]$$

Wherein, the diffusion parameter of  $s_Y$ -Y direction m is determined by the following formula:

$$s = \begin{cases} (s_v x / u) / [1 + 0.5x / (uT_{xr})]^{1/2} & (F_m < 0.1) \\ 1.6F_m^{1/3} X_m^{2/3} Z_i & (F_m > 0.1, u./w_m^3 \geq 2) \\ 0.8F_m^{1/3} X_m^{2/3} Z_i & (F_m > 0.1, u/w_m < 2) \end{cases}$$

Wherein,  $C_Y$ —Crosswind integral concentration of ground, mg/m<sup>3</sup> is determined by the following formula:

$$\frac{C_Y u h}{Q} = \frac{2F_1}{\sqrt{2ps_{z_1}^*}} \exp\left(-\frac{h_1^{*2}}{2s_{z_1}^*}\right) + \frac{2F_2}{\sqrt{2ps_{z_2}^*}} \exp\left(-\frac{h_2^{*2}}{2s_{z_2}^*}\right)$$

#### (2) Breeze convection scale mode

Under the unstable condition, for the plume with large buoyancy, adopt breeze convection scale mode of briggs (1985), i.e. when  $x < 10F/W^3$ ;

$$C = 0.021Qw_*^3 x^{1/3} (F^{4/3} Z_i) \exp\left[-\frac{1}{2}\left(\frac{Y - Y_p}{s_y}\right)^2\right]$$

$$s_y = 1.6F_*^{1/3} X_*^{2/3} Z_i$$

$$\text{When } x^3 < 10F / w_*^3$$

$$C = [Q/(w_* x h)] \exp\left[-\left(\frac{7F}{zw_*^3}\right)^{3/2}\right] \exp\left[-\frac{1}{2}\left(\frac{Y - Y_p}{s_y}\right)^2\right]$$

$$s_y = 0.6X_* Z_i$$

### (3) Loft mode

For the plume with large buoyancy under near-neutral condition, adopt Loft mode of Weil (1991), i.e.:

$$C = \frac{Q}{\sqrt{2\pi} Z_i s_y u} [1 - \text{erf}(\ddot{E})] \exp\left[-\frac{1}{2}\left(\frac{Y - Y_p}{s_y}\right)^2\right]$$

$$s_y = \begin{cases} 1.6F_*^{1/3} X_*^{2/3u-1} & (L > 0 \text{ or } L < 0_3 \text{ and } u / w_*^3 > 2) \\ 0.8F_*^{1/3} X_*^{2/3u-1} & (L > 0, \text{ and } u / w_* < 2) \end{cases}$$

### (4) ATDL mode

In the general Gaussian model system, adopt ATDL model with non-point source height to calculate the pollutant concentration discharged by non-point source. According to the actual distribution situation of the urban pollution sources, this mode divides them into several non-point sources arranged in boxes, and assuming that the spatial distribution of the source strength is uniform and the pollution diffusion complies with the rules of the narrow plume, Calculate the ground concentration of point A:

$$K_A = \left(\frac{2}{\rho}\right)^{y_z} \frac{L}{u} \left\{ Q_0 \ddot{O}^{L/2} \frac{1}{bx^q} \exp\left[-\frac{h^2}{2b^2 x^2 q}\right] dx + \sum_{i=1}^N Q_f \ddot{O}^{(i+\frac{1}{2})L} \frac{1}{bx^q} \exp\left[-\frac{h^2}{2b^2 x^2 q}\right] dx \right\}$$

Wherein: K—calculate the ground concentration at point A, mg/m<sup>3</sup> ;

Q0—calculate the source strength of the point's source block, mg/s·m<sup>2</sup>

Qr—the source strength of the No. i source block on the direction of its upper wind, mg/s·m<sup>2</sup>;

L—the side length of the network, m;

u—average wind speed, m/s;

b, q—respectively is the parameter to determine the atmosphere vertical diffusion standard  $\sigma_z$ , and they get different values with different types of stability, and meet the relation of  $\sigma_z = bxq$ ;

$h$ —the average height of the non-point source, m;

$N$ —the grid number of the upper wind direction.

#### (5) Daily average concentration

Use the successive meteorological observation data to calculate the hourly average concentration, and then work out their average, thus derived the daily average concentration.

#### (6) Long-term average concentration

Use the successive daily meteorological observation data to calculate the successive daily average concentration, and then work out their average, thus derived the annual average concentration.

### 8.2.2 Prediction and evaluation of air quality

Prediction area for air quality is a rectangular region taking the proposed project site as an origin. Five items of  $\text{SO}_2$ , smoke and dust (counted on  $\text{PM}_{10}$ ),  $\text{NO}_2$ ,  $\text{Cl}_2$  and smell (counted on  $\text{H}_2\text{S}$ ) are determined as evaluation factors according to the nature of pollutant discharge of the proposed project and current environmental situation.

Evaluation content:

#### (1) Average concentration on hourly basis

Use the successive daily meteorological observation data of Beihai meteorological station in 2006 to calculate the hourly average concentration of every pollutant after each project construction period goes into operation, select the maximum concentration of every grid point to evaluate and draw the isoline of the maximum hourly average concentration. Make statistics of and evaluate the maximum hourly average concentration of the concerned point.

(2) Prediction and evaluation are conducted for pollutant concentration under conditions of non-desulfurization and dedusting efficiency decline.

#### (3) Daily average concentration

Use the daily meteorological observation data of Beihai meteorological station in 2006 to calculate the daily average concentration of every pollutant after each project construction period goes into operation, select the maximum concentration of every grid point to evaluate and draw the isoline of the maximum daily average concentration. Make statistics of and evaluate the maximum daily average concentration of the concerned point.

#### (4) Annual average concentration

Use the daily meteorological observation data of the Beihai meteorological station in 2006 to calculate the daily average concentration, Make statistics of and average the concentration of every grid point to get annual average concentration of each grid point of the evaluation area. Draw isoline of annual average concentration of pollutant in each

operation period and evaluate.

#### (5) Analysis of impact on environmental protection objectives

Predict and evaluate the concentration contribution to the surrounding protective objectives by the air pollutant discharged by proposed projects, and superpose with the pollution contribution and background concentration of the proposed project and analyze the impact degree.

#### (6) Calculating grids and concerned points

For high elevation point source, adopt 200m×200m square grid in the evaluation area, and the calculation range of the area (with the boiler stack of thermal power station as grid origin):

EW: -10000 m ~5000m, calculating 15km;

NS: -7000m ~8000m, calculating 15km.

For fugitive emission source of smell, adopt 50m×50m square grid, and the calculation range of non-point source:

EW: -1500 m ~2500m, calculating 4 km;

NS: -2000m ~2000m, calculating 4 km.

Select other seven sensitive points near the plant zone: Huangshao, Houtang, Banjiu, Yanduncun, administrative and residential area of Tieshan Port district, government of Xinggang Township and Nankang Township as representative sensitive points for prediction. All these sensitive points are given in Table 8.2-1.

**Table 8.2-1 List of representative sensitive points for prediction**

| Sensitive point                        | Opposite to plant zone | Distance from plant zone (m) | Property                   | Function    |
|----------------------------------------|------------------------|------------------------------|----------------------------|-------------|
| 1# Huangshao                           | SW                     | 5100                         | Village                    | Residential |
| 2# Houtang                             | SW                     | 7500                         | Village                    | Residential |
| 3# Banjiu                              | SWW                    | 6500                         | Village                    | Residential |
| 4# Binchi                              | NW                     | 2500                         | Village                    | Residential |
| 5# Administrative And residential area | W                      | 8000                         | Residential area of office | Residential |
| 6# Xinggang Township government        | NWN                    | 6500                         | Governmental office        | Office      |
| 7# Nankang Township                    | NW                     | 10000                        | Township                   | Sum         |



### (7) Scheme of prediction calculation

Two kinds of coal: design coal and checking coal are provided with regard to quality of burning coal in the project feasibility study report. This project gives prediction calculation of these two kinds of coal and evaluates the one with the highest concentration.

For the fugitive emission source that produces smell such as wastewater treatment station, sludge treatment, bleach plant, etc., calculate the concentration distribution of total reduced sulfur (counted on H<sub>2</sub>S) of every grid according to the discharge intensity and the shape of discharge source, and determine the distance for environmental protection based on the maximum allowable concentration limit of the harmful substance in residential area.

### 8.2.3 Prediction results and evaluations

Refer to Chapter 3 Brief Introduction of Project and Table 3.4-7 Project Analysis for discharge intensity of air pollution source and relevant parameters of the proposed project in each operation period.

#### (1) Hourly average concentration

Based on the seasonal features of air pollution meteorology in the evaluation area and given wind directions unfavorable for major sensitive objectives, three hourly average concentration prediction meteorological conditions are selected for calculation with results given in Table 8.2-2.

Use the observation data updated four times a day of Beihai meteorological station in 2006 to predict the atmospheric pollutant ground concentration of 2 different kinds of coal in different operation periods of project. Refer to Table 8.2-2 for prediction results and figure 8.2-1~8.2-3 for maximum hourly average concentration distribution of every grid of the Phase III project.

**Table 8.2-2 List of prediction results of maximum hourly average concentration**  
**Standard limit: SO<sub>2</sub> 0.50mg/m<sup>3</sup>; NO<sub>2</sub> 0.24mg/m<sup>3</sup>, Cl<sub>2</sub> 0.10mg/m<sup>3</sup>**

| Predicti<br>on<br>factor | Running<br>stage of<br>project | Description of meteorological<br>conditions for maximum<br>ground concentration | Maximum<br>ground<br>concentration<br>mg/m <sup>3</sup> | Distance<br>from<br>source<br>km | Percentage in<br>evaluation<br>standard<br>% | Function<br>area     |
|--------------------------|--------------------------------|---------------------------------------------------------------------------------|---------------------------------------------------------|----------------------------------|----------------------------------------------|----------------------|
| SO <sub>2</sub>          | 1 <sup>st</sup> stage          | 2006.8.24.08,NW,2.5m/s                                                          | 0.0318                                                  | 3.578                            | 6.36                                         | Sea area             |
|                          | 2 <sup>nd</sup> stage          | 2006.10.22.02, SW,2.2m/s                                                        | 0.0463                                                  | 3.4                              | 9.26                                         | Field                |
|                          | 3 <sup>rd</sup> stage          | 2006.7.22.14,W,1.8m/s                                                           | 0.0629                                                  | 2.4                              | 12.58                                        | Beach,<br>salt field |
| NO <sub>2</sub>          | 1 <sup>st</sup> stage          | 2006.7.22.14,W,1.8m/s                                                           | 0.0202                                                  | 2.0                              | 8.42                                         | Beach,<br>salt field |
|                          | 2 <sup>nd</sup> stage          | 2006.7.22.14,<br>W,1.8m/s                                                       | 0.0405                                                  | 2.0                              | 16.88                                        | Beach,<br>salt field |
|                          | 3 <sup>rd</sup> stage          | 2006.8.24.08,NW,2.5m/s                                                          | 0.0063                                                  | 3.578                            |                                              | Sea area             |
| PM <sub>10</sub>         | 1 <sup>st</sup> stage          | 2006.10.12.14,SSW,2.8m/s                                                        | 0.0080                                                  | 3.4                              |                                              | Field                |
|                          | 2 <sup>nd</sup> stage          | 2006.10.12.14,SSW,2.8m/s                                                        | 0.0099                                                  | 3.4                              |                                              | Field                |
|                          | 3 <sup>rd</sup> stage          | 2006.5.6.08,E,0.6m/s                                                            | 0.0003                                                  | 0.447                            | 0.3                                          | Land<br>area         |
| Cl <sub>2</sub>          | 1 <sup>st</sup> stage          | 2006.5.6.08,E,0.6m/s                                                            | 0.0003                                                  | 0.447                            | 0.3                                          | Land<br>area         |
|                          | 2 <sup>nd</sup> stage          | 2006.5.6.08,E,0.6m/s                                                            | 0.0003                                                  | 0.447                            | 0.3                                          | Land<br>area         |
|                          | 3 <sup>rd</sup> stage          | 2006.8.24.08,NW,2.5m/s                                                          |                                                         |                                  |                                              |                      |

As can be seen in Table 8.2-2, in the normal production situation, the grid maximum contribution values of hourly average concentration of SO<sub>2</sub>, NO<sub>2</sub> and Cl<sub>2</sub> in discharged air pollutants after the project goes into operation are not high, lower than the standard concentration limit. After phase III project goes into operation, the grid maximum contribution values of hourly average concentration of SO<sub>2</sub> and NO<sub>2</sub> are 0.0629 mg/m<sup>3</sup> and 0.0405 mg/m<sup>3</sup> accounting for 12.58% and 16.88% of standard limit respectively. The discharge of Cl<sub>2</sub> of project in each project remains the same and the grid maximum contribution value of hourly average concentration is 0.0003 mg/m<sup>3</sup> accounting for 0.3% of standard limit only.

## (2) Calculation of coastline fumigation

The distance between every pollution source of the project and the coastline is more than 2000m, through the calculation by Isc Screen, the results indicate: because the height of pollution source plume of the project is lower than that of the thermal internal boundary layer, there will be no coastline fumigation in the areas over 2000m away from the coastline. Therefore, the project does not calculate the pollutant distribution concentration under coastline fumigation.

## (3) Average daily concentration

Use the daily observation data of Beihai meteorological station in 2006 to predict the

average daily concentration of pollutant concentration of the 2 kinds of coal of phase III project. Because the hourly average concentration of  $\text{Cl}_2$  is relatively low, average daily concentration of only three items including  $\text{SO}_2$ ,  $\text{NO}_2$  and  $\text{PM}_{10}$  will be calculated.

Refer to figure 8.2-4~9 for the grid maximum average daily concentration distribution of  $\text{SO}_2$ ,  $\text{NO}_2$  and smoke and dust of phase II and III projects and figure 8.2-10~12 for the date when maximum average daily value occurs. Refer to Table 8.2-4~6 for the prediction results of average daily concentration of pollutants after project of each phase goes into operation.

**Table 8.2-4 Prediction results of daily average concentration of air pollutant at Phase I of the project**

Standard limit:  $\text{SO}_2$  0.15  $\text{mg}/\text{m}^3$ ,  $\text{NO}_2$  0.12  $\text{mg}/\text{m}^3$ ,  $\text{PM}_{10}$  0.15  $\text{mg}/\text{m}^3$

| Date and meteorological conditions |                   |                 |                |            | Prediction factor | Max. ground conc. $\text{mg}/\text{m}^3$ | Direction | Distance from source, km | Percentage in standard % | Exceeded area $\text{km}^2$ | Functional area |
|------------------------------------|-------------------|-----------------|----------------|------------|-------------------|------------------------------------------|-----------|--------------------------|--------------------------|-----------------------------|-----------------|
| Date: 2006.2.9                     |                   |                 |                |            | $\text{SO}_2$     | 0.0167                                   | NEN       | 1.887                    | 11.13                    | 0                           | Field           |
| Time                               | Total cloud cover | Low cloud cover | Wind direction | Wind speed |                   |                                          |           |                          |                          |                             |                 |
| 2                                  | 11                | 11              | E              | 4.5        |                   |                                          |           |                          |                          |                             |                 |
| 8                                  | 10                | 10              | N              | 3.7        |                   |                                          |           |                          |                          |                             |                 |
| 14                                 | 10                | 10              | N              | 4.1        |                   |                                          |           |                          |                          |                             |                 |
| 20                                 | 10                | 10              | N              | 3.7        |                   |                                          |           |                          |                          |                             |                 |
|                                    |                   |                 |                |            | $\text{PM}_{10}$  | 0.0034                                   | NEN       | 1.887                    | 2.262                    | 0                           | Field           |

**Table 8.2-5 Prediction results of daily average concentration of air pollutant at Phase II of the project**

Standard limit  $\text{SO}_2$  0.15  $\text{mg}/\text{m}^3$ ,  $\text{NO}_2$  0.12  $\text{mg}/\text{m}^3$ ,  $\text{PM}_{10}$  0.15  $\text{mg}/\text{m}^3$

| Date and meteorological conditions |                   |                 |                |            | Prediction factor | Max. ground conc. $\text{mg}/\text{m}^3$ | Direction | Distance from source, km | Percentage in standard % | Exceeded area $\text{km}^2$ | Functional area |
|------------------------------------|-------------------|-----------------|----------------|------------|-------------------|------------------------------------------|-----------|--------------------------|--------------------------|-----------------------------|-----------------|
| Date: 2006.2.9                     |                   |                 |                |            | $\text{SO}_2$     | 0.0222                                   | NEN       | 2.060                    | 14.8                     | 0                           | Field           |
| Time                               | Total cloud cover | Low cloud cover | Wind direction | Wind speed | $\text{NO}_2$     | 0.0083                                   | NEN       | 1.523                    | 6.917                    | 0                           | Field           |
| 2                                  | 11                | 11              | E              | 4.5        |                   |                                          |           |                          |                          |                             |                 |
| 8                                  | 10                | 10              | N              | 3.7        |                   |                                          |           |                          |                          |                             |                 |
| 14                                 | 10                | 10              | N              | 4.1        |                   |                                          |           |                          |                          |                             |                 |
| 20                                 | 10                | 10              | N              | 3.7        |                   |                                          |           |                          |                          |                             |                 |
|                                    |                   |                 |                |            | $\text{PM}_{10}$  | 0.0040                                   | NEN       | 2.060                    | 2.7                      | 0                           | Field           |

**Table 8.2-6 Prediction results of daily average concentration of air pollutant at the Phase III of the project**

| Date and meteorological conditions |                   |                 |                |            | Prediction factor | Max. ground conc. mg/m <sup>3</sup> | Direction | Distance from source, km | Percentage in standard % | Exceeded area km <sup>2</sup> | Functional area |
|------------------------------------|-------------------|-----------------|----------------|------------|-------------------|-------------------------------------|-----------|--------------------------|--------------------------|-------------------------------|-----------------|
| Date: 2006.2.9                     |                   |                 |                |            | SO <sub>2</sub>   | 0.0294                              | NEN       | 1.789                    | 19.60                    | 0                             | Field           |
| Time                               | Total cloud cover | Low cloud cover | Wind direction | Wind speed | NO <sub>2</sub>   | 0.0166                              | NEN       | 1.523                    | 13.83                    | 0                             | Field           |
| 2                                  | 11                | 11              | E              | 4.5        |                   |                                     |           |                          |                          |                               |                 |
| 8                                  | 10                | 10              | N              | 3.7        |                   |                                     |           |                          |                          |                               |                 |
| 14                                 | 10                | 10              | N              | 4.1        |                   |                                     |           |                          |                          |                               |                 |
| 20                                 | 10                | 10              | N              | 3.7        | PM <sub>10</sub>  | 0.0048                              | NEN       | 1.789                    | 3.20                     | 0                             | Field           |

As can be seen in Table 8.2-4~6, the contribution values of maximum ground concentration of pollutants in discharged waste gas at each stage of the project are not high, but it is relatively high at Phase III of the project, the maximum ground concentrations of SO<sub>2</sub>, NO<sub>2</sub> and inhalable particulates on the typical days account for 19.6%, 13.83% and 3.2% of evaluation standard respectively.

The effect of each pollutant on sensitive points is given in Table 8.2-7~9. The contribution values of average daily concentration from discharged air pollutants at each sensitive point after each stage of the project completed for production are relatively low, basically all lower than monitoring background values; the contribution values of daily concentration of three inhalable particulates of the pollutant are the lowest, while SO<sub>2</sub> is the highest, and the contribution value of maximum daily concentration at Phase III is 0.0114 mg/m<sup>3</sup> of 4<sup>#</sup> Binchi, accounting for 7.6% of the standard value. The contribution value of NO<sub>2</sub> at this concerned point ranks highest among all the concerned points, which is 0.0071 accounting for 5.9% of the standard value. The pollutant accounting for the largest share of standard value after being added with background concentration is inhalable particulates, due to a relatively monitoring background value of the pollutant. The concentration values of three air pollutants at each sensitive point even added with background values do not exceed the provided standard.

**Table 8.2-7 Average daily concentration of SO<sub>2</sub> at the most concerned (sensitive) points Standard limit: 0.15mg/m<sup>3</sup>**

| Item and name                                         | Description of Function concerned point              | Current concentration mg/m <sup>3</sup> | Running stage of project | Contributed concentration range mg/m <sup>3</sup> | Current concentration and contributed concentration added range mg/m <sup>3</sup> | Percentage of daily average concentration in standard value % |
|-------------------------------------------------------|------------------------------------------------------|-----------------------------------------|--------------------------|---------------------------------------------------|-----------------------------------------------------------------------------------|---------------------------------------------------------------|
| 1 <sup>#</sup> Huangshao                              | Village, residential                                 | 0.014                                   | 1 <sup>st</sup> stage    | 0~ <a href="#">0.0033</a>                         | 0.014~ <a href="#">0.0173</a>                                                     | 9.33~11.53                                                    |
|                                                       |                                                      |                                         | 2 <sup>nd</sup> stage    | 0~ <a href="#">0.0045</a>                         | 0.014~ <a href="#">0.0185</a>                                                     | 9.33~12.33                                                    |
|                                                       |                                                      |                                         | 3 <sup>rd</sup> stage    | 0~ <a href="#">0.0060</a>                         | 0.014~ <a href="#">0.0200</a>                                                     | 9.33~13.33                                                    |
| 2 <sup>#</sup> Houtang                                | Village, residential                                 | 0.008                                   | 1 <sup>st</sup> stage    | 0~ <a href="#">0.0035</a>                         | 0.008~ <a href="#">0.0115</a>                                                     | 5.33~7.67                                                     |
|                                                       |                                                      |                                         | 2 <sup>nd</sup> stage    | 0~ <a href="#">0.0051</a>                         | 0.008~ <a href="#">0.0131</a>                                                     | 5.33~8.73                                                     |
|                                                       |                                                      |                                         | 3 <sup>rd</sup> stage    | 0~ <a href="#">0.0066</a>                         | 0.008~ <a href="#">0.0146</a>                                                     | 5.33~9.73                                                     |
| 3 <sup>#</sup> Banjiu                                 | Village, residential                                 | 0.005                                   | 1 <sup>st</sup> stage    | 0~ <a href="#">0.0040</a>                         | 0.005~ <a href="#">0.0090</a>                                                     | 3.33~6.00                                                     |
|                                                       |                                                      |                                         | 2 <sup>nd</sup> stage    | 0~ <a href="#">0.0060</a>                         | 0.005~ <a href="#">0.0110</a>                                                     | 3.33~7.33                                                     |
|                                                       |                                                      |                                         | 3 <sup>rd</sup> stage    | 0~ <a href="#">0.0082</a>                         | 0.005~ <a href="#">0.0132</a>                                                     | 3.33~8.80                                                     |
| 4 <sup>#</sup> Bingchi                                | Village, residential                                 | 0.016                                   | 1 <sup>st</sup> stage    | 0~ <a href="#">0.0049</a>                         | 0.016~ <a href="#">0.0209</a>                                                     | 10.67~13.93                                                   |
|                                                       |                                                      |                                         | 2 <sup>nd</sup> stage    | 0~ <a href="#">0.0079</a>                         | 0.016~ <a href="#">0.0239</a>                                                     | 10.67~15.93                                                   |
|                                                       |                                                      |                                         | 3 <sup>rd</sup> stage    | 0~ <a href="#">0.0114</a>                         | 0.016~ <a href="#">0.0274</a>                                                     | 10.67~18.27                                                   |
| 5 <sup>#</sup> Administrative and residential area in | Residential area of administrative unit, residential | 0.008                                   | 1 <sup>st</sup> stage    | 0~ <a href="#">0.0036</a>                         | 0.008~ <a href="#">0.0116</a>                                                     | 5.33~7.73                                                     |
|                                                       |                                                      |                                         | 2 <sup>nd</sup> stage    | 0~ <a href="#">0.0055</a>                         | 0.008~ <a href="#">0.0135</a>                                                     | 5.33~9.00                                                     |
|                                                       |                                                      |                                         | 3 <sup>rd</sup> stage    | 0~ <a href="#">0.0074</a>                         | 0.008~ <a href="#">0.0154</a>                                                     | 5.33~10.27                                                    |
| 6 <sup>#</sup> Xinggang Township government           | Administrative office                                | 0.010                                   | 1 <sup>st</sup> stage    | 0.0002~0.0027                                     | 0.0102~0.0127                                                                     | 6.80~8.47                                                     |
|                                                       |                                                      |                                         | 2 <sup>nd</sup> stage    | 0.0004~ <a href="#">0.0046</a>                    | 0.0104~ <a href="#">0.0146</a>                                                    | 6.93~9.73                                                     |
|                                                       |                                                      |                                         | 3 <sup>rd</sup> stage    | 0.0005~ <a href="#">0.0064</a>                    | 0.0105~ <a href="#">0.0126</a>                                                    | 7.00~8.40                                                     |
| 7 <sup>#</sup> Nankang Township                       | Small township residential, commerce, logistics      | 0.014                                   | 1 <sup>st</sup> stage    | 0~ <a href="#">0.0019</a>                         | 0.014~ <a href="#">0.0159</a>                                                     | 9.33~10.60                                                    |
|                                                       |                                                      |                                         | 2 <sup>nd</sup> stage    | 0~ <a href="#">0.0030</a>                         | 0.014~ <a href="#">0.0170</a>                                                     | 9.33~11.33                                                    |
|                                                       |                                                      |                                         | 3 <sup>rd</sup> stage    | 0~ <a href="#">0.0040</a>                         | 0.014~ <a href="#">0.0180</a>                                                     | 9.33~12.00                                                    |

Note: The maximum real-time value at monitoring point is taken as the current concentration; daily average concentration at Power Plant is an added value of current concentration and contributed concentration at Power Plant. Table 8.2-8 and Table 8.2-9 are the same.

**Table 8.2-8 Average daily concentration of NO<sub>2</sub> at the most concerned (sensitive) points standard limit: 0.12mg/m<sup>3</sup>**

| Item and name                             | Description of Function concerned point              | Current concentration mg/m <sup>3</sup> | Running stage of project | Contribution from project mg/m <sup>3</sup> | Current concentration and contributed concentration added range mg/m <sup>3</sup> | Percentage of daily average concentration in standard value % |
|-------------------------------------------|------------------------------------------------------|-----------------------------------------|--------------------------|---------------------------------------------|-----------------------------------------------------------------------------------|---------------------------------------------------------------|
| 1# Huangshao                              | Village, residential                                 | 0.013                                   | 1 <sup>st</sup> stage    |                                             |                                                                                   |                                                               |
|                                           |                                                      |                                         | 2 <sup>nd</sup> stage    | 0~0.0013                                    | 0.013~0.0143                                                                      | 10.83~11.92                                                   |
|                                           |                                                      |                                         | 3 <sup>rd</sup> stage    | 0~0.0026                                    | 0.013~0.0156                                                                      | 10.83~13.00                                                   |
| 2# Houtang                                | Village, residential                                 | 0.012                                   | 1 <sup>st</sup> stage    |                                             |                                                                                   |                                                               |
|                                           |                                                      |                                         | 2 <sup>nd</sup> stage    | 0~0.0015                                    | 0.012~0.0135                                                                      | 10.00~11.25                                                   |
|                                           |                                                      |                                         | 3 <sup>rd</sup> stage    | 0~0.0031                                    | 0.012~0.0151                                                                      | 10.00~12.58                                                   |
| 3# Banjiu                                 | Village, residential                                 | 0.014                                   | 1 <sup>st</sup> stage    |                                             |                                                                                   |                                                               |
|                                           |                                                      |                                         | 2 <sup>nd</sup> stage    | 0~0.0021                                    | 0.014~0.0161                                                                      | 11.67~13.42                                                   |
|                                           |                                                      |                                         | 3 <sup>rd</sup> stage    | 0~0.0041                                    | 0.014~0.0181                                                                      | 11.67~15.08                                                   |
| 4# Bingchi                                | Village, residential                                 | 0.010                                   | 1 <sup>st</sup> stage    |                                             |                                                                                   |                                                               |
|                                           |                                                      |                                         | 2 <sup>nd</sup> stage    | 0~0.0035                                    | 0.010~0.0135                                                                      | 8.33~11.25                                                    |
|                                           |                                                      |                                         | 3 <sup>rd</sup> stage    | 0~0.0071                                    | 0.010~0.0171                                                                      | 8.33~14.25                                                    |
| 5# Administrative and residential area in | Residential area of administrative unit, residential | 0.016                                   | 1 <sup>st</sup> stage    |                                             |                                                                                   |                                                               |
|                                           |                                                      |                                         | 2 <sup>nd</sup> stage    | 0~0.0019                                    | 0.016~0.0179                                                                      | 13.33~14.92                                                   |
|                                           |                                                      |                                         | 3 <sup>rd</sup> stage    | 0~0.0037                                    | 0.016~0.0197                                                                      | 13.33~16.42                                                   |
| 6# Xingang township government            | Administrative office                                | 0.015                                   | 1 <sup>st</sup> stage    |                                             |                                                                                   |                                                               |
|                                           |                                                      |                                         | 2 <sup>nd</sup> stage    | 0~0.0018                                    | 0.0150~0.0168                                                                     | 12.50~14.00                                                   |
|                                           |                                                      |                                         | 3 <sup>rd</sup> stage    | 0~0.0036                                    | 0.0150~0.0186                                                                     | 12.50~15.50                                                   |
| 7# Nankang Township                       | Small township residential, commerce, logistic       | 0.010                                   | 1 <sup>st</sup> stage    |                                             |                                                                                   |                                                               |
|                                           |                                                      |                                         | 2 <sup>nd</sup> stage    | 0~0.0011                                    | 0.010~0.0111                                                                      | 8.33~9.25                                                     |
|                                           |                                                      |                                         | 3 <sup>rd</sup> stage    | 0~0.0022                                    | 0.010~0.0122                                                                      | 8.33~10.17                                                    |

**Table 8.2-9 Average daily concentration of PM<sub>10</sub> at the most concerned (sensitive) points standard limit: 0.15mg/m<sup>3</sup>**

| Item and name                                         | Description of Function concerned point              | Current concentration mg/m <sup>3</sup> | Running stage of project | Contributed concentration range mg/m <sup>3</sup> | Current concentration and contributed | Percentage of daily average concentration |
|-------------------------------------------------------|------------------------------------------------------|-----------------------------------------|--------------------------|---------------------------------------------------|---------------------------------------|-------------------------------------------|
| 1 <sup>#</sup> Huangshao                              | Village, residential                                 | 0.067                                   | 1 <sup>st</sup> stage    | 0~0.0006                                          | 0.067~0.0676                          | 44.67~45.07                               |
|                                                       |                                                      |                                         | 2 <sup>nd</sup> stage    | 0~0.0008                                          | 0.067~0.0678                          | 44.67~45.20                               |
|                                                       |                                                      |                                         | 3 <sup>rd</sup> stage    | 0~0.0010                                          | 0.067~0.0680                          | 44.67~45.33                               |
| 2 <sup>#</sup> Houtang                                | Village, residential                                 | 0.077                                   | 1 <sup>st</sup> stage    | 0~0.0007                                          | 0.077~0.0777                          | 51.33~51.80                               |
|                                                       |                                                      |                                         | 2 <sup>nd</sup> stage    | 0~0.0009                                          | 0.077~0.0779                          | 51.33~51.93                               |
|                                                       |                                                      |                                         | 3 <sup>rd</sup> stage    | 0~0.0011                                          | 0.067~0.0781                          | 51.33~52.07                               |
| 3 <sup>#</sup> Banjiu                                 | Village, residential                                 | 0.087                                   | 1 <sup>st</sup> stage    | 0~0.0008                                          | 0.087~0.0878                          | 58.00~58.53                               |
|                                                       |                                                      |                                         | 2 <sup>nd</sup> stage    | 0~0.0010                                          | 0.087~0.0880                          | 58.00~58.67                               |
|                                                       |                                                      |                                         | 3 <sup>rd</sup> stage    | 0~0.0013                                          | 0.087~0.0883                          | 58.00~58.87                               |
| 4 <sup>#</sup> Bingchi                                | Village, residential                                 | 0.063                                   | 1 <sup>st</sup> stage    | 0~0.0010                                          | 0.063~0.0640                          | 42.00~42.67                               |
|                                                       |                                                      |                                         | 2 <sup>nd</sup> stage    | 0~0.0013                                          | 0.063~0.0643                          | 42.00~42.87                               |
|                                                       |                                                      |                                         | 3 <sup>rd</sup> stage    | 0~0.0017                                          | 0.063~0.0647                          | 42.00~43.13                               |
| 5 <sup>#</sup> Administrative and residential area in | Residential area of administrative unit, residential | 0.074                                   | 1 <sup>st</sup> stage    | 0~0.0007                                          | 0.074~0.0747                          | 49.33~49.80                               |
|                                                       |                                                      |                                         | 2 <sup>nd</sup> stage    | 0~0.0009                                          | 0.074~0.0749                          | 49.33~49.93                               |
|                                                       |                                                      |                                         | 3 <sup>rd</sup> stage    | 0~0.0012                                          | 0.074~0.0752                          | 49.33~50.13                               |
| 6 <sup>#</sup> Xingang township government            | Administrative office                                | 0.084                                   | 1 <sup>st</sup> stage    | 0~0.0005                                          | 0.0840~0.0845                         | 56.07~56.33                               |
|                                                       |                                                      |                                         | 2 <sup>nd</sup> stage    | 0~0.0008                                          | 0.0840~0.0848                         | 56.07~56.53                               |
|                                                       |                                                      |                                         | 3 <sup>rd</sup> stage    | 0~0.0010                                          | 0.0840~0.0850                         | 56.07~56.67                               |
| 7 <sup>#</sup> Nankang Township                       | Small town ship residential, commerce, logistic      | 0.070                                   | 1 <sup>st</sup> stage    | 0~0.0004                                          | 0.070~0.0704                          | 46.67~46.93                               |
|                                                       |                                                      |                                         | 2 <sup>nd</sup> stage    | 0~0.0005                                          | 0.070~0.0705                          | 46.67~47.00                               |
|                                                       |                                                      |                                         | 3 <sup>rd</sup> stage    | 0~0.0006                                          | 0.070~0.0706                          | 46.67~47.07                               |

### (3) Long-term average concentration

The contribution distributions of annual average concentration of SO<sub>2</sub>, NO<sub>2</sub> and smoke and dust (counted upon inhalable suspended particulates) at the 2<sup>nd</sup> and 3<sup>rd</sup> stages of the proposed project are shown in Fig. 8.2-13~18. The contributed values of annual average concentration of SO<sub>2</sub>, NO<sub>2</sub> and inhalable particulates at each sensitive point at the 1<sup>st</sup> ~3<sup>rd</sup> stages of the proposed project are given in Table 8.2-10.

It can be known from Fig. 8.2-10 and Fig. 8.2-15 that due to the yearly wind frequency at the plant location dominated by N, S and SE, the annual average concentration on the south side, north side and northwest side of the discharge source in the location is relatively higher than that in other areas. The contributed values of annual average concentration at each sensitive point is not so high, but effect on Binchi is relatively big, and the concentration of SO<sub>2</sub>, NO<sub>2</sub> and inhalable suspended particulates after Phase III is completed for production is 0.0004 mg/m<sup>3</sup>, 0.00026 mg/m<sup>3</sup>, and 0.00007 mg/m<sup>3</sup> respectively, accounting for 0.67%, 0.33%, and 0.07% of the standard concentration limit respectively; and the maximum concentration of SO<sub>2</sub>, NO<sub>2</sub> and inhalable suspended particulates at the grid is 0.0029 mg/m<sup>3</sup>, 0.0015 mg/m<sup>3</sup>, and 0.0004 mg/m<sup>3</sup> respectively, accounting for 4.83%, 1.88%, and 0.40% of the standard concentration limit respectively. Therefore, the effect of discharged smoke and dust of the proposed project on surrounding air at the sensitive points is not big.

**Table 8.2-10 Contributed values to annual average concentration of each sensitive point by discharged pollutant of the proposed project**

Standard limit: SO<sub>2</sub> 0.06mg/m<sup>3</sup>, NO<sub>2</sub> 0.08mg/m<sup>3</sup>, PM<sub>10</sub> 0.10 mg/m<sup>3</sup>

| Running stage of project | pollutant                            | Huangshao | Houtang | Banjiu  | Bingchi | Administrative and residential area in | Xinggang township government | Nankang Township |
|--------------------------|--------------------------------------|-----------|---------|---------|---------|----------------------------------------|------------------------------|------------------|
| 1 <sup>st</sup> stage    | SO <sub>2</sub> (mg/m <sup>3</sup> ) | 0.0001    | 0.0001  | 0.0001  | 0.0002  | 0.0002                                 | 0.0001                       | 0.0002           |
|                          | NO <sub>2</sub> (mg/m <sup>3</sup> ) |           |         |         |         |                                        |                              |                  |
|                          | PM10 (mg/m <sup>3</sup> )            | 0.00002   | 0.00002 | 0.00002 | 0.00003 | 0.00004                                | 0.00002                      | 0.00003          |
| 2 <sup>nd</sup> stage    | SO <sub>2</sub> (mg/m <sup>3</sup> ) | 0.0002    | 0.0002  | 0.0002  | 0.0003  | 0.0003                                 | 0.0002                       | 0.0003           |
|                          | NO <sub>2</sub> (mg/m <sup>3</sup> ) | 0.00007   | 0.00005 | 0.00007 | 0.00013 | 0.00010                                | 0.00008                      | 0.00009          |
|                          | PM10 (mg/m <sup>3</sup> )            | 0.00003   | 0.00003 | 0.00003 | 0.00004 | 0.00004                                | 0.00004                      | 0.00005          |
| 3 <sup>rd</sup> stage    | SO <sub>2</sub> (mg/m <sup>3</sup> ) | 0.0002    | 0.0002  | 0.0002  | 0.0004  | 0.0004                                 | 0.0003                       | 0.0004           |
|                          | NO <sub>2</sub> (mg/m <sup>3</sup> ) | 0.00014   | 0.00011 | 0.00013 | 0.00026 | 0.00020                                | 0.00016                      | 0.00018          |
|                          | PM10 (mg/m <sup>3</sup> )            | 0.00004   | 0.00004 | 0.00004 | 0.00004 | 0.00007                                | 0.00006                      | 0.00004          |



#### (4) Analysis on impact of smell and $\text{Cl}_2$ and distance for environmental protection

Harmful waste gases discharged in the project include smell and  $\text{Cl}_2$ , etc. Therefore, the distance for environmental protection of this project is determined by taking into comprehensive consideration the impact range of the two pollutants, smell and  $\text{Cl}_2$  and the distance for health protection specified in the *Standard of Health Protection Distance for Sulfate Paper Mill* (GB/T11654-1989).

In accordance with the *Standard of Health Protection Distance for Sulfate Paper Mill* (GB/T11654-1989) and in combination with the annual average wind speed (3.6m/s) in Beihai City, the distance for health protection is determined in the range of 800m outside the pulping workshop. The pulping workshop is located at central by NW direction of the plant, 478m in closest distance from northwest boundary, 523m from northeast boundary, 747m from southwest boundary and 1110m from southeast boundary. There are some residents in Haishanba (630m in closest distance), Yaxi village (710m in closest distance) and Xinwupo (760m in closest distance) within the health protection distance from the pulping workshop (excluding the removed villages or units).

Under normal production, smell substances discharged in an unorganized way include  $\text{H}_2\text{S}$ , methanethiol, dimethanethiol, etc., which are collectively called Total Reductive Sulfur (TRS); and the volume of TRS is indicated in the equivalent volume of  $\text{H}_2\text{S}$ . The fugitive emission sources of TRS in this project are mainly located at wastewater treatment station, sludge dewatering workshop, solid waste storage yard, drainage ditch, and workshops such as alkali recovery and bleaching, etc.;  $\text{Cl}_2$  is mainly produced in the bleaching workshop. Use the daily successive meteorological observation data in 2006 to calculate the hourly average concentrations of  $\text{H}_2\text{S}$  and  $\text{Cl}_2$  at all grids and concerned points, and refer to Table 8.2-11 and Fig. 8.2-19~20 for the statistics of calculation results. As is shown by the calculation results, only a small volume of  $\text{Cl}_2$  is discharged through a 50m high exhaust funnel, so its contributed concentration at every concerned point and area is relatively low. The maximum value at the regional grid is only  $0.0001 \text{ mg/m}^3$ , accounting for 0.1% of the standard value; therefore, it has little influence on the environment.

Since the seven concerned points listed are all more than 1.8km away from the plant boundary, their  $\text{H}_2\text{S}$  contributed values of concentrations do not exceed the standard limit. However, the maximum concentration of grid amounts to  $0.0316 \text{ mg/m}^3$ , 2.16 times more than the standard value. The point is located at the northwest corner of the plant, posing a certain degree of impact on the environment. Therefore, this project only takes into consideration the impact range of  $\text{H}_2\text{S}$  in determining the distance for environmental protection.

**Table 8.2-11 Maximum contributed values of hourly average concentrations of H<sub>2</sub>S and Cl<sub>2</sub> at each sensitive point**Standard limit: H<sub>2</sub>S, 0.01 mg/m<sup>3</sup>, and Cl<sub>2</sub>, 0.1 mg/m<sup>3</sup>

| Pollutant        | Pollutant                          | Huangshao | Houtang | Banjiu  | Binchi  | Administrative and residential area in Port area | Xinggang township government | Nankang Township | Maximum value and location of grid |
|------------------|------------------------------------|-----------|---------|---------|---------|--------------------------------------------------|------------------------------|------------------|------------------------------------|
| H <sub>2</sub> S | Concentration (mg/m <sup>3</sup> ) | 0.00138   | 0.0008  | 0.0010  | 0.0030  | 0.0065                                           | 0.0011                       | 0.0004           | 0.0316 Southwest outside the plant |
|                  | Times of ultra standard            | 0         | 0       | 0       | 0       | 0                                                | 0                            | 0                | 2.16                               |
| Cl <sub>2</sub>  | Concentration (mg/m <sup>3</sup> ) | 0.00003   | 0.00002 | 0.00002 | 0.00003 | 0.00002                                          | 0.00001                      | 0.0001           | 0.0001 Northeast inside the plant  |
|                  | Times of ultra standard            | 0         | 0       | 0       | 0       | 0                                                | 0                            | 0                | 0                                  |

Calculate the up-to-standard distance of H<sub>2</sub>S concentration in reference to the maximum allowable concentration (H<sub>2</sub>S 0.01 mg/m<sup>3</sup>) of harmful substance in residential area defined in Hygienic standards for the Design of Industrial Enterprises (TJ36-79).

According to Fig. 8.2-20 – isoline of maximum concentration contributed value of H<sub>2</sub>S at every grid, all the isolines over 0.01mg/m<sup>3</sup> are basically located in the periphery of the plant. Since the wastewater treatment station is located at the south of the plant in the general layout, the up-to-standard distance at the periphery of southern plant boundary is the longest, the farthest of which is 500m away from the southeast plant boundary. The up-to-standard distance at the northernmost plant boundary is the shortest, basically the plant boundary; and the up-to-standard distances at the eastern and western sides are about 200-300m away from the plant boundary. Residential areas within the zone of up-to-standard distance of the project include Beimu Village, Pokoutang, Xinwupo Yaxi Village, Haishanba, etc., and refer to Table 8.2-12 for their locations and H<sub>2</sub>S concentration.

**Table 8.2-12 Locations of sensitive points with hourly average H<sub>2</sub>S concentration exceeding limit and concentrations**Standard limit: 0.01 mg/m<sup>3</sup>,

| Sensitive point | Position against plant | Minimum distance from plant boundary | Character | Function    | Hourly average concentration of H <sub>2</sub> S mg/m <sup>3</sup> | Times of ultra standard |
|-----------------|------------------------|--------------------------------------|-----------|-------------|--------------------------------------------------------------------|-------------------------|
| Beimu Village   | S                      | 0                                    | Village   | Residential | 0.0154                                                             | 0.54                    |
| Pokoutang       | SW                     | 273                                  | Village   | Residential | 0.0116                                                             | 0.16                    |
| Xinwupo         | NW                     | 90                                   | Village   | Residential | 0.0150                                                             | 0.50                    |
| Yaxi Village    | NW                     | 136                                  | Village   | Residential | 0.0138                                                             | 0.38                    |
| Haishanba       | W                      | 136                                  | Village   | Residential | 0.0109                                                             | 0.09                    |

Smell of great intensity is produced during the operation of waste water treatment station and sludge dewatering. According to the analogy investigation of Jinhai Pulp and Paper Industry Co., Ltd., which has a similar production scale, the impact range of smell

produced by the sewage treatment station extends 300-500m in the leeward direction. Hence, the distance for environmental protection is determined as the scope enveloped by isolines of H<sub>2</sub>S concentration over 0.01mg/m<sup>3</sup> and within 800m of the periphery of the pulping workshop. Refer to Fig. 8.2-21 for details.

#### (5) Analysis of environmental effect of coal-dumping yard

The main pollution sources in coal-dumping yard are bucket conveyor, belt conveyor and crawler dozer, etc. which will generate flying dust on the surface of coal-dumping yard under the action of wind force when various mechanical equipments are in operation. The coal particles in Power Plant can be divided according to their particle size into fine coal particles (<100μm), and coarse coal particles (>100μm). The moving distance of coarse coal particles under the action of wind force is very limited, no more than several meters generally, while fine coal particles form a major factor of flying dust pollution at coal-dumping yards.

The wind speed causing flying dust of coal dust with different particle size under different moisture content conditions can be calculated according to the following semiempirical formula:

$$V_0 = 1.9504d^{0.334}w^{1.114}$$

Wherein:

$V_0$ —wind speed causing flying dust, m/s;

$w$ —moisture content on coal surface, %;

$d$ —particle size of coal dust, mm.

Based on the formula above, the wind speed causing flying dust with different moisture content on coal surface is given in Table 8.2-13.

**Table 8.2-13 Wind speed causing flying dust with different moisture content on coal surface (m/s)**

| Moisture (%)<br>particle size (m) | 4   | 6   | 7.45 | 8   | 10   |
|-----------------------------------|-----|-----|------|-----|------|
| 50                                | 3.3 | 5.2 | 6.7  | 7.1 | 9.3  |
| 100                               | 4.1 | 6.5 | 8.5  | 9.0 | 11.8 |

It can be known from analysis of coal-fired industry that the wind speed causing flying dust is 9.3m/s when the moisture content of design coal in the proposed project is 10% and the particle size of the coal is 50μm, and 11.8m/s when the particle size of coal dust is 100μm.

The annual average wind speed at the plant site is 3.6m/s, and the occurrence frequency at each wind speed segment is given in Table 8.2-14.

**Table 8.2-14 Occurrence frequency with different levels of wind speed at plant site (%)**

| Wind speed (m/s) | ≤0.4 | 0.5~1.4 | 1.5~3.0 | 3.1~5.0 | 5.1~7.0 | 7.1~9.0 | ≥9.1 |
|------------------|------|---------|---------|---------|---------|---------|------|
| Frequency (%)    | 7.8  | 5.5     | 38      | 31.3    | 12.9    | 3.8     | 0.7  |

As can be known from the table that the wind speed frequency is only 0.7% when the wind speed is over 9.1m/s, therefore, the occurrence frequency of pollution caused by coal dust under the action of wind force at the coal-dumping yard in the proposed project area is less than 1%, which means the probability of effect is relatively low.

The examination results in the Report on evaluation and inspection of environmental protection for completion of 2×300MW thermal power generator set at Phase I project of Beihai Power Plant have indicated that the daily average concentration of dust at 1# monitoring point (TSP) near the wharf for unloading coal windward of the coal-dumping yard is further less than that stipulated in Comprehensive Discharge Standard for Atmospheric Pollutants (GB16297-1996) in which the maximum standard limit value for concentration outside the boundary in unorganized discharge is 1.0 mg/m<sup>3</sup>. The analogy monitoring data for unorganized discharged pollutants at the coal-dumping yard are given in Table 8.2-15.

**Table 8.2-15 Monitoring results for unorganized discharge particulates at coal-dumping yard at Phase I of Beihai Power Plant Unit: mg/m<sup>3</sup>**

| Monitoring direction                                                                            | dominant wind at 1# coal-dumping yard windward | dominant wind at 2# coal-dumping yard side wind | dominant wind at 3# coal-dumping yard leeward | dominant wind at 4# coal-dumping yard leeward | dominant wind at 5# coal-dumping yard leeward |
|-------------------------------------------------------------------------------------------------|------------------------------------------------|-------------------------------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|
| Results of evaluation                                                                           | 0.001L                                         | 0.232                                           | 0.416                                         | 0.37                                          | 0.278                                         |
| Comprehensive discharge standard of atmospheric pollutant (GB16297-1996) : 1.0mg/m <sup>3</sup> |                                                |                                                 |                                               |                                               |                                               |

Note: "L" means undetectable, a general expression of detection limit

The concentration of particulates at 3# and 4# monitoring points, leeward the coal-dumping yard is relatively higher, indicating a certain effect of coal powdered dust in coal-dumping yard at Phase I of Beihai Power Plant on the air environment of the main plant area,. The concentration of particulates at 1# monitoring point is low, indicating that the effect of coal powdered dust resulting from unloading coal at the wharf is

relatively low. A dry coal shed in the size of 110x110m is set at the coal-dumping yard at Phase I of Beihai Power Plant. Spraying water with spraying head in the operation of charging, discharging and transferring coal plays an important role in reducing the pollution caused by coal powdered dust, which also meets the requirement of Comprehensive discharge standard of atmospheric pollutants (GB16297-1996) . In order to prevent the unfavorable effect of typhoon, it is considered to plant windbreaks surrounding the coal-dumping yard at Phase I of Beihai Power Plant. A row of Horsetail Trees have been planted on north side of the yard, and local Omoto Nipponlily on the other three sides. Due to insufficient density of planting and deficiency of managerial measures taken, the windbreak result is presently poor.

Therefore, as to measures and effectiveness for prevention in coal plant of Beihai Power Plant, a windbreak belt for the proposed project, spraying water during charging, discharging and transferring coal for prevention of coal powdered dust and moisture content on coal surface over 8% under the normal operation would give less effect of flying dust which the ground concentration in the zone would all meet the requirement of *Comprehensive discharge standard for atmospheric pollutants* without effect on the air environment in the zone and health of personnel. The concentration of coal powdered dust in workshop surrounding the coal-duping place would also meet the requirement of *Hygienic standards for the Design of Industrial Enterprises*.

Though the frequency of wind speed is only 0.7% when the wind speed in the evaluated area is greater than 9.1m/s, it is suggested that the construction company build wind-proof and dust suppressing meshwork around the coal yard in order to prevent coal dust pollution. In this way, the wind-proof and dust suppressing meshwork may reduce the wind speed significantly to below the dusting speed in case of a big wind speed.

#### (6) Analysis of impact of abnormal emission

Based on the characteristics of waste gas emission and treatment facilities of the proposed project, this evaluation on abnormal emission mainly takes into consideration the abnormal emission of the smoke from the Circulating Fluidized Bed Boiler (CFBB). Refer to Table 8.2-16 for the working conditions of abnormal emission.

**Table 8.2-16 Working conditions and source strength of abnormal emission (design coal)**

| Emission source               | Situation of emission                                                                                                                                        | Emission source strength of SO <sub>2</sub> | Emission source strength of smoke and dust |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|--------------------------------------------|
| One CFBB of Phase II project  | Efficiency of desulfurization is 0;<br>One electric field of the electrostatic precipitator cannot work normally, and the dedusting efficiency drops to 99%. | 0.47t/h                                     | 0.0426t/h                                  |
| Two CFBB of Phase III project | The same as above                                                                                                                                            | 9.4 t/h                                     | 0.0852t/h                                  |

The most common weather conditions is selected as the predicting weather condition, namely, annual average wind speed is 3.6m/s at the indifferent stability, with influencing wind directions respectively being those having the biggest impact on every sensitive point. Refer to Tables 8.2-17~8.2-18 for the calculation results.

**Table 8.2-17 Maximum hourly average concentration of SO<sub>2</sub> of smoke to main concerned (sensitive) points during abnormal emission**Standard limit: 0.50mg/m<sup>3</sup>

| No. and name                                                         | Description of functions of concerned point          | Current concentration mg/m <sup>3</sup> | Running stage of project | Maximum contributed concentration range mg/m <sup>3</sup> | Current concentration and contributed concentration added value mg/m <sup>3</sup> | Percentage in standard value % |
|----------------------------------------------------------------------|------------------------------------------------------|-----------------------------------------|--------------------------|-----------------------------------------------------------|-----------------------------------------------------------------------------------|--------------------------------|
| 1 <sup>#</sup> Huangshao                                             | Village, residential                                 | 0.016                                   | 2 <sup>nd</sup> stage    | 0.0438                                                    | 0.0598                                                                            | 11.96                          |
|                                                                      |                                                      |                                         | 3 <sup>rd</sup> stage    | 0.0740                                                    | 0.0900                                                                            | 18.00                          |
| 2 <sup>#</sup> Houtang                                               | Village, residential                                 | 0.008                                   | 2 <sup>nd</sup> stage    | 0.0492                                                    | 0.0572                                                                            | 11.44                          |
|                                                                      |                                                      |                                         | 3 <sup>rd</sup> stage    | 0.0842                                                    | 0.0922                                                                            | 18.44                          |
| 3 <sup>#</sup> Banjiu                                                | Village, residential                                 | 0.019                                   | 2 <sup>nd</sup> stage    | 0.0637                                                    | 0.0827                                                                            | 16.54                          |
|                                                                      |                                                      |                                         | 3 <sup>rd</sup> stage    | 0.1110                                                    | 0.1300                                                                            | 26.00                          |
| 4 <sup>#</sup> Binchi                                                | Village, residential                                 | 0.017                                   | 2 <sup>nd</sup> stage    | 0.1000                                                    | 0.1170                                                                            | 23.40                          |
|                                                                      |                                                      |                                         | 3 <sup>rd</sup> stage    | 0.1840                                                    | 0.2010                                                                            | 40.20                          |
| 5 <sup>#</sup> Administrative and residential areas in the Port area | Residential area of administrative unit, residential | 0.013                                   | 2 <sup>nd</sup> stage    | 0.0533                                                    | 0.0663                                                                            | 13.26                          |
|                                                                      |                                                      |                                         | 3 <sup>rd</sup> stage    | 0.0924                                                    | 0.1054                                                                            | 21.08                          |
| 6 <sup>#</sup> Xinggang Township Government                          | Administrative office                                | 0.017                                   | 2 <sup>nd</sup> stage    | 0.0534                                                    | 0.0704                                                                            | 14.08                          |
|                                                                      |                                                      |                                         | 3 <sup>rd</sup> stage    | 0.0963                                                    | 0.1133                                                                            | 22.66                          |
| 7 <sup>#</sup> Nankang Town                                          | Small township residential, commerce, logistics      | 0.018                                   | 2 <sup>nd</sup> stage    | 0.0292                                                    | 0.0472                                                                            | 9.44                           |
|                                                                      |                                                      |                                         | 3 <sup>rd</sup> stage    | 0.0516                                                    | 0.0696                                                                            | 13.92                          |
| Maximum value at regional grid                                       |                                                      | 0.018                                   | 2 <sup>nd</sup> stage    | 0.1410                                                    | 0.1590                                                                            | 31.80                          |
|                                                                      |                                                      |                                         | 3 <sup>rd</sup> stage    | 0.2610                                                    | 0.2790                                                                            | 55.80                          |

Note: The maximum real-time value at monitoring point is taken as the current concentration.

**Table 8.2-18 Maximum hourly average concentration of PM<sub>10</sub> of smoke to main concerned (sensitive) points during abnormal emission**

| No. and name                                                         | Description of functions of concerned point          | Running stage of project | Contributed concentration range mg/m <sup>3</sup> |
|----------------------------------------------------------------------|------------------------------------------------------|--------------------------|---------------------------------------------------|
| 1 <sup>#</sup> Huangshao                                             | Village, residential                                 | 2 <sup>nd</sup> stage    | 0.0053                                            |
|                                                                      |                                                      | 3 <sup>rd</sup> stage    | 0.0081                                            |
| 2 <sup>#</sup> Houtang                                               | Village, residential                                 | 2 <sup>nd</sup> stage    | 0.0059                                            |
|                                                                      |                                                      | 3 <sup>rd</sup> stage    | 0.0092                                            |
| 3 <sup>#</sup> Banjiu                                                | Village, residential                                 | 2 <sup>nd</sup> stage    | 0.0074                                            |
|                                                                      |                                                      | 3 <sup>rd</sup> stage    | 0.0117                                            |
| 4 <sup>#</sup> Binchi                                                | Village, residential                                 | 2 <sup>nd</sup> stage    | 0.0099                                            |
|                                                                      |                                                      | 3 <sup>rd</sup> stage    | 0.0175                                            |
| 5 <sup>#</sup> Administrative and residential areas in the port area | Residential area of administrative unit, residential | 2 <sup>nd</sup> stage    | 0.0063                                            |
|                                                                      |                                                      | 3 <sup>rd</sup> stage    | 0.0099                                            |
| 6 <sup>#</sup> Xinggang Township Government                          | Administrative office                                | 2 <sup>nd</sup> stage    | 0.0060                                            |
|                                                                      |                                                      | 3 <sup>rd</sup> stage    | 0.0099                                            |
| 7 <sup>#</sup> Nankang Town                                          | Small town, residential, commercial, and logistic    | 2 <sup>nd</sup> stage    | 0.0034                                            |
|                                                                      |                                                      | 3 <sup>rd</sup> stage    | 0.0054                                            |
| Maximum value at regional grid                                       |                                                      | 2 <sup>nd</sup> stage    | 0.0138                                            |
|                                                                      |                                                      | 3 <sup>rd</sup> stage    | 0.0248                                            |

As is shown in Table 8.2-18, under the circumstance that the CFBB has not desulfurized, SO<sub>2</sub> discharged in 2<sup>nd</sup> stage and 3<sup>rd</sup> stage of the proposed project does not have significant impact on each environmental concerned point. The maximum added value of maximum contributed concentration and maximum background concentration at the grid is 0.2790 mg/m<sup>3</sup> and does exceed the limit, but only accounts for 55.8% of the standard limit.

(7) Analysis of superposition influence of pollution sources of proposed projects or projects under construction in the region

Proposed projects in the evaluation region mainly include Beihai Taibang Oil Refining Project (about 3km SWS of this Project's site), Beihai Power Plant Project at second phase (about 3.1km northeast of this Project's site), Kaidi Coal Chemical (Beihai) Base cool and thermal power project and carbamide project (about 3.4km northeast of this Project's site). Consideration is mainly given to the superposition influence of the three atmospheric pollutants, SO<sub>2</sub>, NO<sub>2</sub>, and PM<sub>10</sub>, of the above proposed projects related to this project. Refer to Tables 8.2-19~8.2-21 for the superposition influence of pollution discharge of the three above-mentioned proposed projects in the region when using the design coal, after Phase III of this project goes into operation. As is shown in tables, the daily average concentration of every pollutant still meets Grade II standards for ambient air quality after the contributed value of pollution sources of Phase III of this project and the proposed projects in region is superposed with the background concentration.

**Tables 8.2-19 Maximum daily average concentration contribution of SO<sub>2</sub> of smoke of the project and regional pollution sources to the main concerned (sensitive) points**Standard value: 0.15mg/m<sup>3</sup>

| No. and name                                                         | Item of concentration       | Contributed concentration mg/m <sup>3</sup> | Added value with regional pollution source mg/m <sup>3</sup> | Current value mg/m <sup>3</sup> | Added value with current value mg/m <sup>3</sup> | Percentage in standard value % |
|----------------------------------------------------------------------|-----------------------------|---------------------------------------------|--------------------------------------------------------------|---------------------------------|--------------------------------------------------|--------------------------------|
| 1 <sup>#</sup> Huangshao                                             | Daily average concentration | 0.0060                                      | 0.0079                                                       | 0.014                           | 0.0219                                           | 14.6                           |
| 2 <sup>#</sup> Houtang                                               | Daily average concentration | 0.0066                                      | 0.0091                                                       | 0.008                           | 0.0171                                           | 11.4                           |
| 3 <sup>#</sup> Banjiu                                                | Daily average concentration | 0.0082                                      | 0.0095                                                       | 0.005                           | 0.0145                                           | 9.7                            |
| 4 <sup>#</sup> Binchi                                                | Daily average concentration | 0.0114                                      | 0.0114                                                       | 0.016                           | 0.0274                                           | 18.3                           |
| 5 <sup>#</sup> Administrative and residential areas in the port area | Daily average concentration | 0.0074                                      | 0.0083                                                       | 0.008                           | 0.0163                                           | 10.9                           |
| 6 <sup>#</sup> Xinggang Township Government                          | Daily average concentration | 0.0064                                      | 0.0114                                                       | 0.010                           | 0.0214                                           | 14.3                           |
| 7 <sup>#</sup> Nankang Town                                          | Daily average concentration | 0.0040                                      | 0.0066                                                       | 0.014                           | 0.0187                                           | 13.7                           |
| Maximum value at regional grid                                       | Daily average concentration | 0.0294                                      | 0.1070                                                       | 0.016                           | 0.1230                                           | 82.0                           |

**Tables 8.2-20 Maximum daily average concentration contribution of NO<sub>2</sub> of smoke of the project and regional pollution sources to the main concerned (sensitive) points**Standard value: 0.12mg/m<sup>3</sup>

| No. and name                                                         | Item of concentration       | Contributed concentration mg/m <sup>3</sup> | Added value with regional pollution source mg/m <sup>3</sup> | Current value mg/m <sup>3</sup> | Added value with current value mg/m <sup>3</sup> | Percentage in standard value % |
|----------------------------------------------------------------------|-----------------------------|---------------------------------------------|--------------------------------------------------------------|---------------------------------|--------------------------------------------------|--------------------------------|
| 1 <sup>#</sup> Huangshao                                             | Daily average concentration | 0.0026                                      | 0.0303                                                       | 0.013                           | 0.0433                                           | 36.1                           |
| 2 <sup>#</sup> Houtang                                               | Daily average concentration | 0.0031                                      | 0.0270                                                       | 0.012                           | 0.0390                                           | 32.5                           |
| 3 <sup>#</sup> Banjiu                                                | Daily average concentration | 0.0041                                      | 0.0250                                                       | 0.014                           | 0.0390                                           | 32.5                           |
| 4 <sup>#</sup> Binchi                                                | Daily average concentration | 0.0071                                      | 0.0286                                                       | 0.010                           | 0.0386                                           | 32.2                           |
| 5 <sup>#</sup> Administrative and residential areas in the port area | Daily average concentration | 0.0037                                      | 0.0141                                                       | 0.016                           | 0.0301                                           | 25.1                           |



| No. and name                    | Item of concentration       | Contributed concentration mg/m <sup>3</sup> | Added value with regional pollution source mg/m <sup>3</sup> | Current value mg/m <sup>3</sup> | Added value with current value mg/m <sup>3</sup> | Percentage in standard value % |
|---------------------------------|-----------------------------|---------------------------------------------|--------------------------------------------------------------|---------------------------------|--------------------------------------------------|--------------------------------|
| 6# Xinggang Township Government | Daily average concentration | 0.0036                                      | 0.0716                                                       | 0.015                           | 0.0866                                           | 72.2                           |
| 7# Nankang Town                 | Daily average concentration | 0.0022                                      | 0.0360                                                       | 0.010                           | 0.0460                                           | 38.3                           |
| Maximum value at regional grid  | Daily average concentration | 0.0165                                      | 0.0872                                                       | 0.016                           | 0.1032                                           | 86.0                           |

**Tables 8.2-21 Maximum daily average concentration contribution of PM<sub>10</sub> of smoke of the project and regional pollution sources to the main concerned (sensitive) points**

Standard value: 0.15mg/m<sup>3</sup>

| No. and name                                             | Item of concentration       | Contributed concentration mg/m <sup>3</sup> | Added value with regional pollution source mg/m <sup>3</sup> | Current value mg/m <sup>3</sup> | Added value with current value mg/m <sup>3</sup> | Percentage in standard value % |
|----------------------------------------------------------|-----------------------------|---------------------------------------------|--------------------------------------------------------------|---------------------------------|--------------------------------------------------|--------------------------------|
| 1# Huangshao                                             | Daily average concentration | 0.0010                                      | 0.0021                                                       | 0.067                           | 0.0691                                           | 46.1                           |
| 2# Houtang                                               | Daily average concentration | 0.0011                                      | 0.0021                                                       | 0.077                           | 0.0791                                           | 52.7                           |
| 3# Banjiu                                                | Daily average concentration | 0.0013                                      | 0.0021                                                       | 0.087                           | 0.0891                                           | 59.4                           |
| 4# Binchi                                                | Daily average concentration | 0.0017                                      | 0.0026                                                       | 0.063                           | 0.0656                                           | 43.7                           |
| 5 #Administrative and residential areas in the port area | Daily average concentration | 0.0012                                      | 0.0014                                                       | 0.074                           | 0.0754                                           | 50.3                           |
| 6# Xinggang Township Government                          | Daily average concentration | 0.0010                                      | 0.0041                                                       | 0.084                           | 0.0881                                           | 58.7                           |
| 7# Nankang Town                                          | Daily average concentration | 0.0006                                      | 0.0022                                                       | 0.070                           | 0.0722                                           | 48.1                           |
| Maximum value at regional grid                           | Daily average concentration | 0.0048                                      | 0.0356                                                       | 0.087                           | 0.1226                                           | 81.7                           |

#### 8.2.4 Analysis of reasonableness of chimney height

There are three kinds of kiln in this project: alkaline recovery kiln, boiler of Power Plant and limestone kiln. Due to a relatively low discharge in the limestone kiln the chimney height is consistent to one for the alkaline recovery kiln, thus, this evaluation is just to verify the reasonableness of chimney height for alkaline kiln and boiler of the Power Plant. Because the feasibility study has provided a designing scheme for chimney height of alkaline kiln and boiler of Power Plant, this evaluation has made the analysis

of reasonableness of chimney height proposed in the feasibility study.

Based on the feasibility report of this project, chimney height is only 120m in the scheme. In this EIA report, the argumentation on environmental rationality is merely based on the scheme.

In the selection of chimney height, three aspects should be mainly considered from the view of environmental protection:

- a) Discharge of pollutant will meet the standard for discharge, dischargeable to reach the standard.
- b) Enabling to overcome the unfavorable effect of terrain and topography and meteorological conditions on smoke elevation.
- c) Ground concentration of atmospheric pollutant should meet the requirement for on-site surrounding air quality.
- d) Avoiding the occurrence of smoke "downwash".

#### 8.2.4.1 Analysis of discharge meeting the standard

After various measures for environmental protection taken for alkaline kiln, limestone kiln and boiler of Power Plant the discharging concentration and discharge of waste gas could meet the relevant standard of discharge. See the chapter concerning the project analysis and feasibility analysis of measures of pollutant prevention.

#### 8.2.4.2 Analysis of effect of topography on smoke diffusion

##### (1) Analysis of effect of topography on smoke diffusion

The proposed plant location is near waterfront region with its smooth terrain and less wavy terrain, thus the effect of topography on smoke elevation is extremely low for a chimney in a height over 120m, negligible for effect on smoke diffusion.

##### (2) Analysis of meteorological effect on smoke diffusion

The meteorological factor that will affect the elevation height of smoke is mainly the condition of atmospheric stratification; the most effective one is atmospheric inversion. According to meteorological observation on pollution at a low altitude, occurrence frequency of atmospheric temperature inversion in plant location is relatively low with less effect on smoke diffusion; the height of untouched inversion below 300m in 123-179m, lower than the elevation height of the chimney designed which most of smoke would be continuously diffused in the inversion layer such that it could meet the designed object for environmental protection.

#### 8.2.4.3 Calculation of ground concentration of pollutants

Refer to Table 8.2-22 for the calculation results of the maximum ground concentration of

waste gas discharged through the chimneys of alkali recovery boiler and power plant boiler of the design coal in Phase III project.

**Table 8.2-22 Predicted results of maximum ground concentrations and distances of pollutants**

| Discharge source                    | Pollutant        | Max. ground concentration (mg/m <sup>3</sup> ) | Appearing distance (m) | Standard limit (mg/m <sup>3</sup> ) | Percentage of max. ground concentration in standard limit (%) |
|-------------------------------------|------------------|------------------------------------------------|------------------------|-------------------------------------|---------------------------------------------------------------|
| Chimney of boiler of Power Plant    | SO <sub>2</sub>  | 0.0424                                         | 2000                   | 0.50                                | 8.48                                                          |
|                                     | NO <sub>2</sub>  | 0.0405                                         | 2000                   | 0.24                                | 16.88                                                         |
|                                     | PM <sub>10</sub> | 0.0066                                         | 2000                   |                                     |                                                               |
| Chimney of alkaline recovery boiler | SO <sub>2</sub>  | 0.0203                                         | 3578                   | 0.50                                | 4.6                                                           |
|                                     | PM <sub>10</sub> | 0.0051                                         | 3578                   |                                     |                                                               |

It can be seen from the above table that, when the chimney is over 120m in height, the maximum ground concentrations of the chimneys of power plant boiler and alkali recovery boiler are all relatively low and lower than the standard value; moreover, due to the different of elevation height of smoke of each chimney, each site of occurrence of maximum ground concentration is quite different; the addition of maximum contributed values would not appear such that it would diminish the effect on environment. In addition, the sites of occurrence of maximum ground concentration are mostly not in the object of environmental protection, thus the height of chimney designed is reasonable.

#### 8.2.2.4 Analysis of the situation of smoke “downwash”

In accordance with regulations of Article 5.6 in the *Technical methods for making local emission standards of air pollutants* (GB/T13201-91), the circumstances corresponding to the proposed project are as follows: no buildings which require special protection should be built around the project for residential and working purposes; the buildings within the plant are mainly offices and production workshops, the maximum height of which are generally about 20m, and the height of the chimneys of thermal power plant boiler and alkali recovery boiler are much greater than that of the buildings to which they

belong by two folds; smoke speeds at the outlets of chimneys of thermal power plant boiler and alkali recovery boiler are 12.6m/s and 11.46m/s respectively. Under common indifferent stability and annual average wind speed, the average environmental wind speed at the height of chimney of 120m is 5.2m/s. Through calculation,  $V_C=4.2\text{m/s}$ . Hence, the smoke speeds at the outlets of chimneys of thermal power plant boiler and alkali recovery boiler are both greater than 1.5 times of  $V_C$  (6.3m/s). Therefore, the design heights of chimneys of thermal power plant boiler and alkali recovery boiler both meet the requirements of the *Technical methods for making local emission standards of air pollutants* (GB/T13201-91), capable of avoiding the occurrence of smoke “downwash”.

### 8.3 Summary

- (1) The evaluation location is in seafront region having smooth terrain and low static wind frequency, which the annual average wind speed is high, the atmospheric transition and diffusion is strong, advantageous to diffusion of atmospheric pollutants.
- (2) Effect of discharged waste gas on air quality at the evaluation area and each sensitive point under the normal production condition after the each stage of the project completed would be weak, the air quality at the location would not be deteriorated.
- (3) The smell discharged in the project will affect the air quality in the range of 500m around the plant boundary. According to analogy investigation, the impact of smell in a distance of 450m leeward from the waste water treatment station would not be apparent, so the maximum distance for environmental protection is 500m (southeast plant boundary).
- (4) Due to 10% of moisture content of coal designed, the wind speed of dusting would be over 9.3 m/s which is rare in the evaluation location, thus the effect of coal powdered dust is relatively small. Therefore, by building wind-proof and dust suppressing meshwork, big wind speed may be reduced to below the dusting wind speed and the ground concentration in the location can meet the requirement of *Comprehensive Discharge Standard for Atmospheric Pollutants*, having less effect on health of personnel and air environment in the location. The concentration of coal powdered dust in workshops surrounding the coal-dumping yard can also meet the requirements of *Hygienic standards for the Design of Industrial Enterprises*.
- (5) The chimney heights of boiler, alkaline recovery kiln, and limestone kiln are reasonable in design.
- (6) Under the circumstance that CFBB does not desulfurize, the concentration contribution of SO<sub>2</sub> discharged from Phase II and III of the proposed project to each concerned point increases to some extent, but it is still within the limit of Grade II standard after being added with the background value.

## 9 Ecological and Environmental Impact Analysis

### 9.1 Marine ecological and environmental Impact

As planned in the engineering design, the waste water generated by the project will be discharged into deep sea at Tieshan Port. Major pollutants contained in the discharged waste water include COD, SS, AOX, dioxin, total nitrogen, and total phosphorus, etc. The prediction time of this report is after the implementation of current coastline and planned coastline, and the prediction is based on the discharge outlet B<sub>3</sub>, and prediction calculation is carried out according to the source strength provided by Stora Enso. The possible impact of major pollutants on the marine environment of the project's sea area is evaluated based on the emission result of Phase III project with the largest emission concentration.

#### 9.1.1 Analysis of impacts by discharged COD of project on marine ecological environment

##### 9.1.1.1 Analysis of impacts by discharged COD of project on marine organisms

COD and BOD discharged in the project will lead to changes in dissolved oxygen (DO) contents in part of sea area. DO with sufficient concentration contained in the sea water is critical to the existence and reproduction for all marine plants and animals. Discharged waste water containing high oxygen-demanding substances may reduce the DO concentration of sea water, have negative impacts on respiration of fishes and invertebrates and cause active marine organisms (such as fishes or marine mammal) to slide over areas containing low-content of DO. Oxygen dissolved in the sea water can be directly supplemented by the atmosphere (enhanced through water flow) and the photosynthesis of alga and marine plants.

Waste water discharged in the project can be quickly diffused due to good dynamic conditions of sea water in the drainage area. Oxygen dissolving capacity of nearby sea water of the drainage area is 7.02~7.49mg/L, while discharged COD of project only has little impact on marine organisms in Tieshan Port. Because of low estimated increment of COD pollutants in the sea water, discharged oxygen-demanding organic substances won't cause perceptible impact to the concentration of dissolved oxygen in this harbor.

However, discharged waste water of project will still lead into changes of biologic population near the discharge outlet particularly causing species resistant to pollution gradually turn into dominant species.

##### 9.1.1.2 Analysis of Impacts by discharged COD of project on nature reserves

Refer to Table 9.1-1 for the maximum area influenced by each concentration of COD emission after Phase III project.

**Table 9.1-1 Increased COD concentration and influenced area after Phase III project**

| Maximum area under possible influence of every concentration of current coast (km <sup>2</sup> ) |        |        |        | Influenced area of every concentration after the completion of planned coast (km <sup>2</sup> ) |        |        |        |
|--------------------------------------------------------------------------------------------------|--------|--------|--------|-------------------------------------------------------------------------------------------------|--------|--------|--------|
| >5mg/L                                                                                           | >4mg/L | >3mg/L | >2mg/L | >5mg/L                                                                                          | >4mg/L | >3mg/L | >2mg/L |
| Local                                                                                            | Local  | 0.0027 | 0.0187 | Local                                                                                           | Local  | 0.0008 | 0.0146 |

It can be known from the prediction calculation results that the impact of COD on water environment is confined to local areas near the discharge outlet B<sub>3</sub>. The maximum influence distance of water bodies with COD concentration over 2mg/L is about 160m, after the implementation of planned coastlines, the maximum influence distance of water bodies with COD concentration contained in sewage over 2mg/L is about 140m. Therefore, after the completion of Phase III project and implementation of planned coastlines, the COD discharged in this project will not have direct impact on the marine protection objects.

Based on prediction calculation results of the impacts on marine environment, after completion of the engineering period III, maximum concentration increment of waste water increased will reach 0.022mg/L in Mangrove reserve, 0.002 mg/L in dugong reserve; under normal conditions of waste water discharge, maximum concentration increment of waste water will reach 0.284mg/L in mangrove reserve, 0.031 mg/L in dugong reserve. At present, the COD concentration in vicinity of Nature Reserves is about 1.5mg/L, total COD concentration plus the largest concentration increased won't exceed the COD concentration value (2mg/L) of Class 1 of sea water. It is obvious that discharged COD has slight impact on dugong nature reserve and mangrove nature reserve.

#### **9.1.1.3 Analysis of impacts on breeding and proliferation zones**

According to division of functional areas in the offshore sea area, several major breeding zones involved in the assessment accord with Class 2 sea water quality standard ( $\leq 3\text{mg/L}$ ). Based on the prediction calculation result concerning the impact on water environment by COD contained in the sewage discharged in projects during all phases, under normal working conditions, the impact of COD on water environment is only local and almost has no superposition influence with COD in the sewage discharged from the planned discharge outlet A. Under normal circumstances, the area with COD increment concentration over 2mg/L only amounts to 0.0187km<sup>2</sup>. Even under accident discharge, only local mixed zone (about 1.96 km<sup>2</sup>) goes beyond the requirements of standard for the quality of ultra Class 4 sea water. In addition, the COD increment concentration reaching Yingpan mariculture zone added with the background value of the sea area (about 1.5mg/L) will not exceed the standard for sea water quality required by the mariculture zone. Therefore, the COD emission of the project will not have direct impact on Yingpan mariculture zone.

### 9.1.2 Analysis of Impacts by SS drainage of project on marine ecology

Suspending substances will increase in the sea water, reducing transparency of the water and affecting photosynthesis of phytoplankton. Primary productivity in local sea area will be lowered and zooplankton consuming phytoplankton will be reduced, leading to shortage of baits for planktivorous fishes and decline in fishery resources. In addition, excessive suspending substances will chock aquatic's food filtration system and peptic, particularly when concentration of suspending substances reaches as high as 300mg/L or above will obviously restrain livability of larvae of pelagic copepods. Exorbitant quantity of suspending substances will also slow down propagation of fishes and for some fishes, the speed of their propagation will be significantly reduced once the threshold value of 75-100mg/L is exceeded.

After Phase III project, when SS is normally discharged, the maximum concentration increment of waste water discharged in the project in mangrove and dugong protection area and Yingpan mariculture zone is below 1mg/L in, thus having limited impact, in terms of degree and range, and slight impact on phytoplankton, zooplankton, roes and fries as well as nature reserves and mariculture zones. In a word, discharged waste water of the project has slight impact on marine ecological environment in evaluation sea area.

Table 9.1-2 Analysis on the influence of SS in sewage discharged to water environment after Phase III project

| Sewage emission of Phase III project of current<br>coastline                       |        |          | Sewage emission of Phase III project of planned<br>coastline                       |        |          |
|------------------------------------------------------------------------------------|--------|----------|------------------------------------------------------------------------------------|--------|----------|
| Maximum possible area influenced by different<br>concentrations (km <sup>2</sup> ) |        |          | Maximum possible area influenced by different<br>concentrations (km <sup>2</sup> ) |        |          |
| >10mg/L                                                                            | >1mg/L | >0.1mg/L | >10mg/L                                                                            | >1mg/L | >0.1mg/L |
| Local                                                                              | 0.0031 | 0.6486   | Local                                                                              | 0.0024 | 0.6193   |

It can be known from the prediction result that the impact of SS on water environment is only confined in the areas near the discharge outlet B<sub>3</sub>. The maximum influence distance of water body with SS concentration over 1mg/L is about 60m, so it will not have direct impact on the water environment protection objects and mariculture zone.

Besides, as shown by studies on standard deposits in Tieshan Port, sands and grits constitute most of the seabed with relatively lower contents of organic carbon (<0.7%), which indicates that fine grains won't naturally settle in vicinity of the discharge outlet in Tieshan Port. This result is consistent with the observation result that the tidal flow is relatively high and typhoon has relatively high transfer effect on sediments on seabed in Tieshan Port. After the waste water of the project is treated according to tertiary treatment, the suspending particles in the discharged waste water will have nearly neutral buoyancy and won't accumulate on seabed around the diffuser and form large quantity of anoxic deposits, having slight impact on benthic organism.



### 9.1.3 Analysis of impacts by discharged AOX of project on marine ecology

#### 9.1.3.1 Biological Toxicity of AOX

Zhao Yihong, from Policy Research Center for Environment and Economy, SEPA, has conducted research on biological toxicity of waste water, studying toxicity of waste water for pulp making, bleaching waste water, waste water in the main discharge outlet and each of discharge outlets of the plant. According to the studies,  $EC_{50}$  variation range of bleaching waste water is relatively large, ranging from 2.50 % to 63.83 %. As analyzed, this range is, more or less, related to the content of residual chlorine in the waste water. The higher the chlorine content is, the lower the  $EC_{50}$  value is and the higher the measured toxicity is. Meanwhile, as shown by lots of studies, toxic substances in bleaching waste water (mainly AOX) cause acute toxicity to aquatic animals and are teratogenic, carcinogenic and mutagenic.

Organism test method can be adopted to directly reflect the toxicity of industrial waste water and hazards and impacts on aquatic environment brought by industrial waste water. Roes and larvae are most sensitive to environment in process of growth of fishes. Toxicity test conducted in early growing phase of roes and larvae has been widely recognized by scholars. Sparus macrocephalus are common benthic and economic fishes along the shore. There are many fish communities of sparus macrocephalus dispersed in sea area of Tieshan Port. Some Chinese scholars have carried out toxicity tests with roes and early larvae of sparus macrocephalus to comprehend the toxicity of AOX bleaching waste water on these roes and larvae. One research for test toxicity towards roes and larvae of sparus macrocephalus applied solutions with different concentrations prepared by original waste water (major toxic substance is AOX with a concentration of 3.75mg/L) generated in bleaching of chemical pulp of some paper mill. According to the research, the incubation rate of roes and death rate of larvae are much higher than blank control group when the dilution multiple is below 30; However, the rates mentioned above are almost the same as large difference between the control group and blank control group within 96h when the dilution multiple is 100, 300 and 1,000. This indicates that the original waste water generated in paper bleaching will have slight impact on roes and larvae after being diluted 100 times. The research report also indicates that in the test on acute toxicity of AOX on sparus macrocephalus larvae, the lowest effective concentration (LOEC) and the highest effective concentration (NOEC) within 96h are respectively 0.003 ml/ml and 0.001ml/ml, i.e. 3mg/L and 1mg/L and the 50% lethal concentration to larvae is 774 mg/L (96h). According to a foreign report on acute toxicity test, the livability of salmons can maintain 95~100% when the content of AOX is 2.0~6.0mg/L.

At the end of 1990s, Columbia of Canada carried out many studies on impacts of AOX generated by 14 paper mills of pulp-paper industry. And the results showed that when  $ClO_2$  replaced more than 50 % of Cl, chlorine, hydroxybenzene and aldehyde substances contained in bleaching waste water were largely reduced and organic chlorides were different: few perchloric organic substances were generated, the toxicity was 1000 times weaker and almost no dioxin was detected. Currently, advanced paper

making enterprises has phased out element chlorine and replaced it with element-chlorine-free (ECF) and totally- element-chlorine-free (TCF) bleaching process.

### 9.1.3.2 Impacts of discharged AOX of project on Marine ecology

AOX yield is directly related to the amount of active chlorine used in the bleaching process, and the yield of AOX will greatly decrease with the increasing amount of liquid chlorine being substituted by chlorine dioxide in the chlorination stage.

The project will adopt deep braising and boiling, oxygen de-lignification, ECF bleaching process and many other technologies to reduce quantity of AOX produced, and it is estimated that AOX yield will be below 0.4kg/t pulp. The concentration of AOX in waste water discharged from the pulping workshop can meet the requirements of *Discharge Standard of Water Pollutants for Pulp and Paper Industry* (GB3544-2008), and it can also eliminate production of such biologically accumulative and toxic substances such as dibenzo-p-dioxins and diphenylene-oxide.

Because the concentration of AOX in discharged waste water is 0.92~1.30mg/L and the diffusion coefficient of the diffuser at the discharge outlet is 100, the concentration will be quickly reduced to below 0.01 mg/L once the waste water is discharged through the diffuser. According to the results of water quality forecast, after the Phase III project, under normal working conditions, the emission of AOX will be below 0.38t/d after sewage treatment. Take B<sub>3</sub> as discharge outlet the area with diffusion concentration over 0.01mg/L only amounts to 0.89 km<sup>2</sup>. The maximum increment concentration of AOX reaching the boundary of dugong reserve is below 0.001mg/L; the one that reaches the nearest mangrove reserve is only 0.002mg/L, and one that reaches Yingpan mariculture zone is below 0.003mg/L. Under abnormal emission (namely, without treatment of the wastewater treatment station), the water area with AOX>0.01mg/L is 31.1147 km<sup>2</sup>, the area with AOX>0.05mg/L 0.2093 km<sup>2</sup>, and the area with AOX>0.10mg/L merely 0.0483 km<sup>2</sup>. All these indicate that the degree and range of impact on marine environment by AOX discharged in the project are not large and it is reasonable to deem that AOX has slight impact on aquatic creatures in the evaluation sea area.

**Table 9.1-3 Analysis of impact on water environment by AOX in sewage discharge**

| Sewage emission of Phase III project of current coastline                       |           | Sewage emission of Phase III project of planned coastline                       |           |
|---------------------------------------------------------------------------------|-----------|---------------------------------------------------------------------------------|-----------|
| Maximum possible area influenced by different concentrations (km <sup>2</sup> ) |           | Maximum possible area influenced by different concentrations (km <sup>2</sup> ) |           |
| >0.10mg/L                                                                       | >0.01mg/L | >0.10mg/L                                                                       | >0.01mg/L |
| 0.0043                                                                          | 0.9895    | 0.0040                                                                          | 0.8904    |

It can be known from the prediction result that the impact of AOX on water environment is the areas in the downstream direction of the discharge outlet B<sub>3</sub>. The maximum influence distance of water bodies with AOX incremental concentration over 0.01mg/L is

about 2100m, having slight impact on the marine reserve and mariculture zone.

#### 9.1.4 Analysis of impact on marine environment by dioxin in wastewater discharged in the project

According to the engineering analysis, discharge volumes of dioxin after the completion of Phase I, II and III, are similar, about  $4.72 \times 10^8$  pg TEQ/d, so the prediction calculation only takes it as source strength in calculation.

**Table 9.1-4 Analysis of impact on water environment by dioxin in sewage discharge**

| Sewage emission of Phase III project of current coastline                       |              | Sewage emission of Phase III project of planned coastline                       |              |
|---------------------------------------------------------------------------------|--------------|---------------------------------------------------------------------------------|--------------|
| Maximum possible area influenced by different concentrations (km <sup>2</sup> ) |              | Maximum possible area influenced by different concentrations (km <sup>2</sup> ) |              |
| >0.10pgTEQ/L                                                                    | >0.01pgTEQ/L | >0.10pgTEQ/L                                                                    | >0.01pgTEQ/L |
| 0.0083                                                                          | 1.5496       | 0.0065                                                                          | 1.4970       |

It can be known from the prediction result that the impact of dioxin on water environment is the areas in the downstream direction of the discharge outlet B<sub>3</sub>. The maximum influence distance of water bodies with dioxin incremental concentration over 0.01 pgTEQ/L is about 2200m. However, the standard content of dioxin (2,3,7,8-TCDD) of US Environmental Protection Agency (EPA) and the Standards for Drinking Water Quality (GB 5749-2006) approved in China is 30pg, so it can be deemed that the concentration of dioxin discharged in the project has slight direct impact on the marine protection objects.

#### 9.1.4 Analysis of influence of nitrogen and phosphorous nutrient salts

Because nitrogen and phosphorus are important indicators for water eutrophication, and especially, the contents of total nitrogen and phosphorous directly reflect the degree of water eutrophication, it is necessary to forecast the major nutrient salts nitrogen and phosphorus discharged from the project into the sea. The forecast analysis is based on the maximum concentration of total nitrogen and phosphorus discharged after the Phase III project (refer to Tables 9.1-5 and 9.1-6 for the results).

**Table 9.1-5 Areas influenced by the normal emission of total nitrogen after Phase III project**

| Area influenced by every concentration on current coast (km <sup>2</sup> ) |          |          |          | Area influenced by every concentration after the completion of planned coast (km <sup>2</sup> ) |          |          |          |
|----------------------------------------------------------------------------|----------|----------|----------|-------------------------------------------------------------------------------------------------|----------|----------|----------|
| >0.5mg/L                                                                   | >0.4mg/L | >0.3mg/L | >0.2mg/L | >0.5mg/L                                                                                        | >0.4mg/L | >0.3mg/L | >0.2mg/L |
| 0.0024                                                                     | 0.0046   | 0.0161   | 0.2737   | 0.0014                                                                                          | 0.0033   | 0.0145   | 0.2647   |

**Table 9.1-6 Areas influenced by the normal emission of total phosphorous after**

### Phase III project

| Area influenced by every concentration on current coast (km <sup>2</sup> ) |            |            | Area influenced by every concentration after the completion of planned coast (km <sup>2</sup> ) |            |            |
|----------------------------------------------------------------------------|------------|------------|-------------------------------------------------------------------------------------------------|------------|------------|
| >0.045mg/L                                                                 | >0.030mg/L | >0.015mg/L | >0.045mg/L                                                                                      | >0.030mg/L | >0.015mg/L |
| 0.0010                                                                     | 0.0037     | 0.0175     | 0.0004                                                                                          | 0.0029     | 0.0156     |

It can be known from the prediction result that the impact of total nitrogen on water environment is only confined to the areas near the discharge outlet B<sub>3</sub>. The maximum influence distance of water bodies with total nitrogen concentration over 0.3mg/L is about 170m, and maximum influence distance of water bodies with total nitrogen concentration over 0.2mg/L is about 950m. The impact of total phosphorous on water environment is only confined to the areas near the discharge outlet B<sub>3</sub>. The maximum influence distance of water bodies with total phosphorous concentration over 0.015mg/L is about 180m

Due to the small increments of total nitrogen and phosphorous, they still remain at a relatively level after adding the background value of sea water in this sea area. According to the evaluation standard for eutrophication suggested by National Institute of Environmental Pollution of Japan, it will reach the degree of “mid-eutrophication” when the total nitrogen and total phosphorous reach 0.65 and 0.05mg/L. Therefore, after the project goes into operation, sea water in this sea area generally remains in the state of “olipotrophication-mesotrophication (total nitrogen 0.16~0.31mg/L and total phosphorous 0.01~0.02mg/L)”, and it will not lead to water eutrophication or red tide. Therefore, it will not impose direct impact on the environmental protection objects of this sea area.

#### 9.1.4 Analysis of other impacts

Despite the impact range of discharged waste water of project is limited, some parts of marine environment will still be changed, causing differences to composition of species and structure of communities of sensitive groups, especially planktons and benthic creatures, especially those slowly moving ones:

- (1) Due to large amount of waste water discharge into the sea, the salinity will change in mixed zones, and species and quantity of stenohaline planktons may be reduced, although euryhaline planktons won't be largely affected;
- (2) In the drainage area, species resistant to pollution will increase and develop into dominant ones;
- (3) In mixing area, suspending substances and color radicals will change the transparency of the sea water. To some extent, light-sensitive phytoplankton will be affected.

Changes mentioned above will lead to changes of distribution of other creatures in the sea area that prey the above-mentioned ones.

#### 9.1.5 Summary

Generally, discharge waste water of project will only have certain impact on population distribution of planktons and benthic creatures in the sea around drainage area, leaving small impact on marine organisms in evaluation sea area and slight impact on major objects of environmental protection (Two nature reserves and mariculture zones). It won't damage the stability of the ecology in the evaluation sea area and is environmentally acceptable.

In addition, it is necessary to implement post-operation monitoring and study to follow up with the project since few studies have been carried out for accumulative impact of AOX concentration in waste water on various organisms.

## 9.2 Analysis of Ecological environmental Impact in Land Area

### 9.2.1 Analysis of impacts on vegetation

#### 9.2.1.1 Analysis of Impact by land use of the project on vegetation

Construction of the project will, to some extent, damage the original vegetation. Crops and forests are major vegetations on the land used for the project. Types and species of vegetation will a lot and most original plants will disappear in the area after completion of the construction. Based on the inspection, the quantity of creatures in the area is about 20~78t/hm<sup>2</sup> (Dry weight) occupying 39.85hm<sup>2</sup> forest and about 1800t creatures is lost. Maintaining 20% of green land in the area after completion of the construction can offset the loss of vegetation to some extent.

**Table 9.2.-1 Statistics of organism loss due to the land occupation of the project**

| Land type         | Sub-item                                                 | Area (hm <sup>2</sup> ) | Organism lost (t) |
|-------------------|----------------------------------------------------------|-------------------------|-------------------|
| Agricultural land | Farmland                                                 | 73.0488                 | 289.3             |
|                   | Woodland                                                 | 39.8537                 | 1638.0            |
|                   | Other agricultural land                                  | 54.4464                 | 141.4             |
|                   | Subtotal                                                 | 167.3489                | 2068.7            |
| Construction land | Residential location, and land for special purpose, etc. | 19.8001                 | 42.1              |
|                   | Salt field and independent industrial and mining lands   | 23.1120                 | 20.7              |
|                   | Subtotal                                                 | 42.9121                 | 62.8              |
| Unutilized land   | Bare land                                                | 1.2075                  | 5.4               |
|                   | Wild grass ground                                        | 1.6521                  | 14.2              |
|                   | Other unutilized land                                    | 23.1803                 | 60.3              |
|                   | Subtotal                                                 | 26.0399                 | 79.9              |
| Total             |                                                          | 236.3009                | 2211.4            |

#### 9.2.1.2 Impact of SO<sub>2</sub> Emission to Vegetation

Damage degree to vegetation by SO<sub>2</sub> is in direct proportion to the concentration of SO<sub>2</sub> in the air and time of pollution. The pollution occurs when the pollutants enter from open pores of plants and diffuse into the spongy and palisade tissues to damage the chloroplast and cause cells to die from dehydration (Speckles among veins of leaves are the main features of damage to leaves). The symptom of injury to plants usually starts from the leaf edges or tips, deteriorating into white and brown stains along the veins and then into brown spots. In case of acute injury, brown spots may cross the veins, followed by falling or withering of leaves. New leaves with vigorous physiology are most sensitive to damage by SO<sub>2</sub>, while the hurt to young leaves and old leaves with declined physiology are relatively lighter.

Shown by a research, SO<sub>2</sub> has obvious chronic effect to the growth of woods when the annual concentration of SO<sub>2</sub> reaches 0.044mg/m<sup>3</sup>. Chronic effect to growth of woods is not obvious when the annual concentration of SO<sub>2</sub> is 0.02mg/m<sup>3</sup>. Status monitoring shows that the air quality in the area is high; Air monitoring shows that after completion of the engineering period III, the contribution of SO<sub>2</sub> generated by the project to the

annual concentration is  $0.0029\text{mg/m}^3$ , much lower than the chronic injury concentration. Therefore the chronic effect on plants is not obvious.

After completion of the engineering period III, the largest ground level concentration of  $\text{SO}_2$  generated by coal combustion designed per day is  $0.0167\sim 0.0294\text{ mg/m}^3$  and supposed with the largest background monitoring value  $0.013\text{mg/m}^3$  of evaluation area, it becomes  $0.0424\text{mg/m}^3$  still within Tier 2 standard regulated in Ambient Air Quality Standard (GB3095-1996). The impact of  $\text{SO}_2$  emission of the project on plants isn't large.

According to the "Forecast and Appraisal of Atmospheric Environmental Impacts" section, day-to-day highest concentration and annual discharged concentration of  $\text{SO}_2$  in the project under assessment reach Grade 2 atmospheric environmental quality standard. Thus, it is reasonable to deem that impacts of  $\text{SO}_2$  emission by the project to surrounding vegetation are acceptable.

### 9.2.2 Analysis of impact on ecological integrity

At present, the total  $198\text{hm}^2$  lands occupied by the project are mainly plowland, forests, construction lands and brine pans, forming an ecological transition system from the land to the ocean. Most of the forests are eucalypt woods and birds are the major species of wild animals. The impact of the project on natural ecology is light.

Variety of species is the basis for ecological diversity and the important factor for more stable ecological system. The variety of species in project area changes as the ecological system changes. Some local plants are reduced by the construction. However, man-made forests and agricultural vegetation are major plants in the evaluation area where most species of are manually planted. These species are common ones and widely distributed in the area, which won't reduce diversity of plants in the area. Species extinction won't happen since no valuable and rare protected species are found in the project area. Besides, birds are the major species of wild animals. The impact of project construction on biological diversity is slight.

### 9.2.3 Impacts on agricultural production

#### 9.2.3.1 Analysis of impacts by land occupation

Major impact by the construction on agriculture is caused by occupation of plow land. Project construction will turn the original occupied land into industrial application and change the agricultural function of the land from into industrial use and change the application mode of the land by changing agricultural ecology in some parts of the area. Impact on physical features of the agricultural ecology is irreversible. Occupation of plow land will increase pressure on rest of the plow land, leaving certain impact on agriculture production. The occupation of the land by the project will also bring short-term impact on economic incomes of farmers. Similarly, though temporary occupation of land during construction is negative for agriculture production, it can be offset by economic

compensation. Total area of construction land for the planned project is 236.3hm<sup>2</sup>, occupying 73hm<sup>2</sup> of plow land, i.e. 16.7hm<sup>2</sup> paddy field and 38.1hm<sup>2</sup> dry land. The occupied fields will lose the ability of agriculture production. Given that both the paddy field and dry land are calculated as crops, 365t grains will be lost each year as calculated on the basis that the average grain yield is 50000kg per hectare.

The construction will occupy 58.04 hm<sup>2</sup> basic farmland, which accounts for 24.56% of the total area of land used. For occupation of farmland, it is required to go through formalities of application and compensation in accordance with relevant national regulations.

#### 9.2.3.2 Impacts of pollutant drainage on nearby crops

According to data, when average concentration of SO<sub>2</sub> per day is 0.33~1.3 mg/m<sup>3</sup> and the highest concentration per day is 0.5~1.9 mg/m<sup>3</sup>, yield of cereal crops will reduce 20%. In air-polluted area, SO<sub>2</sub> restrains tiller of rice, delays tassel, reduces number of panicles and further affects weight of 1000-seed and fruiting rate of brown rice, causing production reduction. In the area where concentration of SO<sub>2</sub> is 0.1mg/m<sup>3</sup>, compared with other crops, growth rate and yield of potatoes, sugar beets, lettuces and spinaches are obviously reduced by 20-60% relative to comparison zone.

As shown by the prediction result of the ambient air impact of the project, the daily average maximum concentration contribution of SO<sub>2</sub> in the air is 0.0294 mg/m<sup>3</sup> and maximum value added with the background value is 0.0424mg/m<sup>3</sup> (refer to the "Forecast and Appraisal of Atmospheric Environmental Impacts" section), much lower than limits on the average concentration of SO<sub>2</sub> per day and any contribution to the concentration once specified in GB9137-88 *Maximum Allowable Concentration of Pollutants in Atmosphere for Protection Crops* (Refer to Table 9.2-2 for standards). Therefore, SO<sub>2</sub> discharged by the project won't have obvious impact on crops in the area being assessed.



**Table 9.2-2 GB9137-88 Maximum Allowable Concentration of Pollutants in Atmosphere for Protecting Crops (mg/m<sup>3</sup>)**

| Pollutants      | Sensitivity of crops       | Average concentration in growing period | Average concentration per day | Once | Types of crop                                                                                                                                                                                                             |
|-----------------|----------------------------|-----------------------------------------|-------------------------------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SO <sub>2</sub> | Sensitive crops            | 0.05                                    | 0.15                          | 0.50 | Winter whprey, spring whprey, barley, buckwhprey, soybean, sugar beet, sesame, spinach, greengrocery, cabbage, lettuce, cucumber, pumpkin, vegetable marrow, potato, apple, pear, grape, clover blossom, clover, ryegrass |
|                 | Moderately sensitive crops | 0.08                                    | 0.25                          | 0.70 | Rice, corn, oat, broomcorn, cotton, tobacco, tomato, egg plant, carrot, peach, apricot, plum, orange, cherry                                                                                                              |
|                 | Resistant crops            | 0.12                                    | 0.30                          | 0.80 | Horsebean, cole, sunflower, cabbage, taro, strawberry                                                                                                                                                                     |

## 10 Analysis on Regional Social & Economic Impact

The project generates direct and indirect impact on social environment. The former refers to that project plant occupies an area, affecting agricultural production and the local residents to be relocated. The latter refers to the impact on regional social and economic development after the project is completed for use, as well as the impact of project construction on driving other related industries.

### 10.1 Direct Social Impact of the Project

#### 10.1.1 Land acquisition and relocation for the mill project

The project expropriates a total land area of 236.3hm<sup>2</sup>, including 198.01hm<sup>2</sup> for production plant; 18.29 hm<sup>2</sup> for compensated land for relocated houses; 20 hm<sup>2</sup> salt field for permanent use as slag stockpile. Among the expropriated land, the basic agricultural land covers an area of 45.25hm<sup>2</sup> (including paddy field 10.69hm<sup>2</sup>, dry land 1.89hm<sup>2</sup>, and adjustable water surface for aquaculture 32.12hm<sup>2</sup>), accounting for 19.14% of total expropriated land. The expropriated land belongs to Nanle Village Committee of Xinggang Town in Tieshan Port Area, and the expropriated compensated land belongs to the collective land of Honghuagen Village of Binchi Village Committee, and the land expropriated for slag stockpile is the salt field of Beimu Salt Works.

The project involves 2246 residents of 662 to-be-relocated households, including 976 people of 294 to-be-relocated households within the plant location, 1270 people of 368 relocated households within the environmental protection distance outside the plant boundary. There will be 60224m<sup>2</sup> of residential buildings to be relocated, including 55857m<sup>2</sup> of brick-and-wood houses and 4367 m<sup>2</sup> of brick-and-concrete houses. In addition, the following buildings need to be relocated: Nanle Primary School, an office building of Nanle Village Committee, a communication base station of China Mobile, Tianliao Village Brick Plant, two communication base stations of China Unicom, and 1100 tombs.

The to-be-relocated residents in the plant area belong to Tianliao Village, Pokoutang Village and Beimu Village under Nanle Village Committee of Xinggang Town and Haishanba Village under Potou Village Committee, etc.

The to-be-relocated residents within the environmental protection distance beyond plant boundary belong to Beimu Village, Xinwupo Village and Pokoutang Village under Nanle Village Committee of Xinggang Town and Haishanba Village and Yaxi Village under Potou Village Committee, etc.

Refer to Table 10.1-1 for types and area of expropriated land for the project, and see Table 10.1-2 for relocation details.

Table 10.1-1

## Type and Area of Expropriated land for the Project

Unit: hm<sup>2</sup>

|                                                                                                               | Total land area | Agricultural land |                 |             |          |                                          |                         |               |              |             |            |                  |                                     | Construction land |                        |                         |                  |                          | Sub-total | Unutilized land       |                   |                   |
|---------------------------------------------------------------------------------------------------------------|-----------------|-------------------|-----------------|-------------|----------|------------------------------------------|-------------------------|---------------|--------------|-------------|------------|------------------|-------------------------------------|-------------------|------------------------|-------------------------|------------------|--------------------------|-----------|-----------------------|-------------------|-------------------|
|                                                                                                               |                 | Total             | Cultivated land |             |          |                                          | Other agricultural land |               |              |             |            |                  |                                     |                   |                        |                         |                  |                          |           |                       |                   |                   |
|                                                                                                               |                 |                   | Subtotal        | Paddy field | Dry land | Adjustable water surface for aquaculture | Subtotal                | Forestry land | Young forest | Drying yard | Rural road | Breeding surface | Land for farmland water conservancy | Subtotal          | Industrial mining land | Land for transportation | Special-use land | Land for rural residents |           | Other unutilized land | Exposed soil land | Wild grass ground |
| Land for production plant                                                                                     | 198.01          | 149.06            | 102.45          | 16.70       | 38.06    | 47.69                                    | 46.59                   | 34.93         | 4.92         | 3.10        | 0.89       | /                | 2.75                                | 22.91             | 3.11                   | 0.47                    | 2.95             | 16.37                    | 26.04     | 23.18                 | 1.21              | 1.65              |
| Compensated land for relocated houses                                                                         | 18.29           | 18.29             | 18.29           | /           | 18.29    | /                                        | /                       | /             | /            | /           | /          | /                | /                                   | /                 |                        |                         |                  |                          | /         |                       |                   |                   |
| Land for slag stockpile                                                                                       | 20 (salt field) | /                 |                 |             |          |                                          |                         |               |              |             |            |                  |                                     | /                 |                        |                         |                  |                          | /         |                       |                   |                   |
| Total                                                                                                         | 236.3           | 167.35            | 120.74          |             | 56.35    |                                          | /                       |               |              |             |            |                  |                                     | /                 |                        |                         |                  |                          | /         |                       |                   |                   |
| Total land expropriated for the project=production plant+compensated land for relocated houses+slag stockpile |                 |                   |                 |             |          |                                          |                         |               |              |             |            |                  |                                     |                   |                        |                         |                  |                          |           |                       |                   |                   |

**Table 10.1-2**

**Relocation Details for the Project**

| Nature of relocation                                                      | Name of relocated parties                  | Quantity                                                 |
|---------------------------------------------------------------------------|--------------------------------------------|----------------------------------------------------------|
| Relocation within the plant area                                          | Tianliao Village                           | 600 people of 191 households                             |
|                                                                           | Pokoutang Village                          | 36 people of 6 households                                |
|                                                                           | Beimu Village                              | 337 people of 96 households                              |
|                                                                           | Haishanba Village                          | 3 people of 1 household                                  |
|                                                                           | Nanle Primary School                       | 1                                                        |
|                                                                           | Office building of Nanle Village Committee | 1                                                        |
|                                                                           | Communication base station of China Mobile | 1                                                        |
|                                                                           | Tianliao Village Brick Plant               | 1                                                        |
|                                                                           | Communication base station of China Unicom | 2                                                        |
|                                                                           | Tomb                                       | 1100                                                     |
|                                                                           | Subtotal                                   | 976 people of 294 households, 6 buildings and 100 tombs  |
| Relocation within environmental protection distance beyond plant boundary | Beimu Village                              | 568 people of 166 households                             |
|                                                                           | Haishanba Village                          | 243 people of 53 households                              |
|                                                                           | Yaxi Village                               | 203 people of 45 households                              |
|                                                                           | Xinwupo Village                            | 160 people of 52 households                              |
|                                                                           | Pokoutang Village                          | 96 people of 52 households                               |
|                                                                           | Subtotal                                   | 1270 people of 368 households                            |
| Total                                                                     |                                            | 2246 people of 662 households, 6 buildings and 100 tombs |

### **10.1.2 Land acquisition and relocation settlement plan and relocation implementation particulars for the project**

If the acquisition of large area of land for the project is not well done, there will be significant negative impact generated on production and living of peasants whose land is acquired or residents who are relocated, which may therefore lead to issues like social instability. Beihai Government, where the project is based, attaches high importance to land acquisition and relocation compensation as well as migrant settlement for the project, and has established a dedicated office for land acquisition and relocation for Beihai Forestry, Pulp and Paper Integration Project, for the purpose of reinforcing management on land acquisition and relocation for the above project, and maintaining legal rights of land user, relocated company and people of which the land is acquired, to ensure the project is carried out successfully. The office made Implementation Particulars of Land Acquisition and Relocation for Beihai Forestry, Pulp and Paper Integration Project (hereinafter called "Particular". Refer to Appendix 20) (May 14, 2007) and Relocation Settlement Plan for Beihai Forestry, Pulp and Paper Integration Project (hereinafter called "Plan") (June 8, 2007), according to related national and local regulations as well as local reality.

Land acquisition and relocation for Beihai Forestry, Pulp and Paper Integration Project is carried out under uniform direction of city committee of CPC and Beihai government, and implemented by the government of Tieshan Port Area and Beihai Bureau of Land and Resources.

Follow the regulation in the Particular and Plan for land acquisition and relocation settlement within the plant area and project environmental protection distance. Compensated land for relocated houses is all arranged in Honghuagen Village under Binchi Village Committee.

Details of the Particular and Plan are described as below:

#### **10.1.2.1 Land acquisition and relocation plan for the project**

##### **1. Method and details of relocation settlement**

For relocation settlement, monetary compensation and compensated land for relocated houses are both used, mainly including:

(1)Monetary compensation. Based on investigation, registration and confirmation of the houses and other ground attachment of the indemnitee, the indemnitor and indemnitee enter into a house relocation indemnity agreement under which the indemnitor pays compensation to the indemnitee for house and other ground attachment. Refer to the Particular for indemnity standards.

(2)Settlement by compensated land for relocated houses. According to the house relocation indemnity agreement between the indemnitor and indemnitee, if the indemnitee requires compensated land for relocation, the indemnitor shall arrange all such land in a compensated quarter, 20m<sup>2</sup> per capita and not exceeding 100 m<sup>2</sup> for each household. Site of compensated quarter shall be selected by the indemnitor according to general land utilization plan and urban construction plan in uniform design, with three supplies and one leveling (supply of water, electricity and road and leveled ground). The indemnitee shall build the house by own according to the plan.

(3)Monetary settlement for compensated land. For those qualified for compensated land, if the indemnitee requires monetary settlement instead of compensated land, indemnity shall be made based on evaluated compensation for the indemnitee's house as well as corresponding compensated land, without offering compensated land.

(4)Transitional settlement for relocation. Combination of self support and governmental aid. For those who arrange transitional housing on their own, the indemnitor shall disburse one-off temporary transitional settlement allowance and relocation subsidy, RMB 250 for each household as temporary transitional settlement allowance and RMB 500 for each household as relocation subsidy for each month (on 12-month basis); for those who cannot arrange transitional housing on their own, the indemnitor shall build transitional houses in the compensated quarter without disbursing temporary transitional settlement allowance.

As for office buildings of collective economic organizations like village committee and villager community, common good houses and school houses, follow the above method and standards for indemnity and settlement.

## 2. Site of relocation settlement and process of settlement implementation

The compensated land for relocation lies in Honghuagen Village under Binchi Village

## Committee of Xinggang Town in Tieshan Port Area.

Relocation settlement is planned to be performed from April 20 to Sept. 30 in 2007. However, due to issues of project argumentation and preparations for report of land acquisition for approval, relocation has not been implemented up to now.

Now preparations for land acquisition for plant area and compensated land are still going on. Pre-announcement for land acquisition has been released. Investigation and confirmation is being made on the ownership, land type and area, ownership, category and quantity of ground attachment that are planned to be acquired. Some land acquisition agreement and relocation agreement have been entered into. Investigation and confirmation before reporting for approval and hearing of land acquisition are estimated to be done before the end of December in 2007. Land acquisition in the plant area will be implemented after the modification proposal to the general plan for utilization of project land and land acquisition are approved in a legal process.

Relocation within the environmental protection distance is proposed to be launched after project construction kicks off within the forestry, pulp and paper plant area, and finished before forestry, pulp and paper production line is officially put into use. Relocation includes: investigation, registration and confirmation on houses and other ground attachment, entering into relocation agreement and disbursing indemnity, completing design of compensated quarter and acquisition of compensated land, starting construction of compensated houses, etc.

### 3. Related policies and measures

Beihai Government adopts other policies and measures relating to social insurance and employment, on the basis of monetary indemnity and settlement by compensated land to the indemnitee.

(1)Policy of changing the status from rural residents to urban residents. For those qualified, change their status from rural residents to urban residents so that they can enjoy the rights and benefit of urban residents.

(2)Policy of subsistence allowance. For those relocated people with living difficulty and qualified for subsistence allowance, offer the allowance to them.

(3)Policy of re-employment favor. Relocated indemnitees are exposed to



community management for unemployed people, free re-employment training, and those who seek for jobs on their own can enjoy tax-reduction policy for re-employment of un-employed people.

(4)Employment policy. Endeavor to procure Beihai Government approves to provide common good positions, coordinating with investors to provide logistic service positions. Provide strong support on relocated people engaged in labor and social service, as well as guidance from agriculture and fishery to labor work and business. Xinggang Town Government of Tieshan Port Area shall establish a professional service company that organizes relocated people and provide employment opportunities around project construction, including construction, transportation and catering. Labor and social insurance authorities shall conduct skill training on knowledgeable and educated youth and recommend them to related enterprises in the city.

#### 10.1.2.2 Implementation particulars for land acquisition and relocation

Refer to Appendix 20 –Implementation Particular for Beihai Forestry, Pulp and Paper Integration Project, for supplementary standards on all types of land and attachment to be acquired and relocated.

#### 10.1.3 Compensation plan for occupied cultivated land and farmland

##### 10.1.3.1 Compensation plan for occupied cultivated land

The project occupies a total area of cultivated land up to 120.74 hm<sup>2</sup> (102.45 hm<sup>2</sup> for plant area and 18.29 hm<sup>2</sup> for compensated land for relocated houses), including basic farmland of 46.25 hm<sup>2</sup>. According to national requirement of “one occupied, one compensated”, Beihai Bureau of Land and Resources and Planning Institute of Land and Resources of Guangxi Zhuang Autonomous Region completed the *Modification Proposal to General Plan of Land Utilization for the 900kt/a Pulp, 900kt/a Paper and Paperboard Project of Stora Enso (Guangxi) Forestry, Pulp and Paper Co., Ltd* in November 2007. This proposal provides compensation for the cultivated land and basic farmland occupied by the plant area of 198.01 hm<sup>2</sup>, excluding the compensated land for relocated houses of 18.29 hm<sup>2</sup>. Compensated land for relocated houses shall be incorporated into land utilization plan of Tieshan Port Area of Beihai for unified compensation. Other land shall be arranged according to the modification proposal. The following is the compensation plan for cultivated land occupied by the project:

##### (1)Compensation plan for cultivated land

The 102.4509 hectares of new cultivated land in the land reclamation project of Daxin

Village, Wujia Town, Hepu County, accepted and confirmed by the Department of Land and Resources of Autonomous Region (No. 53 GSLRR [2005]), shall be used as compensation for the cultivated land occupied by the project construction.

## (2) Compensation plan for farmland

Among the land for Beihai Forestry, Pulp and Paper Integration Project, the cultivated land of 46.2560 hm<sup>2</sup> belongs to the basic farmland of Xinggang Town (including the paddy field of 45.3989 hm<sup>2</sup> and dry land of 0.8571 hm<sup>2</sup>). In order to guarantee successful implementation of the project, occupied basic farmland is adjusted into general cultivated land in the modification proposal.

To ensure that the protection area and quality of the basic farmland do not decline, it is proposed to designate 46.2560 hectares of cultivated land (including the paddy field of 44.3200 hm<sup>2</sup> and dry land of 1.9360 hm<sup>2</sup>) as basic farmland for Santang Village of Nankang Town, from the land marked with F-49-87-31 and protection number of GDA-01-005 and GDA-01-002 in Santang Village of Nankang Town.

Through the compensation plan for occupied cultivated land and basic farmland, the area of cultivated land occupied by the Beihai Forestry, Pulp and Paper Integration Project is equivalent to that of the compensated cultivated land of Wujia Town Hepu County, and the area of occupied basic farmland is equivalent to that of compensated basic farmland of Nankang Town, so the area of cultivated land and basic farmland within Tieshan Port Area of Beihai remains the same.

The project occupies a large area of farmland, so it must be reported for approval according to related national regulations, and can be started only when the approval document is acquired from land authorities.

## 10.1.4 Analysis of impact by land acquisition and relocation

### 10.1.4.1 Information on village committees concerned with land acquisition and relocation

Project land acquisition and relocation is concerning Nanle and Potou Village Committee, for which the area of cultivated land per capita is higher than the average of Guangxi (0.057hm<sup>2</sup>) in 2006, and that of Binchi Village Committee is slightly lower than that of Guangxi. Net income per capita of peasants is higher than that of Guangxi (RMB 2,771). Refer to Table 10.1-3 for basic information of the three village committees.

**Table 10.1-3 Information of Village Committees for Land Acquisition  
and Relocation by the End of 2006**

| Project                                              | Nanle Village Committee                         | Binchi Village Committee          | Potou Village Committee           | Xinggang Town                                                                   |
|------------------------------------------------------|-------------------------------------------------|-----------------------------------|-----------------------------------|---------------------------------------------------------------------------------|
| Villager community                                   | 14                                              | 17                                | 13                                | 258                                                                             |
| Natural village                                      | 8                                               | 7                                 | 10                                | 121                                                                             |
| Household                                            | 605                                             | 680                               | 543                               | 11498                                                                           |
| Total population                                     | 2510                                            | 2731                              | 2197                              | 47611                                                                           |
| Land area(hm <sup>2</sup> )                          | /                                               | /                                 | /                                 | 11000                                                                           |
| Including: cultivated land(hm <sup>2</sup> )         | 155.0                                           | 149.0                             | 280.0                             | 2805                                                                            |
| cultivated land per capita(hm <sup>2</sup> )         | 0.062                                           | 0.055                             | 0.127                             | 0.059                                                                           |
| Peasant net income per capita(yuan)                  | 3389                                            | 3327                              | 335 4                             | 3527                                                                            |
| Residential area per capita in town(m <sup>2</sup> ) | N/A                                             | N/A                               | N/A                               | 30.0                                                                            |
| Resident income source                               | Sea water breeding; plantation of cassava, etc. | Plantation of cassava, cane, etc. | Plantation of cassava, cane, etc. | Sea water breeding; plantation of cassava, cane; working in other regions, etc. |

#### 10.1.4.2 Impact of land acquisition on agricultural production

149.06hm<sup>2</sup> of agricultural land (including 102.45hm<sup>2</sup> of cultivated land) of Nanle Village Committee is occupied for project plant area, and 18.29hm<sup>2</sup> of agricultural land (dry land) of Binchi Village Committee for compensated land. It reduced 35.3% of cultivated land of Nanle Village Committee and 12.3% of cultivated land of Binchi Village Committee.

Therefore, national policy of “highly treasure, appropriately utilize land and protect cultivated land” must be abided by for economic construction, to handle the relation between economic development, protection of cultivated land and construction of ecological environment; according to the features of land resources and land supply capability, based on local reality, reinforce general coordination of land development, utilization, protection and regulation, integrate land development with protection, and facilitate intensive utilization and optimized allocation of land resources; in the premise ecological environment is protected and improved, reinforce land consolidation and re-cultivation, and develop backup land resources to secure the goal of cultivated land conservancy specified in the plan, and ensure sustainable social and economic development. Beihai Bureau of Land and Resources, Planning Institute of Land and Resources of Guangxi Zhuang Autonomous Region made compensation for the cultivated land and farmland related with the project, to maintain the target volume of cultivated land and farmland in Beihai, optimize quality and layout, beneficial to implementation of land development, consolidation and planning for Beihai.

#### 10.1.4.3 Impact of land acquisition and relocation on migrants

The project is involved with 2246 people of 662 households to be relocated, and 60224 m<sup>2</sup> of residential buildings. The migrants have lived for dozens of years in the area. According to the Plan, the settlement site for migrants is situated at Binchi Village of Xinggang Town, around 1km from the north of project plant boundary, as vicinal settlement. There is no big change to their living surrounding and they will be familiar with the new settings soon. Migrants are entitled to monetary compensation or compensated houses as stipulated in the Particular. But based on the 20m<sup>2</sup> compensated area per capita and 100 m<sup>2</sup> for each household, which is lower than the housing area per capita in Guangxi rural area in 2006 (29.6 m<sup>2</sup>), most peasants believe the compensation amount or the compensation area is too low and small, in public survey.

Since the farmland of relocated peasants are nearby their living area, and most relocated people are also those subject to land acquisition, as long as the indemnitor makes indemnity according to the Plan and Particular, their life will not be affected too much. And the government accelerates settlement to motivate indemnities, and adopts other policies and measures relating to social insurance and employment on the basis of monetary compensation and compensated land, providing guarantee for their life and re-employment.

#### 10.1.4.4 Other impact by land acquisition and relocation in the plant area

For land acquisition in the plant area, the following needs to be relocated: Nanle Primary School, office building of Nanle Village Committee, a communication base station for China mobile, Tianliao Village Brick Plant, two communication base stations for China Unicom, 1100 tombs.

As for office buildings of collective economic organizations like village committee and villager community, common good houses and school houses, follow the Particular for compensation. And for tomb relocation, take into full consideration the culture and custom of Tieshan Port Area to minimize social impact.

#### 10.1.4.5 Impact of compensated quarter construction on the environment

##### 1. Land use for compensated quarter

According to the relocation settlement plan, the settlement site shall be selected by the indemnitor according to general land utilization plan and urban construction plan in uniform design, with three supplies and one leveling (supply of water, electricity and road and leveled ground). The indemnitee shall build the house by own according to the plan.

The compensated quarter for the project is selected at residential area in General Plan for Tieshan Port Area, a dry land in Honghuagen Village under Binchi Village Committee in Xinggang Town which is around 1km from the northwest of project cassava, cane plant boundary, in the upwind direction of the project plant site and beyond the distance for environmental protection. The land is cultivated land (dry land), with relatively even and broad terrain, now planted with cassava, cane, etc. Site selection for compensated quarter is basically rational.

## 2. Impact of compensated quarter on the environment

The impact of compensated quarter construction on the environment includes the impact on the environment by quarter construction and use after completion.

The project of three supplies and one leveling shall be managed by the government for around 3 months. Major impact comes from dust, construction noise. Since the construction period is short, the impact does not take long. After the above project is completed, the compensated houses shall be built by indemnities on their own. In similarity to residents in Guangxi urban area, small machine is used for such construction, so the impact of construction dust and noise is relatively small and mild.

The project involves the relocation of 2246 residents in all. The compensated quarter belongs to rural area, now without facilities like sewage pipeline network, sewage treatment plant and domestic garbage transfer station. After the quarter is built up for use, based on 200L per capita per day for domestic sewage, 80% drainage, and 0.7kg per capital per day for domestic garbage, the generated sewage will be around 294m<sup>3</sup>/d; and generated domestic garbage will be around 1287kg/d. If these are directly discharged without treatment, the environment will be polluted. According to the reality in the rural area, domestic sewage can be used for agricultural irrigation after treatment in a septic tank, and domestic garbage can also be used for agricultural purpose after wet compost, for the good of comprehensive utilization and mitigating impact on the environment.

In summary, Beihai Government has formulated detailed Particular and Plan according to related national regulations and standards for compensation of project land acquisition and resident relocation. As long as indemnitor performs compensation and settlement for relocated residents well under such regulations, the production and life and relocated residents will not be affected measurably or for long.

## 10.2 Regional Socio-Economic Impact Assessment

The socio-economic impact of the project will not be limited to the directly affected City of Beihai, it will spread to the whole Guangxi Province and even the whole country.

The Forestry-Pulp-Paper Integration Project of Stora Enso (Guangxi) Forestry-Pulp-Paper Co. Ltd, is designed to have an annual output of 900,000 tons of pulp, 900,000 tons of paper and paperboard. Total profits of the project amounts to RMB ----- with an income tax paid up to RMB ---. The operation of the project not only brings annual increases to national and local fiscal revenues, but also significantly promotes regional and local economic development through improved employment, local revenues, and the development of the tertiary industry, agriculture, and other industries.

### 10.2.1 Impact Assessment of the Project on Guangxi's Economy

At present, China is at a stage of accelerated industrialization medium-term, with per capita GDP reaching 1,000 U.S. dollars in 2002. But the Guangxi Zhuang Autonomous Region is still in the initial stage of industrialization, with 2004 per capita GDP just over 800 U.S. dollars. In terms of supply and demand, it is of a "shortage economy", lacking in regional effective supply and product competitiveness. Financially, Guangxi expenditure amounted to over 500 million in the year of 2004, but the available was merely 23 billion Yuan. On the market, not only the high-end category, but also the low-end products are mostly produced outside the region. Its domestic trade deficit amounts to billions of Yuan. In terms of the system, the level of marketization is low, typically a planned economy. While the dependence on foreign imports and exports amounts to 701% on a national level, Guangxi is less than 10%. Looking into the near future, the world economy is about to enter a new growth cycle. China's economy will enjoy sustained and rapid development. Guangxi is also faced with good opportunities for development. By giving full play to regional advantages on the basis of further reforms and opening-up and improvement of overall quality and efficiency of national economy, the regional economy should be able to maintain rapid growth in many years to come.

Guangxi is rich in resources and the conditions are ripe for Aluminum, Manganese, Forestry-Pulp-Paper and Automobile industries to develop and thrive. Only by concentrating on the development of large-scale industries is it possible for effective

conservation of resources and energy and for sustainable development to take hold. It is also indispensable for the rapid formation of industrial clusters and the development of small and medium-sized companies. Therefore, raising total economic output is the major agenda of the "11<sup>th</sup> Five-Year Plan" of Guangxi, which lays emphasis on the development of market-based, resource-type large-scale industries.

Stora Enso (Guangxi) Forestry-Pulp-Paper Integration Project, is the focus of industrial development in Guangxi. The project completed will become the largest papermaking forest base in Guangxi and even the world as a whole. The grade, quality of products, its technology and management would be of world-advanced. It will play a leading role for companies in the region to walk on the road of advanced production and management and encourage them to develop in scale.

The development of paper industry, not least due to its relationship with upstream and downstream products and the effect of its horizontal proliferation, has a tremendous effect on the national economy. The contribution to the national economy by its activation effect even exceeds that of its direct products, which is mainly reflected in:

(1) Effect on development of upstream products

All kinds of raw and auxiliary materials, production equipment and related product support are indispensable for the Paper industry as a comprehensive industry, the provision of which relies on a whole set of upstream industries as agriculture/forestry, machinery, used paper, pulp, chemicals, water, electricity, gas, coal, etc.

(2) Effect on development of downstream products

Over 80% of products of the paper industry goes to the press, publication, printing, packaging and other industries, and only less than 20% are directly purchased by consumer. The effect of the paper industry on its downstream companies is conspicuous.

(3) Effect on other related industries

The construction and operation of the Project will increase population, permanent and mobile, of the region. This in turn will stimulate development of the tertiary industries as postal communications, information, finance, transport, hotels, catering, commercial, and the service sector; increase employment opportunities and improve people's standard of living.

With the completion of the project, the total local economic output will increase and will be conducive to people's living standards. Public demand for services will also move toward

high-speed, high-quality and the service sector move in the direction of marketization, industrialization and socialization.

Due to the construction of the project, transport industry will be rapidly developed; firstly, for the needed raw materials and product transport, followed by transportation of people and goods due to economic development

### **10.2.2 Impact on the lives of local residents**

(1) In the construction phase of the project, local workers, organized by government, can participate in the project and increase their income. After the completion of the project, some residents could be offered employment. At the same time, and as a result of this Project, the development of other industries such as postal communications, information, finance, transport, hotels, catering, commerce, construction, agriculture (forestry), transport and the services sector will indirectly bring more employment opportunities to local residents, reduce social burden and pressure on employment, and is conducive to social stability.

(2) The large-scale activation of the Project calls for the development of a Forestry-Pulp-Paper base, on a mode of operation of company + base + farmers, which encourage farmers to plant fast-growing forests as paper-making raw material, increase their income, and help them on the road to prosperity.

(3) The Project will cause accelerated population growth, enhance living standard, which create demand for agricultural products, increase the value of land in surrounding area, stimulate farmers to seek more ways to improve unit productivity and quality of grain, cash crops and agricultural by-products. Although the project takes up some agricultural land and some farmers in a short time span are subjected to a certain degree of disturbance by having to leave their cultivated land and relocate, they are offered land compensation, given priority to employment, and benefits if they are to engage in service sector as well as license for reclamation of barren hills and wasteland. The life of farmers whose land is taken will not be much affected. Looking in the long run, the living standard of local residents will improve as the project being implemented.

(4) In the short-term, rapid population growth will inevitably lead to a certain degree of strain on urban infrastructure and public service facilities such as local educational facilities, medical and health service facilities, urban water supply, garbage and sewage treatment, public security, fire prevention and recreational facilities. The pressure may



make residents feel the quality of life taking a down-turn, which situation may extend for a period of time. However, this situation will change along with economic development and increased local revenue which will allow more capital investment in urban infrastructure and public services and eventually lead to improvement and a better living environment for urban residents and speed up the process of urban development. It will be temporary of the indirect effect by the construction of the Project to the quality of local life.

As already stated, the Forestry-Pulp-Paper integration Project of Stora Enso (Guangxi) will produce a certain degree of strain on local urban infrastructure facilities and public services, affect the quality of local life, but it is limited and temporary. In the long run, the project after commissioning directly increases the total economic output and local financial revenue, resulting in more capital investment in urban infrastructure and public services sector and improvement of urban living environment, conducive to raising the living standard of local residents and their quality of life.

### **10.3 Summary**

To sum up, the direct social impact of the Stora Enso (Guangxi) Forestry-Pulp-Paper integration Project is agricultural land requisition and relocation of farmers. Beihai municipal government, in accordance with relevant state regulations and standards on land requisition, demolition compensation and resettlement, has instituted detailed implementation "Rules" and "Program". As long as these are adhered to, and a good job is done on demolition compensation and resettlement, the life and production activity of families to be relocated will not be greatly affected, not over a long period. At the same time, the project brings tremendous indirect social impact. It is of great significance to the easing-up of pulp wood supply and demand contradiction in the country for the next ten years. This also holds true for the overall development of pulp and paper-making technology and equipment, for improving the quality of paper and cardboard products and for revitalizing the economy of Guangxi. The project directly increases local total economic output and national and local fiscal revenue, and indirectly promotes the development of other related industries, increase employment opportunities, and help improve the living standards of local residents and the quality of life.

## 11 Other Environmental Impact Prediction and Evaluation

### 11.1 Sound Environment Impact Prediction and Evaluation

#### 11.1.1 Source Strength of Noise Sources in the Project

The main sound sources of the proposed project are the operation noises of production equipment and the traffic noises caused by the transportation of materials such as raw materials and products. See Table 11.1-1 for the source strength of main noise sources of production systems in various phases of the proposed project.

**Table 11.1-1 List of Main Equipment causing Noises in the Proposed Project and their Noise Levels**  
**Unit: Leq[dB(A)]**

| Workshop                          | Noise source                              | Noise level | Construction time |
|-----------------------------------|-------------------------------------------|-------------|-------------------|
| Raw material preparation workshop | Chipper                                   | 104.0       | Phase I Project   |
|                                   | Wood chip machine                         | 91.0        | Phase I Project   |
| Pulp-making workshop              | Circulating pump, water pump              | 85.0~90.0   | Phase I Project   |
|                                   | Black liquor pump, pulp pump              | 84.0~88.0   | Phase I Project   |
|                                   | Knotter, pressure screen original machine | 85.0~90.0   | Phase I Project   |
|                                   | Pulp pump                                 | 84.0~88.0   | Phase I Project   |
| Pulp board workshop               | Wire section, press section               | 92.0~97.0   | Phase I Project   |
|                                   | Pulp pump, water pump                     | 84.0~88.0   | Phase I Project   |
|                                   | Vacuum pump                               | 95.0~100.0  | Phase I Project   |
|                                   | Refrigerator                              | 96.0        | Phase I Project   |
| Cardboard workshop                | Hydrabrusher                              | 95.0        | Phase II Project  |
|                                   | Pulp pump                                 | 85.0~88.0   | Phase II Project  |
|                                   | Desander                                  | 90.0        | Phase II Project  |
|                                   | Fluffer                                   | 92.0        | Phase II Project  |
|                                   | Disc grinder                              | 96.0~107.0  | Phase II Project  |
|                                   | Fan pulp pump                             | 85.0~88.0   | Phase II Project  |
|                                   | Vacuum pump                               | 85.0~90.0   | Phase II Project  |
|                                   | Fourdrinier section                       | 92.0~97.0   | Phase II Project  |
|                                   | Drying section                            | 87.0~94.0   | Phase II Project  |
|                                   | Calender                                  | 95.0~100.0  | Phase II Project  |
|                                   | Air compressor                            | 90.0~110.0  | Phase II Project  |
| Paper-making workshop             | Hydrabrusher                              | 95.0        | Phase III Project |
|                                   | Pulp pump                                 | 85.0~88.0   | Phase III Project |
|                                   | Desander                                  | 90.0        | Phase III Project |
|                                   | Fluffer                                   | 92.0        | Phase III Project |
|                                   | Disc grinder                              | 96.0~107.0  | Phase III Project |
|                                   | Fan pulp pump                             | 85.0~88.0   | Phase III Project |
|                                   | Vacuum pump                               | 85.0~90.0   | Phase III Project |
|                                   | Fourdrinier section                       | 92.0~97.0   | Phase III Project |
|                                   | Drying section                            | 87.0~94.0   | Phase III Project |
|                                   | Calender                                  | 95.0~100.0  | Phase III Project |
|                                   | Air compressor                            | 90.0~110.0  | Phase III Project |

**Table 11.1-1 List of Main Equipment causing Noises in the Proposed Project and their Noise Levels (Continued)**  
**Unit: Leq[dB(A)]**

| Workshop                         | Noise source                                | Noise level | Construction time |
|----------------------------------|---------------------------------------------|-------------|-------------------|
| Alkali recovery workshop         | Black liquor pump, water pump               | 84.0~88.0   | Phase I Project   |
|                                  | Blower                                      | 95.0        | Phase I Project   |
|                                  | Induced draft fan                           | 100.0       | Phase I Project   |
|                                  | Green liquor pump, water pump               | 84.0~88.0   | Phase I Project   |
|                                  | White liquor pump                           | 84.0~88.0   | Phase I Project   |
|                                  | Mud filter                                  | 85.0~90.0   | Phase I Project   |
|                                  | Blower, induced draft fan                   | 90.0        | Phase I Project   |
| Chemical plant                   | Medical solution pump                       | 84.0~88.0   | Phase I Project   |
|                                  | Water pump                                  | 84.0~88.0   | Phase I Project   |
| Thermal power plant              | Induced draft fan                           | 85.0        | Phase II Project  |
|                                  | Fan                                         | 90.0        | Phase II Project  |
|                                  | Water supply pump                           | 85.0~90.0   | Phase II Project  |
|                                  | Steam turbine                               | 90.0        | Phase II Project  |
|                                  | Medium-pressure/Low-pressure exhaust outlet | 88.0        | Phase II Project  |
|                                  | Generator and exciter                       | 90.0        | Phase II Project  |
| Sewage treatment station         | Blower                                      | 90.0        | Phase I Project   |
| Cooling water circulation system | Cooling tower                               | 80.0        | Phase I Project   |

**11.1.2 Sound Environment Prediction Distance and Mode in the Plant Site of the Proposed Project**

The general layout of the proposed project is laid as a rectangle. According to production process, main high-noise equipment and machine rooms are placed in the central and northwest part of the plant site. Table 11.1-2 [removed] and Fig. 11.1-1 [removed]

There are 5 residential areas within 200m away from the plant boundary, which are Yaxi Village 100m away from north boundary, Haishan Dam 80m away from north boundary, Xinwupo 40m away from west boundary, Pokoutang 200m away from west boundary and the Beimu Village 20m away from south boundary. Therefore, the evaluation shall predict the impacts of project noise sources in normal production conditions on the plant boundary and 5 noise sensitive points, and superpose them with the current values. The impact level of noises in the proposed project on plant boundary and environmental noise sensitive points shall be shown in the analysis on the superposition result. The prediction shall adopt the calculation formula, which is based on the theory that the spot sound source attenuates with the increase of propagation distance.

Prediction mode:

The calculation is based on indoor and outdoor sound sources.

(1) Indoor sound source

a. Calculate an indoor octave band sound pressure level near the enclosure structure:

$$L_{oct,1} = L_{w_{oct}} + 10 \lg \left( \frac{Q}{4\pi r_1^2} + \frac{4}{R} \right)$$

Wherein:  $L_{oct,1}$  is the octave band sound pressure level caused by an indoor sound source near enclosure structure;  $L_{w_{oct}}$  is the octave band sound power level of a sound source;  $r_1$  is the distance between an indoor sound source and adjacent enclosure structure;  $R$  is the room constant;  $Q$  is the direction factor.

b. Calculate the total octave band sound pressure level caused by all indoor sound sources near the enclosure structure:

$$L_{oct,1}(T) = 10 \lg \left[ \sum_{i=1}^N 10^{0.1 L_{oct,1(i)}} \right]$$

(2) Outdoor sound source

Prediction mode:

$$L_2 = L_1 - 20 \lg \frac{r_2}{r_1} - \Delta L$$

Wherein:  $L_2$  – the sound pressure level caused by spot sound source at prediction point;  
 $L_1$  – the sound pressure level caused by spot sound source at reference point;  
 $r_2$  – the distance between reference point and sound source;

$\Delta L$ —the attenuation amount caused by various factors (including those caused by sound barrier, air absorption, etc.)

In the case that more than two sound sources are present at the same time, the total octave band sound pressure level at prediction point is calculated as per the following formula:

$$Leq = 10 \log \left( \sum_{i=1}^n 10^{0.1L_i} \right)$$

Wherein:  $L_{eq}$  — Total equivalent sound level at prediction point (dB(A));

$L_i$  — the impact of No. i sound source on the sound level at prediction point (dB(A)).

### 11.1.3 Evaluation Standard

The evaluation of noises at plant boundary follows Class III standard in GB12348-90 *Standard of Noise at Boundary of Industrial Enterprises*, i.e. 65 dB(A) at daytime and 55 dB(A) at nighttime. The noise at sensitive points follows Class III standard in GB3096-93 *Standard of Environmental Noise of Urban Area*, i.e. 65 dB(A) at daytime and 55 dB(A) at nighttime.

### 11.1.4 Impact Prediction and Evaluation

See Table 11.1-3 for the prediction result of noises at plant boundary and Table 11.1-4 for the prediction result of noises at sensitive points. The distribution diagram of noise contribution values after Phase I, Phase II and Phase III Projects are put into production are shown in Fig. 11.1-2 ~ Fig. 11.1-4.

(1) As shown by the prediction result, in the case that no noise prevention and reduction measures are taken, the prediction values of both daytime and nighttime noises at plant boundary can meet the Class III standard in GB12348-90 *Standard of Noise at Boundary of Industrial Enterprises*, after Phase I and II Projects are put into production; the daytime and nighttime noise values at other prediction points can meet the standard, with the exception that the prediction value of nighttime noise at 2# west plant boundary exceeds the standard value (by 0.2 dB(A)), after Phase III Project is completed;

(2) In the case that no noise prevention and reduction measures are taken, the prediction values of environmental noises at the 5 residential areas can meet the Class III standard in GB3096-93 *Standard of Environmental Noise of Urban Area*, after Phase I, II and III Projects are put into production;

(3) After the proposed project is put into production, the individual noise values at plant boundary (in the case that no measures are taken) are increased by 2~10 dB(A) compared with the current noise values in sound environment and the noises at sensitive points in sound environment are increased by 1 -5 dB(A). In general, the construction of the project has a certain impact on the sound environment in the area. However, the

environmental protection and relocation problems are involve to different extents at all sensitive points in sound environment. As per the scope of environmental protection and relocation in the project, there shall be no residential houses within 200m from the plant site after the relocation is completed. Therefore, the impacts on the sound environment in centralized residential areas shall not be significant.

**Table 11.1-3 Noise Prediction Result at Plant Boundary (if no measures be taken)**  
**Unit: dB(A)**

| Name of prediction points             | Current background value |           | Contribution value      |      | Prediction value (superposition) |           | Evaluation result |                    |
|---------------------------------------|--------------------------|-----------|-------------------------|------|----------------------------------|-----------|-------------------|--------------------|
|                                       | Daytime                  | Nighttime |                         |      | Daytime                          | Nighttime | Daytime           | Nighttime          |
| 1 <sup>#</sup> (west plant boundary)  | 40.2                     | 39.7      | After Phase I Project   | 45.5 | 46.6                             | 46.5      | Up to standard    | Up to standard     |
|                                       |                          |           | After Phase II Project  | 50.3 | 50.6                             | 50.6      | Up to standard    | Up to standard     |
|                                       |                          |           | After Phase III Project | 51.5 | 51.8                             | 51.8      | Up to standard    | Up to standard     |
| 2 <sup>#</sup> (west plant boundary)  | 43.0                     | 42.7      | After Phase I Project   | 50.7 | 51.4                             | 51.3      | Up to standard    | Up to standard     |
|                                       |                          |           | After Phase II Project  | 51.0 | 51.6                             | 51.6      | Up to standard    | Up to standard     |
|                                       |                          |           | After Phase III Project | 55.0 | 55.3                             | 55.2      | Up to standard    | Exceeding standard |
| 3 <sup>#</sup> (north plant boundary) | 40.8                     | 39.4      | After Phase I Project   | 49.2 | 49.8                             | 49.6      | Up to standard    | Up to standard     |
|                                       |                          |           | After Phase II Project  | 49.9 | 50.4                             | 50.3      | Up to standard    | Up to standard     |
|                                       |                          |           | After Phase III Project | 50.1 | 50.6                             | 50.5      | Up to standard    | Up to standard     |
| 4 <sup>#</sup> (north plant boundary) | 45.3                     | 43.6      | After Phase I Project   | 48.7 | 50.3                             | 49.9      | Up to standard    | Up to standard     |
|                                       |                          |           | After Phase II Project  | 49.8 | 51.1                             | 50.7      | Up to standard    | Up to standard     |
|                                       |                          |           | After Phase III Project | 50.2 | 51.4                             | 51.1      | Up to standard    | Up to standard     |
| 5 <sup>#</sup> (east plant boundary)  | 39.9                     | 38.9      | After Phase I Project   | 50.4 | 50.8                             | 50.7      | Up to standard    | Up to standard     |
|                                       |                          |           | After Phase II Project  | 51.6 | 51.9                             | 51.8      | Up to standard    | Up to standard     |
|                                       |                          |           | After Phase III Project | 53.2 | 53.4                             | 53.4      | Up to standard    | Up to standard     |
| 6 <sup>#</sup> (east plant boundary)  | 45.1                     | 43.3      | After Phase I Project   | 47.8 | 49.7                             | 49.1      | Up to standard    | Up to standard     |
|                                       |                          |           | After Phase II Project  | 49.5 | 50.9                             | 50.4      | Up to standard    | Up to standard     |
|                                       |                          |           | After Phase III Project | 53.0 | 53.7                             | 53.4      | Up to standard    | Up to standard     |
| 7 <sup>#</sup> (south plant boundary) | 40.6                     | 38.8      | After Phase I Project   | 43.2 | 45.1                             | 44.6      | Up to standard    | Up to standard     |
|                                       |                          |           | After Phase II Project  | 47.0 | 47.9                             | 47.6      | Up to standard    | Up to standard     |
|                                       |                          |           | After Phase III Project | 47.3 | 48.1                             | 47.9      | Up to standard    | Up to standard     |
| 8 <sup>#</sup> (south plant boundary) | 46.0                     | 43.5      | After Phase I Project   | 42.3 | 47.5                             | 46.0      | Up to standard    | Up to standard     |
|                                       |                          |           | After Phase II Project  | 47.0 | 49.5                             | 48.6      | Up to standard    | Up to standard     |
|                                       |                          |           | After Phase III Project | 47.3 | 49.7                             | 48.8      | Up to standard    | Up to standard     |

**Table 11.1-4 Noise Prediction Result at Sensitive Points (with no measures be taken)**  
**Unit: dB(A)**

| Name of prediction point | Current background value |           | Contribution value      |      | Prediction value (superposition) |           | Evaluation result |                |
|--------------------------|--------------------------|-----------|-------------------------|------|----------------------------------|-----------|-------------------|----------------|
|                          | Daytime                  | Nighttime |                         |      | Daytime                          | Nighttime | Daytime           | Nighttime      |
| Pokoutang                | 52.3                     | 47.0      | After Phase I Project   | 45.8 | 53.2                             | 49.5      | Up to standard    | Up to standard |
|                          |                          |           | After Phase II Project  | 50.6 | 54.5                             | 52.2      | Up to standard    | Up to standard |
|                          |                          |           | After Phase III Project | 51.2 | 54.8                             | 52.6      | Up to standard    | Up to standard |
| Xinwupo                  | 52.7                     | 47.9      | After Phase I Project   | 47.5 | 53.9                             | 50.7      | Up to standard    | Up to standard |
|                          |                          |           | After Phase II Project  | 49.7 | 54.5                             | 51.9      | Up to standard    | Up to standard |
|                          |                          |           | After Phase III Project | 50.0 | 54.6                             | 52.1      | Up to standard    | Up to standard |
| Yaxi Village             | 49.5                     | 43.1      | After Phase I Project   | 45.7 | 51.0                             | 47.6      | Up to standard    | Up to standard |
|                          |                          |           | After Phase II Project  | 47.7 | 51.7                             | 49.0      | Up to standard    | Up to standard |
|                          |                          |           | After Phase III Project | 48.1 | 51.9                             | 49.3      | Up to standard    | Up to standard |
| Haishan Dam              | 53.8                     | 44.7      | After Phase I Project   | 47.5 | 54.7                             | 49.3      | Up to standard    | Up to standard |
|                          |                          |           | After Phase II Project  | 48.9 | 55.0                             | 50.3      | Up to standard    | Up to standard |
|                          |                          |           | After Phase III Project | 49.1 | 55.1                             | 50.5      | Up to standard    | Up to standard |
| Beimu Village            | 50.2                     | 45.8      | After Phase I Project   | 42.3 | 50.8                             | 47.4      | Up to standard    | Up to standard |
|                          |                          |           | After Phase II Project  | 46.8 | 51.8                             | 49.3      | Up to standard    | Up to standard |
|                          |                          |           | After Phase III Project | 47.1 | 51.9                             | 49.5      | Up to standard    | Up to standard |



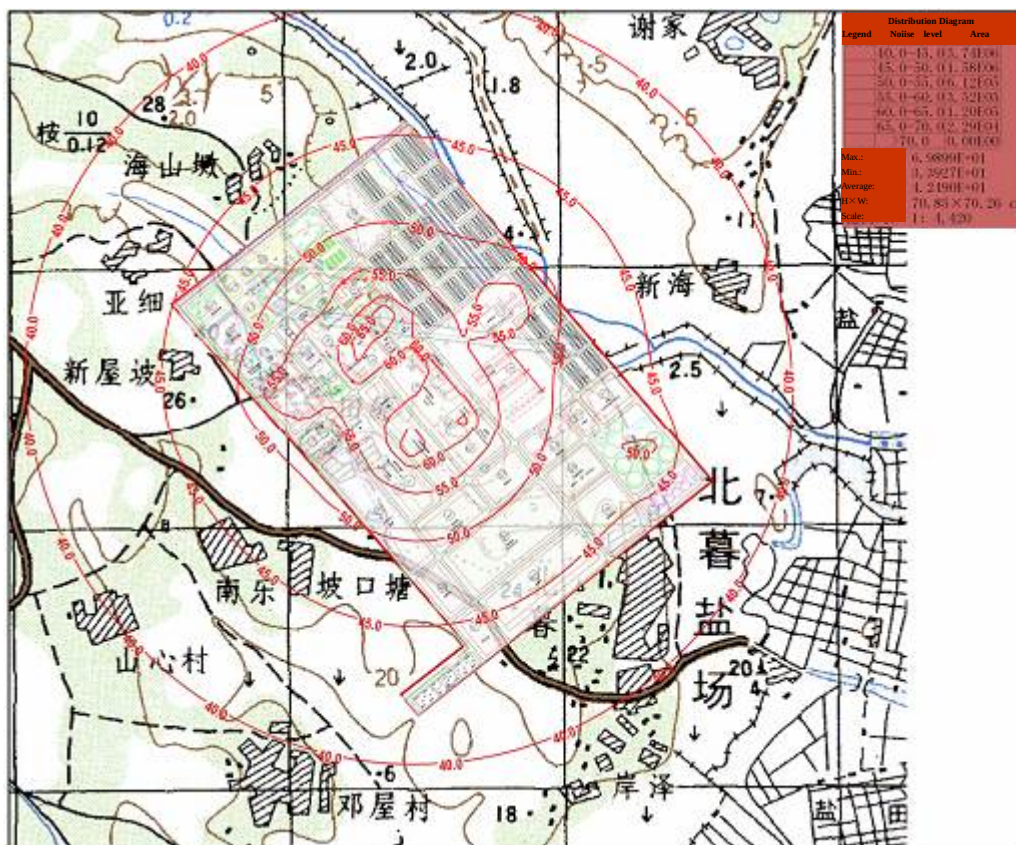


Fig. 11.1-2 Distribution Diagram of Noise Contribution Values after the Completion of Phase I Project

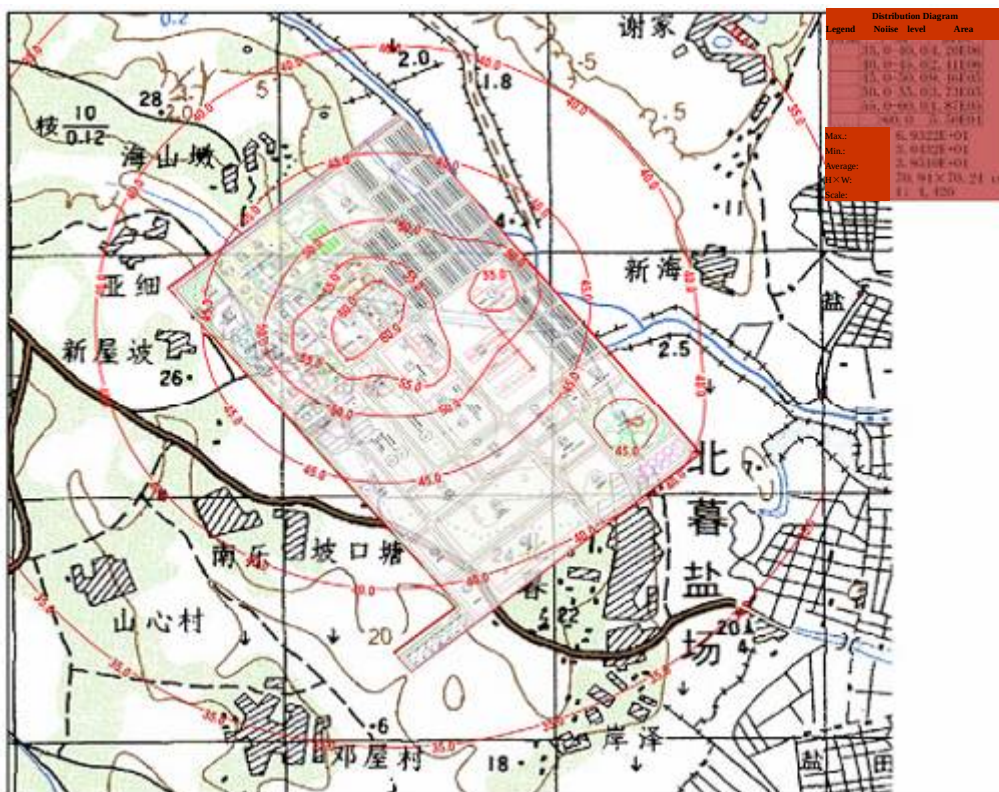


Fig. 11.1-3 Distribution Diagram of Noise Contribution Values after the Completion of Phase I and II Project



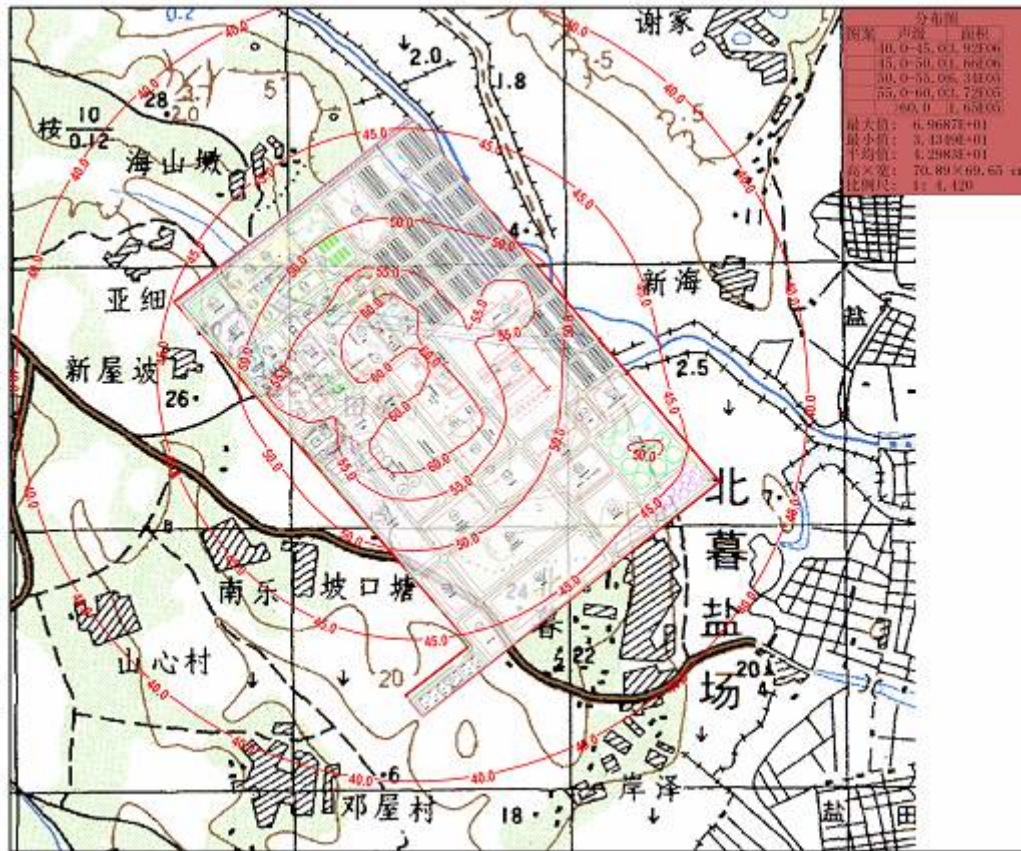


Fig. 11.1-4 Distribution Diagram of Noise Contribution Values after the Completion of Phase I, II and III Projects

## 11.2 Disposal and Impact Analysis of Solid Wastes

### 11.2.1 Characteristics of Solid Wastes and Emission Statistics of the Project

As per the project analysis, the solid wastes generated from the proposed project mainly include the wood wastes produced by raw material preparation workshop, pulp residue produced by pulp-making workshop, the green mud and lime mud produced by alkali recovery workshop, the coal ash slag produced by boilers of thermal power plant, the Class I, II and III sludge produced by sewage treatment station, the polyester nets discarded by paper-making workshop as well as living garbage and construction wastes. The characteristics of solid wastes and statistical results of emissions from the proposed project are shown in Table 11.2-1. Refer to Table 11.2-2 for the analog monitoring over the corrosiveness of green mud. China National Environmental Monitoring Station has made specific analysis of green mud in solid waste, and it is shown by the monitoring result that pH of leachate of green mud in solid waste is 10.54~10.74. Thus, according to the evaluation standard of *Identification Standards for Hazardous Wastes – Identification for Corrosiveness* (GB5085.1-2007), green mud is not corrosive. No mercury and its compounds are identified and the content of lead is less than 0.2mg/L. According to *Identification Standards for Hazardous Wastes – Identification for Leaching Toxicity*, (GB5085.1-2007), the mercury and lead in the waste do not have leaching toxicity. Thus it can be seen that green mud does not belong to hazardous waste but general solid waste (Class II) instead.

**Table 11.2-1 Characteristics of Solid Wastes and Statistical Results of Emissions from the Proposed Project**

| SN | Name of solid wastes         |             | Output (t/a)                 |                              |                              | Property                | Source                   |
|----|------------------------------|-------------|------------------------------|------------------------------|------------------------------|-------------------------|--------------------------|
|    |                              |             | Phase I Project              | Phase II Project             | Phase III Project            |                         |                          |
| 1  | Wood wastes                  |             | 73900<br>(water content 45%) | 73900<br>(water content 45%) | 73900<br>(water content 45%) | General solid           | Raw material preparation |
| 2  | Pulp residue                 |             | 4280<br>(water content 70%)  | 7430<br>(water content 70%)  | 14790<br>(water content 70%) | General solid           | Pulp-making workshop     |
| 3  | Green mud,                   |             | 31080<br>(water content 50%) | 31080<br>(water content 50%) | 31080<br>(water content 50%) | General solid           | Alkali recovery workshop |
| 4  | Lime mud                     |             | 5920<br>(water content 50%)  | 5920<br>(water content 50%)  | 5920<br>(water content 50%)  | General solid           |                          |
| 5  | Coal Ash slag                | Ashes       | /                            | 60000                        | 120000                       | General solid wastes II | Thermal power plant      |
|    |                              | Boiler slag | /                            | 26000                        | 52000                        |                         |                          |
|    |                              | Subtotal    | /                            | 86000                        | 172000                       |                         |                          |
| 6  | Class I mud                  |             | 35357<br>(water content 65%) | 61240<br>(water content 65%) | 93770<br>(water content 65%) | General solid           | Sewage treatment station |
| 7  | Class II mud                 |             | 21737<br>(water content 80%) | 24637<br>(water content 80%) | 30327<br>(water content 80%) | General solid           |                          |
| 8  | Class III mud                |             | 50052<br>(water content 80%) | 46502<br>(water content 80%) | 41402<br>(water content 80%) | General solid           |                          |
| 9  | Living garbage, construction |             | 7080<br>(water content 60%)  | 14160<br>(water content 60%) | 21240<br>(water content 60%) | General solid           | Plant site               |
|    | Total                        |             | 229406                       | 350869                       | 484429                       |                         |                          |

**Table 11.2-2 Analog monitoring over corrosiveness of green mud**

| Factory of analog monitoring        | Date of monitoring                                                                                                                                                                                                                                                           | pH monitoring result |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| Guangxi Heda Pulp & Paper Co., Ltd. | February 20, 2008                                                                                                                                                                                                                                                            | 10.28                |
|                                     | February 21, 2008                                                                                                                                                                                                                                                            | 10.52                |
| Remarks                             | Profile of Heda Pulp & Paper Co., Ltd.: with eucalyptus as raw material, the company adopts sulfate process in pulp making, with a capacity of 70,000t/a, and it employs Displacement Digester System (DDS). It has one alkali recovery boiler with recovery rate up to 90%. |                      |

### 11.2.2 Disposal Measures of Solid Wastes

As per analysis on the project, the wood wastes and Class I sludge shall be sold for comprehensive utilization in Phase I and be utilized as fuel of boilers in Phase II and III; the Class II sludge shall be burned in alkali boiler; the pulp residues shall be sold to small paper-making plants; the living garbage shall be sent to the landfill site in Beihai City for backfilling; the construction wastes shall be sent to the piling site specified by the municipal administration of Beihai City for stacking. The disposal is required for the coal ash slag (ashes and boiler slag), green mud, lime mud and Class III sludge. The disposal measures of solid wastes for the proposed project are shown in Table 11.2-3. The sales agreements of solid wastes are shown in Annex 25 and 26.

**Table 11.2-3 List of Disposal Measures of Solid Wastes for the Project**

| SN | Name of solid wastes |             | Property                | Disposal method                                                                                          | Source                   |
|----|----------------------|-------------|-------------------------|----------------------------------------------------------------------------------------------------------|--------------------------|
| 1  | Wood wastes          |             | General solid wastes I  | To be sold in Phase I as fuel of boilers; to be utilized in Phase II and III as fuel of boilers          | Raw material preparation |
| 2  | Pulp residue         |             | General solid wastes I  | To be sold to local paper-making plants as raw materials.                                                | Pulp-making workshop     |
| 3  | Green mud            |             | General solid wastes II | To be backfilled slag stockpile                                                                          | Alkali recovery workshop |
| 4  | Lime mud             |             | General solid wastes II | To be backfilled slag stockpile                                                                          |                          |
| 5  | Coal ash slag        | Ashes       | General solid wastes II | To be sold to cement mills as auxiliary materials and to be backfilled in slag stockpile.                | Thermal power plant      |
|    |                      | Boiler slag |                         | To be sold to brick plants as auxiliary materials and to be backfilled in slag stockpile.                |                          |
| 6  | Class I mud          |             | General solid wastes I  | To be sent to forestry for fertilizer in Phase I and to be used as fuels of boilers in Phase II and III. | Sewage treatment plant   |
| 7  | Class II mud         |             | General solid wastes I  | To be burned in alkali boiler.                                                                           | Sewage treatment plant   |
| 8  | Class III mud        |             | General solid wastes I  | To be backfilled in slag stockpile.                                                                      | Sewage treatment plant   |
| 9  | Living garbage       |             | General solid wastes I  | To be backfilled in the landfill site in Beihai City.                                                    | Plant site               |
| 10 | Construction wastes  |             | General solid wastes I  | To be placed in the piling site specified by the municipal administration of Beihai City.                | Construction site        |

### 11.2.3 Analysis on the Rationalization of Slag Stockpile Layout

It is proposed to set the slag stockpile for temporarily storage or backfilling of the coal ash slag, green mud, lime mud and Class III sludge which are required to be disposed in the project. The sites of two slag stockpiles at Chijiang and Beimu proposed by the owner are shown in Table 11.2-4.

**Table 11.2-4 Basic Information of two Slag Stockpile Sites at Chijiang and Beimu**

| Name of slag stockpile  | Location                                                                             | Distance to plant site (km) | Area (hm <sup>2</sup> ) | Storage capacity (10000 m <sup>3</sup> ) | Elevation (m) | Mean tidal level (m) | Historical max. tidal level (m) | Service life (years) | Current land use                                                                                                 |
|-------------------------|--------------------------------------------------------------------------------------|-----------------------------|-------------------------|------------------------------------------|---------------|----------------------|---------------------------------|----------------------|------------------------------------------------------------------------------------------------------------------|
| Chijiang slag stockpile | Chijiang, northeast side inside Tieshan Port Offshore Industrial Zone in Beihai City | 11                          | 20                      | 100                                      | 1.5~2.1       | 2.55                 | 5.40                            | 10                   | The land basically is used as the artificially excavated shrimp pools and longitudinal and lateral water ditches |
| Beimu slag stockpile    | Beimu Salt Works, south side of Tieshan Port Offshore Industrial Zone in Beihai City | 0.5                         | 20                      | 100                                      | 1.5~1.8       | 2.55                 | 5.40                            | 10                   | The land mostly is used as the salt fields, and its small part in the west is the shrimp pools.                  |

The analysis on the rationalization of site selection of slag stockpile is as follows:

(1) Comprehensive evaluation on geological hazards in the site

As per the *Evaluation Report on the Risks of Geological Hazards at Construction Site of Spoil Sites for 900,000t Pulp and 900,000t Paper and Paperboards Project of (Guangxi) Pulp-and-Paper Co., Ltd.* by Guangxi Investigation and Design Institute of Geologic Disaster Prevention and Treatment Engineering, the comprehensive evaluation on geological hazards in two slag stockpiles is shown in Table 11.2-4 and the comprehensive evaluation diagrams are shown in Attached Drawing 16 and 17.

**Table 11.2-5 Table of Comprehensive Evaluation on Geological Hazards**

| Name of slag stockpile  | Location                                                       | Area (hm <sup>2</sup> ) | Impacts of project construction on geological environment                                         | Status of geological hazards                                                                                                                                                    | Hazard object | Difficulty level of prevention and treatment | Classification of risks of geological hazards | Classification of applicability of construction land |
|-------------------------|----------------------------------------------------------------|-------------------------|---------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|----------------------------------------------|-----------------------------------------------|------------------------------------------------------|
| Chijiang slag stockpile | About 500m away from the northwest of Chijiang Pottery Factory | 20                      | Causing collapse of foundation ditch, uneven settlement of foundation and ground water pollution. | Two side slope collapse points, located in the position about 0.9km away from the west of Chijiang Pottery Factory and about 0.7km away from the east of Tiantouwu respectively | None          | Relatively difficult                         | High risks                                    | Area with Poor applicability                         |
| Beimu slag stockpile    | Located in Beimu Salt Works in Tieshan Port District           | 20                      | Causing collapse of foundation ditch, uneven settlement of foundation and ground water pollution. | 1 side slope collapse point, located in about 100m away from the east side of Beimu Village.                                                                                    | None          | Relatively easy                              | Medium risks                                  | Area with basic applicability                        |

As shown in the table, the risk of geological hazards in the area of Beimu slag stockpile is lower than that of Chijiang slag stockpile. Therefore, the Beimu slag stockpile is the area with basic applicability as construction land.

(2) Project geological and hydrogeologic conditions of slag stockpiles

As per the *Evaluation Report on the Hydrologic Geology of Construction Site of Spoil Sites for 900,000t Pulp and 900,000t Paper and Paperboards Project of Guangxi Pulp-and-Paper Co., Ltd.* by Guangxi Investigation and Design Institute of Geologic Disaster Prevention and Treatment Engineering, the project geological and hydrogeologic conditions of two slag stockpiles are shown in Table 11.2-6 and the vertical zoning of individual ground water aquifer in the sites is shown in Fig. 11.2-1 and 11.2-2. Refer to Attached Drawing 18 for the type distribution of regional ground water.

**Table 11.2-6 Table of Project Geological and Hydrogeologic Conditions**

| Name of slag stock-piles | Landform and terrain                                                                                                                                                                                                                                                                                                                                                                                                   | Geological features                                                                           | Type of ground water and aquifer system                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Supply, runoff and drainage of ground water                                                                                                                                                                                                                                                                                                                                                                                                                                           | Dynamic feature of ground water                                                       | Chemical feature of ground water                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Chijiang slag stockpile  | Shoal is the major terrain type and the artificially excavated shrimp pools are distributed on most areas. The elevation of shoal is 1.5~2.1m with relatively flat landform. Generally, the landform in the site is that the south and west sides are relatively high and the north and east sides are relatively low.                                                                                                 | Multi-layer soil body with sandy mud, muddy sand, clayish gravel, clayish fine sand, and clay | Located on the northeast side of the regional hydrogeological unit and within the range of discharge area of the three parallel sections: supply, runoff and discharge of the ground water of the regional hydrogeological unit. It is mainly the loose rock type pore water, which can be further classified into pore ground water and pore artesian water. The thickness of pore ground water bearing stratum is about 18~24m, and buried depth of ground water generally is 0.07~1.28m. The major confined aquifer in the III confined aquifer (Huangniuling group) and buried depth of the roof clay layer is about 20~24m. | The major supply source of ground water in the site is the atmospheric precipitation followed by the water from runway and channel and the supply from lateral artesian water. During flood tide, it is also supplied by sea water. The permeability coefficient is $6.83 \times 10^{-3}$ cm/s. The runoff is slow and it mainly is drained into the Chijiang River in the north side and sea area in the east-north side. The artificially pumping is also one of its drainage ways. | It is the tidal effect type, but the tidal effect on phreatic water is insignificant. | It is mainly the $\text{Cl}^- \text{Na}^+$ type and $\text{Cl}^- \text{HCO}_3^- \text{Na}^+$ , $\text{Mg}^{++}$ type. The pH value is 4.30~4.67. The mineralization degree is 31.17~271.86 mg/L. The total hardness is 6.10~94.44 mmol/L.                                                                                                                                                                                                                     |
| Beimu slag stockpile     | Shoal is the major terrain type. After artificial modification, most part is the salt fields. The elevation of shoal is 1.5~1.8m. The landform inclines slightly to the east side representing the higher west side and lower east side and. In the east of site, a Class II highroad is under construction from Yingpan to Zhakou, which passes through the east of site area and extends in the northeast direction. | Multi-layer soil body with sandy mud, muddy sand, clay, medium coarse sand and fine sand.     | Located on the southeast side of the regional hydrogeological unit close to the sea, and within the east discharge area of the regional hydrogeological unit. It is the loose rock type pore water. It can be further classified into pore phreatic water and pore confined water. The buried depth of hybrid water level of I and II confined aquifer in the site is about 2.56~3.88m.                                                                                                                                                                                                                                          | The major supply source of ground water in the site is the atmospheric precipitation. It is also laterally supplied by the water in salt fields and I confined water in Zhanjiang group. The confined water is supplied by the phreatic water in Beihai group. The permeability coefficient is $9.03 \times 10^{-5}$ cm/s. The runoff is slow and drained into the sea in the east side. The artificially pumping of ground water is also one of its drainage methods.                | It is the tidal effect type.                                                          | It is the tidal effect type. It is mainly the $\text{Cl}^- \text{Na}^+$ type and $\text{Cl}^- \text{NO}_3^- \text{Na}^+$ , $\text{Ca}_2^+$ type. The pH value is 5.30~5.61. The mineralization degree is 102.56~161.28 mg/L. The total hardness is 18.27~58.94 mmol/L. Wherein, the phreatic water type mainly is $\text{Cl}^- \text{NO}_3^- \text{Na}^+$ , $\text{Ca}_2^+$ type water and the confined water mainly is $\text{Cl}^- \text{Na}^+$ type water. |

As shown in Table 11.2-6, the hydrogeologic conditions of Beimu slag stockpile is better than those of Chijiang slag stockpile.

### (3) Analysis on the rationalization of wasrw site location

#### ① Comparison and selection of slag stockpiles

In the aspects of the distances between slag stockpiles and plant address, the distribution conditions of surrounding sensitive points, the effects of flyash and sound along the transportation line on sensitive points, the effects of ground water and hydrogeologic conditions, the environmental protection comparison and selection is made between two proposed slag stockpiles, as shown in Table 11.2-7.

As shown in the table, the Beimu slag stockpile is better than Chijiang slag stockpile based on the analysis on environmental protection conditions. The evaluation recommends the Beimu slag stockpile for the proposed project.

**Table 11.2-7 Environmental Protection Comparison and Selection of two Proposed Slag Stockpiles**

| Name of slag stock-pile | Location relative to plant site                                                 | Impacts on surround sensitive points                                           |                                                                        |                                             |                                    | Impacts on sensitive points along                                                                                                                                                                                                                                 |                                                                                                                                                 | Conditions of land use | Impacts on ground water                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                         |                         |
|-------------------------|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------|------------------------------------------------------------------------|---------------------------------------------|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
|                         |                                                                                 | Distance to the sensitive points                                               | Wind direction                                                         | Number of persons possibly being influenced | Whether to meet (GB18599-2001)     | Flyash                                                                                                                                                                                                                                                            | Noise                                                                                                                                           |                        | Hydrogeologic conditions                                                                                                                                                                                                                                                                                                                                             | Whether to meet (GB18599-2001)                                                                                                                                                                                                          | Impacts on ground water |
| Chijiang slag stockpile | Located in the position about 11km away from the north side of plant site.      | The nearest village is Chijiang Villiage, about 560m away from slag stockpile. | It is located in the north of Chijiang Village and in the upwind side. | 500                                         | Inconformity with (GB18599 - 2001) | There are the sensitive points such as Qianweidun, Qianwei Farm 11th Village, Xinwudi, Tan Village, Zhuzaitang, Chijiang Primary School, etc. along the transportation line. The flyash caused during transportation shall have certain effect on these villages. | There are villages along the transportation line. The traffic noises caused during transportation will have a certain effect on these villages. | Shrimp pools           | It is mainly the ground water. The buried depth of water level of ground aquifer is generally 0.07~1.28m. The permeability coefficient $6.83 \times 10^{-3}$ cm/s. The runoff is slow and is mainly drained into the Chijiang River in the north side and sea area in the northeast side.                                                                            | Inconformity with (GB18599 - 2001). The permeability coefficient of natural foundation layer is below the requirement of $1.0 \times 10^{-7}$ cm/s. The natural or artificial material shall be used to make the impermeable layer.     | Having certain impacts  |
| Beimu slag stock-pile   | Located in the position about 0.5km away from the southeast side of plant site. | The nearest village is Xinputun about 500m away from slag stockpile.           | It is located in the southeast of Xinputun and in the crosswind side.  | 459                                         | Conforming with (GB18599-2001)     | The transportation distance is relatively short and there is no sensitive point along the line.                                                                                                                                                                   | The transportation distance is relatively short and there is no sensitive point along the line.                                                 | Salt fields            | There are mainly the phreatic aquifer and confined aquifer. The buried depth of water level of ground water bearing stratum is about 0.31~1.31 m. The buried depth of water level of confined aquifer is about 2.56~3.88 m. The permeability coefficient is $9.03 \times 10^{-5}$ cm/s. The runoff is slow and is mainly drained into the sea area in the east side. | Inconformity with (GB18599-2001). The permeability coefficient of natural foundation layer is below the requirement of $1.0 \times 10^{-7}$ cm/s. The natural or artificial material shall be used to make up of the impermeable layer. | Having certain impacts  |



## ② Analysis on rationality of waste site selection

According to the requirement of *Standards for Pollution Control on the Storage and Disposal Site for General Industrial Solid Wastes* (GB18599-2001) on Class II site selection, the feasibility analysis of site selection of Beimu slag stockpile and corresponding measures are shown in Table 11.2-7.

**Table 11.2-7 Feasibility analysis of site selection and corresponding measures of landfill site**

| No. | (GB 18599-2001) requirement of Class II site selection                                                                                                                                                                 | Landfill site selection of the project                                                                                                                                                                      | Feasibility | Corresponding measures |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|------------------------|
| 1   | The selected site shall conform to the requirements of the local general planning of urban and rural construction.                                                                                                     | In line with General Planning of Beihai.                                                                                                                                                                    | Feasible    | /                      |
| 2   | The site should be selected at the leeward of the predominating wind direction in the centralized industrial and residential area, and the factory boundary should be 500m away from the centralized residential area. | The site is selected at the crosswind direction of the predominating wind in the industrial area, and the nearest Xinputun is at the crosswind side of the site selected, 500 away from the slag stockpile. | Feasible    | /                      |
| 3   | The site should be selected on the foundation which meets the bearing capacity requirement, so as to avoid the influence of foundation subsidence, especially that of uneven or local subsidence.                      | Through comprehensive assessment, the site is evaluated as a zone of medium geologic hazard, so the construction site is basically suitable for construction.                                               | Feasible    | /                      |
| 4   | It is required to avoid the areas influenced by fault, fault fracture zone, karst cave and natural landslide or debris flow                                                                                            | The site is free of fault, fault fracture zone and karst cave and does not belong to areas influenced by natural landslide or debris flow.                                                                  | Feasible    | /                      |
| 5   | It is prohibited to select bottomland and flooded area below the highest water levels of rivers, lakes and reservoirs.                                                                                                 | The site is mainly of sea beach, and now mostly salt field and the elevation of sea beach is 1.5m~1.8m.                                                                                                     | Feasible    | /                      |
| 6   | It is prohibited to select inside natural reserve, scenic resort and other areas requiring special protection.                                                                                                         | There is no natural reserve, scenic resort and other areas requiring special protection within the scope of 5km around the site.                                                                            | Feasible    | /                      |

| No. | (GB 18599-2001) requirement<br>of Class II site selection                                                                                                                                               | Landfill site selection of the<br>project                                                                                                                                                                                                                                                                                                                        | Feasibility                          | Corresponding measures                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7   | It is required to avoid the main<br>ground water supply areas<br>and aquifer of drinking water<br>source.                                                                                               | It is located at the discharge area<br>of ground water, instead of<br>aquifer of drinking water source.                                                                                                                                                                                                                                                          | Feasible                             | /                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 8   | The site should be selected<br>on the foundation with good<br>seepage resistance. The<br>distance between the surface<br>of natural base layer and<br>groundwater level should be<br>no less than 1.5m. | There are mainly phreatic aquifer<br>and confined water aquifer. The<br>buried depth of water level of the<br>phreatic aquifer is about<br>0.31~1.31m and that of the<br>confined water aquifer<br>2.56~3.88m. The permeability<br>coefficient is $9.03 \times 10^{-5}$ cm/s and<br>the slow runoff is mainly<br>discharged to the sea area on the<br>east side. | Not up to<br>the<br>requireme<br>nts | First, it is required to use clay to<br>block up the site, so that the<br>distance between the surface of<br>natural base layer and<br>groundwater level is no less<br>than 1.5m; and then lay anti-<br>seepage film under the site. The<br>specific steps: first, level off the<br>site, fill and tamp the clay layer<br>by layer, so as to meet the<br>requirements of bearing<br>capacity for piling solid wastes;<br>lay anti-seepage film to 50cm<br>(or anti-seepage film + non-<br>woven fabrics, including the<br>surrounding of the slag<br>stockpile), with good welding<br>between anti-seepage films;<br>then, backfill and tamp the rest<br>50cm thick clay; the water vapor<br>permeability coefficient of anti-<br>seepage film should reach<br>$\leq 1.0 \times 10^{-13}$ cm/s; meet the<br>requirements of GB18599-2001. |

As is shown in the table, Beimu slag stockpile meet the requirements of *Standards for Pollution Control on the Storage and Disposal Site for General Industrial Solid Wastes* (GB18599-2001) after the implementation of engineering measures. Therefore, the site selection of the slag stockpile is reasonable.

## 11.2.4 Effect Analysis of Solid Wastes in Slag stockpile

### 11.2.4.1 Analysis on Environmental Impacts of the Landfill of Coal Ash Slag

#### (1) Analysis of Impacts on Sea Area

The earth walls are set around the slag stockpile with disposal ditches around every section. The spraying water blind ditches in the slag stockpile returns to the collection pool of slag stockpile, and the wastewater in the plant shall be pumped for treatment. The volume of collection settling tank is designed as per heavy rain with daily rainfall above 150mm (there are 8 days with heavy rain annually in average), and the capacity is constructed as per 3000m<sup>3</sup>. The collected rainwater shall be used as the spraying water for ash slag stockpile, without external drainage. Generally, there is no water with ashes to be drained in ash storage site and thus no effects shall be made on the water environment in sea area. If super heavy storm occurs (with daily rainfall above 260mm, usually occurring once every two years), the rainwater collection capacity in whole slag stockpile is 5200 m<sup>3</sup>/d and there shall be 2200 m<sup>3</sup>/d in the rainwater collection settling tank. The overflow part shall be drained into sea area of Tieshan Port sea area. In such case, due to the condition that the drained rainwater is mixed with some coal ashes, the pH value and concentration of suspended substances shall be higher. A certain impact on local sea area shall be made after drainage into the sea. However, as the volume of drained rainwater is limited, it shall be diluted by a great deal of rainwater soon. Therefore, the impacts on water quality of water environment in sea area shall be insignificant and the period of influence be relatively short.

#### (2) Analysis of Impacts on Ground water Environment

The Beimu slag stockpile is located in the southeast side of plant site. The site classification is a multilayer soil body with sand and clay, i.e. multi-layer soil body containing the sandy mud, muddy sand, clay, medium coarse sand and fine sand. The top clay in Zhanjiang group has been denuded and depleted in the site. The Holocene series muddy sand part directly contacts with the medium coarse sand layer in Zhanjiang group. The site is within the region of ground water outflow. The buried depth of ground water level is 0.31~1.31m with small annual water level amplitude of 0.2~0.5m. The buried depth of confined water level is usually 2.56~3.88m with annual water level amplitude of 0.9~3.7m. The upper ground water aquifer is relatively thin (about 3~6m) and contains the saline water. Its lower clay layer (roof plate of II confined aquifer) is relatively complete and distributed continuously, which is a good confining stratum. The permeability coefficient in the site is  $9.02 \times 10^{-5}$  cm/s, failing to meet the requirement of natural impermeable layer (below  $1.0 \times 10^{-7}$  cm/s). It is necessary to taken engineering leakage-prevention measures. Based on the actual conditions in proposed slag stockpile, as the buried depth of groundwater level at the site of 0.31~1.31m, in order to protect the

ground water from penetrating fluid, it is necessary to lay anti-seepage film under the site. First, it is required to use clay to block up the site, so that the distance between the surface of natural base layer and groundwater level is no less than 1.5m; and then lay anti-seepage film under the site. The specific steps: first, level off the site, fill and tamp the clay layer by layer, so as to meet the requirements of bearing capacity for piling solid wastes; lay anti-seepage film to 50cm (or anti-seepage film + non-woven fabrics, including the surrounding of the slag stockpile), with good welding between anti-seepage films; then, backfill and tamp the rest 50cm thick clay; the water vapor permeability coefficient of anti-seepage film should reach  $\leq 1.0 \times 10^{-13} \text{cm/s}$ ; meet the requirements of *Standards for Pollution Control on the Storage and Disposal Site for General Industrial Solid Wastes* (GB18599-2001).

Generally, the flow direction of ground water in the site is from west to east (from inner land to sea area). The residential areas around spoil site are distributed in the west, south-west, south and north side, and located in the upstream of flow direction of ground water. After permeability-reducing measures are taken, it will have an insignificant effect on the quality of ground water and have no effect on the drinking ground water for the residents in surrounding areas.

### (3) Analysis on Impacts of Flyash on Environment

After the automobiles transport the coal ash slag, green mud, lime mud and Class III sludge to slag stockpile, they shall be placed in different sections. The coal ash slag is damped into natural loose state. Although the unloaded coal ash slag has the relatively high water content, but the moisture shall dissipate rapidly due to the relatively loose state of coal ash slag, relatively large porosity and the temperature up to 50°C or so. If no rolling measures are taken in time, the coal ash slag shall be dried soon and the flyash shall be caused under the influence of wind.

Refer to related documents for the dust emission of storage dust and the following empirical formula is selected:

$$Q = 0.52 (u - u_0)$$

$$u_0 = 1.93W + 3.02$$

Wherein:

Q - Dust emission of powder coal ashes,  $\text{kg/m}^2 \cdot \text{h}$ ;

u – Wind speed selected for calculation, m/s;

$u_0$  – Start-up wind speed, m/s;

W – Water content rate of powder coal ashes, %.

The  $u_0$  is meant to the wind speed at 1m away from ash level. The water content of ashes is approximate to the one of completely dissipating. W is 8% and the start-up wind

speed is calculated to be 3.17 m/s. If converted to the start-up wind speed in the height of 10m, it shall be 5.64 m/s. The frequency in the case that the wind speed is more than 5.1 m/s in the area is 12.9%. Therefore, the flyash shall have a certain impacts on the surrounding environment. The calculation result of dust emission at the ash site is shown in Table 11.2-8.

**Table 11.2-8 Calculation Result of Dust Emission at the Ash Site**

| At the wind speed of 8 m/s                          |        |        |        |        |         |
|-----------------------------------------------------|--------|--------|--------|--------|---------|
| Area of storage ashes in ash site (m <sup>2</sup> ) | 1000   | 3000   | 5000   | 8000   | 10000   |
| Dust emission ((t/h)                                | 1.227  | 3.681  | 6.135  | 9.816  | 12.270  |
| At the wind speed of 10 m/s                         |        |        |        |        |         |
| Area of storage ashes in ash site (m <sup>2</sup> ) | 1000   | 3000   | 5000   | 8000   | 10000   |
| Dust emission ((t/h)                                | 2.267  | 6.801  | 11.335 | 18.136 | 22.670  |
| At the wind speed of 12 m/s                         |        |        |        |        |         |
| Area of storage ashes in ash site (m <sup>2</sup> ) | 1000   | 3000   | 5000   | 8000   | 10000   |
| Dust emission ((t/h)                                | 3.307  | 9.921  | 16.535 | 26.456 | 33.070  |
| At the wind speed of 15 m/s                         |        |        |        |        |         |
| Area of storage ashes in ash site (m <sup>2</sup> ) | 1000   | 3000   | 5000   | 8000   | 10000   |
| Dust emission ((t/h)                                | 4.867  | 14.601 | 24.335 | 38.936 | 48.670  |
| At the wind speed of 18 m/s                         |        |        |        |        |         |
| Area of storage ashes in ash site (m <sup>2</sup> ) | 1000   | 3000   | 5000   | 8000   | 10000   |
| Dust emission ((t/h)                                | 6.427  | 19.281 | 32.135 | 51.416 | 64.270  |
| At the wind speed of 20 m/s                         |        |        |        |        |         |
| Area of storage ashes in ash site (m <sup>2</sup> ) | 1000   | 3000   | 5000   | 8000   | 10000   |
| Dust emission ((t/h)                                | 7.467  | 22.401 | 37.335 | 59.736 | 74.670  |
| At the wind speed of 25 m/s                         |        |        |        |        |         |
| Area of storage ashes in ash site (m <sup>2</sup> ) | 1000   | 3000   | 5000   | 8000   | 10000   |
| Dust emission ((t/h)                                | 10.067 | 30.201 | 50.335 | 80.536 | 100.670 |

The main disadvantage of dry ash storage is that the flyash pollution is possible badly managed. Therefore, strict management is required. To reduce the pollution of flyash as far as possible, it shall be prevented by spraying water.

Add the water into the dry ashes and blend them to uniform state before transportation and allow the dry ashes to keep a certain water content (about 30%) during transportation. And the enclosed special truck shall be used for transporting them to ash site to ensure that no leakage occurs during transportation. After the dry ashes are transported to ash site, they shall be rolled in time to allow the ash surface to form a casing with a certain thickness. The ash site is equipped with water spraying equipment and the ash surface shall be sprayed periodically to keep it with a certain water content, to reduce the extent of atmospheric pollution of flyash caused by strong wind.

After the ash slag is piled on ash site, it shall become more compact by laminar rolling compaction of compactor. The ashes contain the calcareous substances, and a hard

casing shall be formed on the surface after a period of storage. Therefore, with no disturbance, no flyash is easy. However, due to the passing in and out of transportation vehicles, the flyash is inevitable. For the above problems, the ash site shall be equipped with the manual water spraying and dust prevention equipment (such as spraying car). At the same time, when the storage ashes reach the preset height, the timely earth covering and planting are necessary, to prevent the flyash pollution.

For the current environmental conditions in Phase I storage ash site of Beihai Power Plant, the result of environmental monitoring for Beihai Power Plant performed in September 2005 shows that the TSP daily average concentration value at the boundary of storage ash site is  $0.08\text{mg}/\text{m}^3$ , meeting Class I standard requirements in GB3095-1996 *Ambient Air Quality Standard*. The villages nearest to Beimu slag stockpile are the Xinputun about 500m away in the northwest, Xiejia Village about 0.83km away in the north and Beimu Village about 0.85km away in the west (see Attached Drawing 3). As they are located in the crosswind side, the impacts on the life of residents shall be insignificant. However, if it is considered that the wind speed in coastal areas is relatively high, it is recommended to plant the windbreak forest in the surrounding of spoil site, to reduce the influences on the surrounding environments of slag stockpile.

#### **11.2.4.2 Disposal and Impact Analysis of Lime Mud**

The particle size of lime mud is relatively large and no flyash shall be caused with CaO contained. If they are poured by the rain during backfilling, it is possible to have an impact on ground water due to the weak alkaline leakage water. However, the site selection and construction of slag stockpile strictly follows GB18599-2001 *Standards for Pollution Control on the Storage and Disposal Site for General Industrial Solid Wastes*. They are piled in the section different from coal ash slag, and covered temporarily with waterproof canvas. If the preset height of piling is reached, the earth covering shall be made. The disposal ditches are set in the surroundings of each section. The spraying fluid shall be drained into open channel and pumped back to plant area for treatment after collection. The impacts on ground water are insignificant.

#### **11.2.4.3 Disposal and Impact Analysis of Class III Sludge**

##### **(1) Characteristics of sludge**

The Class III sludge come from the coagulative sediment mud, chemical sediment mud and the mud residues produced by detritus pit and are mostly inorganic sludge. The characteristics are low organic matter content, coarse particles, high density, high water content, generally hydrophobic and easy for dehydration; the order of dewatered Class III sludge is relatively light.

##### **(2) Analysis on Environmental Impacts of Mud Backfilling**

The Class III sludge have the characteristics of the coarse particles, high density and high water content and the flyash is not easily caused. The site selection and construction of slag stockpile strictly follows GB18599-2001 *Standards for Pollution Control on the Storage and Disposal Site for General Industrial Solid Wastes*. The mud is dewatered in the plant and immediately transported to the slag stockpile. The earth-retaining wall is set around storage site. After the mud is piled, the surface is covered with waterproof canvas. If the preset height of piling is reached, the earth covering will be made additionally. The disposal ditches are set in the surroundings of each section. The properly treated Class III sludge shall have no negative influences on the surrounding environment.

#### **11.2.4.4 Disposal and Impact Analysis of Green Mud**

Green mud mainly comes from filtrate precipitate in the causticizing stage, and its major contents include calcium carbonate, calcium silicate and other inorganic substances as well as a small quantity of alkali. Due to its big grain diameter, it is not easy for green mud to raise dust. Since pH is 10.54~10.74, its percolate turns alkaline after being rained during the process of landfill, and thus it may affect the ground water. The site of green mud slag stockpile is selected and constructed in strict accordance with Class II site specified in *Standards for Pollution Control on the Storage and Disposal Site for General Industrial Solid Wastes* (GB18599-2001). After being piled separately from coal slag, Class III sludge, and lime mud, it is covered with waterproof cloth temporarily and it will be earthed after it is piled to a certain height. Moreover, headrace is built around each area to discharge the leaching liquor into open ditch and collected and pumped back into the factory for disposal. Hence, green mud has a little impact on ground water.

#### **11.2.4.5 Environment Impacts during Transportation**

The solid wastes including green mud, lime mud, Class III sludge and coal ash slag are transported by trucks into slag stockpile. The Beimu slag stockpile is 500m about away from plant area and no residential areas are passed through during transportation. The water content of green mud and lime mud is 50%, that of Class III sludge is 80% and the coal ash slag is damped. During transportation, there are a few flyashes and traffic noises on the road. The impacts on air environment and sound environment in the surroundings of plant area are very light. The transportation line goes from west to east. The villages nearest to the slag stockpile include Xintunpu, about 500m away in the northwest, and Xiejia Village, about 0.83km in the north, and Beimu Village, about 0.85km in the west. Therefore, it has slight impact on the life of residents.

#### **11.2.5 Summary**

In a word, the disposal methods of various solid wastes are proper and the site selection

of slag stockpile is reasonable. The solid wastes produced in the project shall have no significant impacts on surrounding environment if the construction meets the requirements in GB18599-2001 *Standards for Pollution Control on the Storage and Disposal Site for General Industrial Solid Wastes*.



### 11.3 Impact Analysis of Transportation and Logistics

The project has a lot of raw materials, products to be transported in and out of plant area. The input materials mainly include log, pulp board, paper, coal and chemical raw materials. The output includes products, coal slags and ashes, and sludge. The total transportation volume is 6,348,000t. Wherein, input quantity is 3,844,000t and output quantity is 2,864,000t. The products, purchased wood pulp, coal, etc. are transported by marine transportation, with the transportation volume of about 3,000,000t/a; the rest are transported by road and railway transportations. The transportation volume of the project is shown in Table 11.3-1.

**Table 11.3-1 Table of Transportation Conditions of Main Raw Materials, Products and Wastes**

| Transported to                     |          | Name of raw materials (product)              | Quantity (t/a) | Source                                                                    | Transportation mode   |
|------------------------------------|----------|----------------------------------------------|----------------|---------------------------------------------------------------------------|-----------------------|
| Products, transported into plant   | 1        | Eucalyptus                                   | 1842300        | From the log of forest bases and commercial wood chip and commercial log. | Train, truck and ship |
|                                    | 2        | Sodium hydroxide                             | ---            | Domestically made                                                         | Truck                 |
|                                    | 3        | Sulfuric acid H <sub>2</sub> SO <sub>4</sub> | ---            | Domestically made                                                         | Truck                 |
|                                    | 4        | Limestone CaCO <sub>3</sub>                  | ---            | Domestically made                                                         | Truck                 |
|                                    | 5        | Sodium sulfate                               | ---            | Domestically made                                                         | Truck                 |
|                                    | 6        | Hydrogen peroxide                            | ---            | Domestically made                                                         | Truck                 |
|                                    | 7        | Commercial softwood pulp                     | ---            | Domestically made, imported                                               | Truck, ship           |
|                                    | 8        | Bleached chemimechanical pulp                | ---            | Domestically made, imported                                               | Truck, ship           |
|                                    | 9        | Sizing agent                                 | ---            | Domestically made                                                         | Truck, train          |
|                                    | 10       | Alum                                         | ---            | Domestically made                                                         | Truck, train          |
|                                    | 11       | Retention aid agent                          | ---            | Domestically made, imported                                               | Truck, train          |
|                                    | 12       | PAM                                          | ---            | Domestically made                                                         | Truck, train          |
|                                    | 13       | Amylum                                       | ---            | Domestically made,                                                        | Truck, ship           |
|                                    | 14       | Latex                                        | ---            | Domestically made, imported                                               | Truck, ship           |
|                                    | 15       | Covered film                                 | ---            | Domestically made                                                         | Truck                 |
|                                    | 16       | Dry net                                      | ---            | Domestically made, imported                                               | Truck, ship           |
|                                    | 17       | Felt cloth                                   | ---            | Domestically made, imported                                               | Truck, ship           |
|                                    | 18       | Packaging materials                          | ---            | Domestically made                                                         | Truck, train          |
|                                    | 19       | AKD                                          | ---            | Domestically made                                                         | Truck, train          |
|                                    | 20       | Polymer                                      | ---            | Domestically made                                                         | Truck, train          |
|                                    | 21       | Dye                                          | ---            | Domestically made                                                         | Truck, train          |
|                                    | 22       | Padding                                      | ---            | Domestically made                                                         | Truck, train          |
|                                    | 23       | Sodium chlorate                              | ---            | Domestically made                                                         | Truck, train          |
|                                    | 24       | Coal                                         | ---            | Shanxi                                                                    | Truck, train, ship    |
|                                    | 25       | Liquefied gas                                | ---            | Public purchase                                                           | Truck tanker          |
|                                    | Subtotal |                                              | I              |                                                                           |                       |
| Products, transported out of plant | 1        | Eucalyptus chemical pulp                     | 900000         | Plant site                                                                | Truck, train, ship    |
|                                    | 2        | Commercial wood board pulp                   | 450000         | Plant site                                                                | Truck, train, ship    |
|                                    | 3        | High quality card packing paper              | 450000         | Plant site                                                                | Truck, train, ship    |
|                                    | 4        | High quality writing print paper             | 200000         | Plant site                                                                | Truck, train, ship    |
|                                    | 5        | Coated paper                                 | 250000         | Plant site                                                                | Truck, train, ship    |

|                                  |            |                                                        |              |            |       |
|----------------------------------|------------|--------------------------------------------------------|--------------|------------|-------|
| Wastes, transported out of plant | Subtotal 1 | Pulp residues                                          | 225<br>26500 | Plant site | Truck |
|                                  | 2          | Green mud, lime mud                                    | 106071       | Plant site | Truck |
|                                  | 3          | Sludge                                                 | 137956       | Plant site | Truck |
|                                  | 4          | Powder coal ashes                                      | 300606       | Plant site | Truck |
|                                  | 5          | Others (including living garbage, construction wastes) | 42480        | Plant site | Truck |
|                                  | Subtotal   | Total                                                  | 61.4         |            |       |
| Total                            |            |                                                        | 634.8        |            |       |

### 11.3.1 Current Status of Transportation

(1) Highroad: The cargo transportation volume in Beihai city is 22,400,000t. It is mainly the volume of transportation and logistics in urban areas of Beihai. The main highroad in Tieshan Port is Beihai – Tieshan Port class I highroad connecting the docks at Tieshan Port. Due to the relatively low handling capacity of the dock at Tieshan Port, the current traffic volume of this highroad is not high.

(2) Railway: The railway of Beihai is put into online operation in national railways. Three pairs of cargo trains are operating. The annual completed cargo volume is about 3,000,000t, which accounts for about 11% of transportation volume only,

(3) Marine transportation: The annual cargo handling capacity of the ports and docks in whole city is 8,040,000t. Wherein, the annual handling capacity of Tieshan Port is more than 400,000t.

(4) Tieshan Port area: There are no other enterprises in scale in Tieshan Port except for power plant. The scale of dock is relatively small. The main highroad is Beihai – Tieshan Port class I highroad. The traffic volume in whole area is very low.

### 11.3.2 Analysis on Environmental Impacts of Highroad Transportation

The environmental impacts of highroad transportation mainly include the traffic noise, flying dust, exhaust gas of transportation and etc. The monitoring result of current pollutants along the highroad can show that the flying dust has a relatively slight impact on surrounding environment on the highroad (hardened road surface). However, the flying dust has a significant impact on some field roads and the roads with sandy soil surface.

The proposed project requires 1,842,300t (extra dry) eucalyptus wood every year, most of which come from the forest bases in the area and transported by highroad transportation. The local purchased log and commercial wood chips will be transported to the plant by railway and marine transportation based on the conditions of purchasing

location. The liquefied gas and heavy oils (local) will be transported by tanker car. The solid wastes will be transported to slag stockpile by highroad. It is expected that annual volume of highroad transportation reaches 2,500,000 -3,000,000t. If each car has 10t averagely for calculation, and then the impact of these cars on the highroad net in the area is slight.

The roads passed through by the transportation for the project don't belong to the urban roads in the constructed area of Beihai city, and they are mostly within the highroad net out of the city. They are basically the highroads above the level. The increasing of traffic volume caused due to the economic development was considered during the construction of these highroads and corresponding measures have been taken for the sensitive points which will be possibly influenced. After investigation, it shows that the traffic transportation volume of these highroads hasn't reached the designed traffic volume at present. In the conditions of current traffic volume, no residents along the highroads complain that the highroad transportation has a negative impact on their environment. Therefore, for the current highroads, the added traffic volume will not increase the traffic congestion level and will have no negative impacts on surrounding environment.

There is only one enterprise in scale in Tieshan Port due to the uncompleted construction of city area. The whole road net hasn't be constructed and the traffic transportation volume is relatively low. The material transportation of the project will allow the traffic volume in the area to significantly increase. However, due to the good Environmental background in the area, the additional transportation volume won't have negative impacts on the environment in the area.

After the materials arrive at Beihai, they will be passed into plant area via the planned roads in Tieshan Port Offshore Industrial Zone – Xinggang Avenue and Gangqu No.1 Road, the planned roads at east and south plant boundary, and the secondary highroads from Yingpan to Zhakou. The solid wastes of the project will arrive in the slag stockpile via the secondary highroads from Yingpan to Zhakou. The project has no self-constructed highroads. The construction department of Tieshan Port will be responsible for the evaluation on road environmental impacts in Tieshan Port Industrial Zone, which will not be listed in the project. At present, the evaluation on environmental impacts of Yingzha Road and Xinggang Road has been completed by Beihai Science Institute of Environmental Protection and been approved by the environmental protection administration. The evaluation on environmental impacts of No. 7 Road, Xiner Road and Xinba Road is prepared by Beihai Bilan Marine Environment Protection and Service Co.,

Ltd. The one of No. 7 Road has been completed and approved. The evaluation on environmental impacts of Xiner Road and Xinba Road is being performed. In the evaluation on environmental impacts of highroads, the corresponding measures to reduce the impacts have been proposed for the influenced sensitive points within 200m at both sides along the highroads. During the construction of highroads, the requirements in the evaluation on environmental impacts shall be followed to take corresponding protection measures for sensitive points in surrounding environments. The traffic volume produced in the transportation for the project is also one of the contents in the prediction of highroad traffic volume. The traffic volume of highroads won't change significantly due to the transportation for the project. Therefore, the material transportation of the project won't have significant and negative impacts on the sensitive points at both sides along the road.

### **11.3.3 Analysis on Environmental Impacts of Railway Transportation**

It is not necessary temporarily to construct special railway for the project. The existing public railway will be utilized. The part of commodities for the project such as log and commercial wood chips will arrive by railway transportation. Part of purchased pulp board and coal are also transported by railway. The transportation of the project will increase the transportation volume of railway. However, the additional operating times of vehicles will be limited and the original transportation volume of railway is very low. The additional transportation volume will not only increase no pressure on the railway transportation, and but also increase the transportation volume of railway to increase the utilization rate of railway.

If the project requires the construction of special railway, the special evaluation on its construction shall be made.

### **11.3.4 Analysis on Environmental Impacts of Water Transportation**

The water transportation mostly is the marine transportation. The main materials to be transported are the products such as pulp board and paper as well as some raw materials and coal. No transportation of dangerous articles is involved. For the marine transportation of finished products, they will be transported to the dock by container car.

Tieshan Port has a good natural condition and good water-depth condition. It has a natural deep-water channel without sufficient utilization. The transportation for the project can promote the construction of the port and the utilization of sea lane, and will have a positive impact on the development in the area. The soil is mainly the mud and sand, and is good for excavation.

The dock project for the transportation of the project will be planned and constructed by Beihai Municipal Government. It is not listed in the construction of the project. The evaluation on environmental impacts caused by its construction and operation will be performed by the construction company for the dock. At present, the owner has commissioned the Second Harbour Engineering Investigation and Design Institute of China Transport Engineering Inc. for its implementation.

#### **11.3.5 Analysis on Social Environmental Impacts of Transportation**

Beihai has a convenient traffic condition and a very complete highroad net above the level. It has an excellent port construction condition and natural channel. However, the transportation and logistics industry in Beihai is lagged and the convenient transportation condition doesn't get sufficient utilization. The transportation and logistics for the project will allow the sufficient utilization of highroad, railway and water transportation. The total annual transportation volume of the project is 6,348,000t. This transportation volume will be solved by the social transportation capacity. It will increase the social employment rate and promote the social economic development.

## 12. Analysis on Environmental Risk

### 12.1 Outline of Environmental Risk Assessment

#### 12.1.1 Classification of Evaluation

Based on the process characteristics of the project and general layout, the plant location would be divided into three functional units, i.e. liquefied petroleum gas station, chemical preparation functional unit, and pulp and paper making functional unit. The functional unit of liquefied petroleum gas station would cover liquefied petroleum gas storage tank area, the functional unit of chemical preparation would cover preparation area and storage area of hazardous chemicals, such as  $\text{ClO}_2$  preparation, sulfuric acid storage tank area, methanol storage tank area, heavy oil storage tank area, the functional unit of pulp and paper making would cover the liquefied petroleum gas station and production area other than the functional unit for chemical preparation. Classification of functional units is shown in Fig. 12.1-1.

The storage capacity of major hazardous substances involving in the project is given in Table 12.1-1. The critical mass of each substance according to Tables 2-4 in Appendix A of *Technical Guidelines for Environmental Risk Assessment on Projects and Identification of Major Hazard Installation* (GB18218-2000) is also given in Table 12.1-1. As can be known from Table 12.1-1, the storage capacity of methanol, liquefied petroleum gas and sodium chlorate storage tank area has exceeded the critical value, which would be a major hazard source; moreover, due to the fact that sodium chlorate belongs to active hazardous substance and methanol and liquefied petroleum gas combustible and inflammable dangerous substances, the evaluation of environmental risk of this project is classified as a Class I based upon the standard of judgment of evaluation classification (see Table 12.1-2).

**Table 12.1-1 Storage capacity and critical value of dangerous substances**

| Name of substance       | Production location |                | Storage location           |                |
|-------------------------|---------------------|----------------|----------------------------|----------------|
|                         | Deposit capacity    | Critical value | Storage capacity           | Critical value |
| Liquefied petroleum gas | 0                   | 1t             | 20t                        | 10t            |
| Methanol                | 0                   | 2t             | 158.3t(200m <sup>3</sup> ) | 20t            |
| Sodium chlorate         | 0                   | 2t             | 400t                       | 20t            |

**Table 12.1-2 Classification of evaluation**

|                              | Extremely toxic substances | Toxic substances | Combustible, inflammable substances | Explosive substances |
|------------------------------|----------------------------|------------------|-------------------------------------|----------------------|
| Major hazard source          | I                          | II               | I                                   | I                    |
| Non-major hazard source      | II                         | II               | II                                  | II                   |
| Environmental sensitive area | I                          | I                | I                                   | I                    |

**12.1.2 Range of Evaluation**

Cover the area of 5km in radius taking the methanol storage tank area and liquefied petroleum gas station as a center.

*Detailed layout removed*



## 12.2 Risk Identification

### 12.2.1 Data Collection and Preparation

#### 12.2.1.1 Current Situation of Environment

The current situation of the project land is dry land and a small amount of paddy land. There are two environment-sensitive points in a range of 500m surrounding the great hazard source, one is Yaxi village on north side of the plant location with 323 residents, 230m from the functional unit for chemical preparation; the other is Haishanpai on north with 262 residents, 250m from the functional unit for chemical preparation. There are 4 residential sites in a range of 0.5-1km surrounding the great hazard source, 8 sites in a range of 1-2km; 10 sites in a range of 2-3km, and 33 sites in a range of 3-5km, which all are given and shown in Table 1.7-1 and attached Fig. 3. The water resource for drinking surrounding the location is underground water.

#### 12.2.1.2 Collection of Data Concerning Risk Accidents

According to accidents relating to 18 kinds of registered chemicals which happened in 95 countries in the period of 1969-1987, various unexpected accidents with their proportion are recorded in the Table 12.2-1.

**Table 12.2-1 Classification of Chemical Accidents**

| Type                | Item                    | Proportion (%) |
|---------------------|-------------------------|----------------|
| Type of chemicals   | Liquefied petroleum gas | 25.3           |
|                     | Petrol                  | 18.0           |
|                     | Ammonia                 | 16.1           |
|                     | Kerosene                | 14.9           |
|                     | Chlorine                | 14.4           |
|                     | Crude oil               | 11.2           |
| State of chemicals  | Liquid                  | 47.8           |
|                     | Liquefied gas           | 27.6           |
|                     | Gas                     | 18.9           |
|                     | Solid                   | 8.2            |
| Production system   | Transportation          | 34.2           |
|                     | Process                 | 33.0           |
|                     | Storage                 | 23.1           |
|                     | Moving                  | 9.6            |
| Source of accidents | Mechanical fault        | 34.2           |
|                     | Collision               | 26.8           |
|                     | Human factor            | 22.8           |
|                     | External factor         | 15.2           |

116 chemical accidents such as fire, explosion, toxic suffocation happened in the country in the period of 1990-1995 are given in Table 12.2-2.

**Table 12.2-2 Causes of Chemical Accidents Resulted from Fire, Explosion and Toxic Suffocation in the Country**

| No. | Major cause                                | Time | Proportion (%) |
|-----|--------------------------------------------|------|----------------|
| 1   | Violation of operation rules               | 60   | 51.1           |
| 2   | Equipment defect                           | 25   | 21.6           |
| 3   | Deficiency of personal protection tools    | 9    | 7.8            |
| 4   | Having no knowledge of technical operation | 7    | 6.0            |
| 5   | Violation of labor discipline              | 5    | 4.3            |
| 6   | Mistake of direction                       | 2    | 1.7            |
| 7   | Defect of design                           | 2    | 1.7            |
| 8   | Lack of on-site inspection                 | 2    | 1.7            |
| 9   | Loosely control of raw material quality    | 1    | 0.9            |
| 10  | Operation failure                          | 1    | 0.9            |
| 11  | Defect of personal protection tools        | 1    | 0.9            |
| 12  | Lack of safety rules                       | 1    | 0.9            |

Note: Quoted from *Collection of Examples of Chemical Accidents Nationwide*

It can be known from Table 12.2-1 that in the unexpected chemical accidents, according to the classification of chemicals, the liquefied petroleum gas is the most serious in terms of proportion of the accidents, while the liquid is the highest in the light of the state of the chemicals.

It can be known from Table 12.2-2 that the major cause leading to chemical accidents is violation of operating instruction, followed by equipment defect.

### 12.2.2 Identification of Substance Danger

The major raw materials and products of this project are not related with any dangerous substances, but dangerous substances among the auxiliary materials include methanol, sulfuric acid, caustic soda, chlorine dioxide, liquefied petroleum gas, H<sub>2</sub>O<sub>2</sub>, etc. Their physicochemical properties and risks are given in Tables 12.2-3~12.2-8.

**Table 12.2-3 Physicochemical Properties and Hazard Characteristics of  
Liquefied Petroleum Gas**

|                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Item                       | Liquefied petroleum gas, compressed petroleum gas                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Physicochemical properties | Colorless gas or brown-yellow oily liquid having peculiar foul smell;<br>Flash point (°C): -74; Explosive limit (v/v%): 2.25-9.65.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Special warning            | Extremely inflammable: if a gas source in leaking cannot be cut off, do not distinguish the burning gas.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Hazard characteristics     | Inflammability and explosion: extremely inflammable, flammable in contact with a heat source, naked flame, and spark or causing burning; forming explosive compound if mixed with air; vapor of liquefied petroleum gas heavier than air that it could be diffused on ground; causing backflash when diffused vapor contacted with a source of ignition; causing explosion if the container is in contact with a heat source; sputtering danger in case steel cylinder broken.<br>Health hazard: in case without protection measures, vapor may cause dizzy condition or suffocation; highly concentrated vapor may cause irritation; contacting with gaseous substances or liquefied gas will cause burn of skin, severe damage and/or frostbite; generating irritant or toxic gas in case of ignition. |

**Table 12.2-4 Physicochemical Properties and Hazard Characteristics of Methanol**

| I. Label                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                   |                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|--------------------------------|
| Name in Chinese: methanol                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Name in English: methyl alcohol   | CAS : 67-56-1                  |
| Molecular formula: CH <sub>3</sub> OH                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Relative molecular weight: —      | Structure: —                   |
| Classification of risk: Type 3.2 inflammable liquid with medium flash point                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Chemical classification: alcohols |                                |
| II. Health hazard                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                   |                                |
| Route of incursion: inhalation, swallow, adsorption through skin.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                   |                                |
| Health hazard: a. acute toxicity: a slight irritating condition in upper respiratory tract in case of a large amount of inhalation in a short duration (or in gastrointestinal tract condition in case of oral administration); conditions in headache, dizziness, exhausted, giddiness, drunk, conscious drowsiness even drunken stupor, double vision, blindness in most severely case. b. chronic effect: neurasthenic syndrome, vegetative nerve functional disturbance, mucous membrane irritation and visual deterioration, etc.                                                                                                                                                                                                                                                                                                          |                                   |                                |
| III. Flammability characteristics and fire control                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                   |                                |
| Inflammability: inflammable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Flash point (°C): 11              | Ignition temperature (°C): 385 |
| Lower limit of explosion [% (V/V)]: 5.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Upper limit [% (V/V)]: 44.0       |                                |
| Min. ignition energy (mJ): 0.215                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Max. explosive pressure (MPa): —  |                                |
| Hazard characteristics: inflammable, vapor could form explosive compound in contact with air. Cause flame explosion in contact with naked fire, heat, and oxidant. Cause fire when reacted with an oxidizing agent. In fire field, may have explosive risk when a container heated. Vapor heavier than air that it could be diffused far at low place on the ground; cause backflash when contact with naked fire.<br>Method of fire control: remove the container from fire field to an open space, spraying water to keep temperature of the container down until the fire extinguished. In case the container in fire field has changed its color or a sound generated from an atmospheric relief unit, immediately withdraw from the dangerous area.<br>Fire extinguishing agent: alcohol resistant foam, dry powder, carbon dioxide, sand. |                                   |                                |

**Table 12.2-5 Physicochemical Properties and Hazard Characteristics of sodium chlorate**

| Item                       | Sodium chlorate, $\text{NaClO}_3$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Physicochemical properties | <p>Usually, odorless, white (colorless) or a bit yellowish equiaxed crystal, and in the metastable state, cubic crystal or rhombic crystal, capable of deliquescence through absorbing moisture in the air.</p> <p>Melting point: <math>248^\circ\text{C}</math>; when it is heated in solid to <math>300^\circ\text{C}</math>, it will decompose and release oxygen.</p> <p>Relative density (water=1): 2.496</p>                                                                                                                                                                                                                         |
| Hazard characteristics     | <p>Class of hazardousness: Class 5, 1 oxidant</p> <p>When it contacts or is mixed with flammable organics, reducer, phosphorous, sulfur, carbon, and metal powder, merely knock or friction may lead to explosion. When this substance or its highly-concentrated solution mixes with strong acid, explosion may be caused by the chlorine dioxide generated in the reaction. The flammability and explosiveness of sodium chlorate may be reduced in the presence of hygroscopic substances, such as calcium chloride, magnesium chloride, and sodium polyborate or sodium metaborate. Product of combustion (decomposition): oxygen.</p> |

**Table 12.2-6 Physicochemical Properties and Hazard Characteristics of Caustic Soda**

|                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Item                       | Sodium hydroxide, NaOH, caustic soda                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Physicochemical properties | Opaque solid in white color, air slaking; solubility: soluble in water, ethanol, glycerol, insoluble in acetone; relative density: 2.12.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Special warning            | Toxic; causing severe damage or even death in case of inhalation, swallow or in contact with skin. Prohibit pouring water into the container.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Hazard characteristics     | <p>When heated, it will generate corrosive and toxic smoke, oxidizing agent may cause burning when contacted with inflammable substances (wooden material, paper, clothing, etc.); may generate inflammable hydrogen in contact with metals. The container is prone to explosion if heated.</p> <p>Health harm: toxic, causing severe damage or even death in case of inhalation, swallow or contact with skin. Cause serious burn when skin, eye contact with melted substances. Prevent contacting with skin. Cause delayed symptom in case of inhalation or contact. Enable to generate irritative toxic or corrosive gas. The extinguishing water may have corrosion and toxicity, causing pollution after fire controlled.</p> |

**Table 12.2-7 Physicochemical Properties and Hazard Characteristics of Sulfuric Acid**

|                            |                                                                                             |                                                                                                                                                                                                                                                                                                                                                                   |                                |              |
|----------------------------|---------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|--------------|
| Physicochemical properties | Appearance and state: oily liquid, colorless and transparent, odorless in the case of pure. |                                                                                                                                                                                                                                                                                                                                                                   |                                |              |
|                            | Melting point (°C)                                                                          | 10.5 (note)                                                                                                                                                                                                                                                                                                                                                       | Saturated vapor pressure (kPa) | 0.13/145.8°C |
|                            | Boiling point (°C)                                                                          | 330.0<br>330.0                                                                                                                                                                                                                                                                                                                                                    | Critical temperature (°C)      |              |
|                            | Relative density                                                                            | 1.83 (water=1)                                                                                                                                                                                                                                                                                                                                                    | Critical pressure (MPa)        |              |
|                            | Solubility                                                                                  | Miscible in water                                                                                                                                                                                                                                                                                                                                                 |                                |              |
| Toxicity and health harm   | Contact limit                                                                               | China MAC: 2mg/m <sup>3</sup>                                                                                                                                                                                                                                                                                                                                     | ACGIH: 1mg/m <sup>3</sup>      |              |
|                            |                                                                                             | Former Soviet Union MAC: 1mg/ m <sup>3</sup>                                                                                                                                                                                                                                                                                                                      | ACGIH: 3mg/m <sup>3</sup>      |              |
|                            | Route of incursion                                                                          | Inhalation swallow                                                                                                                                                                                                                                                                                                                                                |                                |              |
|                            | Toxicity                                                                                    | Medium                                                                                                                                                                                                                                                                                                                                                            |                                |              |
|                            | Health harm                                                                                 | Strong irritation to skin a mucous membrane, may cause conjunctivitis, edeme, corneal opacity, even blindness; strong irritation to respiratory tract, causing edeme in respiratory system and lung. The concentrated acid may cause guttural spasm or glottis edema. Even gastric perforation if swallowed.                                                      |                                |              |
| Hazard characteristics     |                                                                                             | A large amount of heat release when contact with water, causing sputtering; cause rigorous reaction when contact with inflammable substances (e.g. benzene) and combustible substances (e.g. natural fiber), even fire. Cause vigorous reaction when contact with acetylith, perchlorate. nitrate, picric acid, metallic powder, resulting in explosion and fire. |                                |              |

**Table 12.2-8 Physicochemical Property and Hazard Characteristic of H<sub>2</sub>O<sub>2</sub>**

| Item                       | Hydrogen peroxide, H <sub>2</sub> O <sub>2</sub> , ozogen                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Physicochemical properties | Colorless transparent liquid, special weak smell; solubility: soluble in water, alcohol, ether, insoluble in benzene, petroleum ether; relative density (water=1): 1.46 (anhydrous), flash point (°C): insignificant; explosive limit(V/V%): insignificant                                                                                                                                                                                                                                                                                                                                                                                              |
| Hazard characteristics     | May promote intensity of fire; cause fire in contact with inflammable and combustible substances (such as wooden material, paper, clothing etc.); may cause explosively reaction in contact with fuel, packing container may be exploded when heated.<br>Health harm: low toxic; may cause serious damage, burn or even death in inhalation, and intake or to eye, skin in contact with vapor, powder or H <sub>2</sub> O <sub>2</sub> ; generate toxic irritant gas; the toxic gas or powder dust can be collected in the closed space (cellar, container, storage tank/tank truck, ect.). The wastewater from fire extinguishing can cause pollution. |

**Table 12.2-9 Physicochemical Properties and Hazard Characteristics of ClO<sub>2</sub>**

| Item                       | Chlorine dioxide, ClO <sub>2</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Physicochemical properties | It is gas which will change its color from green-yellow to orange along with temperature rising; boiling point: 11°C, freezing point: -59°C, critical point: 153°C.                                                                                                                                                                                                                                                                                                                                                                                                             |
| Hazard characteristics     | May explode when the concentrated vapor exceeded an atmospheric pressure 41Kpa, namely, exploded if its pressure reached to 40KPa; may explode in a low scale when its concentration in solution is higher than 10% (W/V) or explode when its concentration is 10%(V/V) in air. The explosion may become strong in the presence of organic vapor. ClO <sub>2</sub> is unstable, decomposed into oxygen and chlorine if heated or under irradiation of light, causing explosion; may also cause explosion in contact with organic substance which will facilitate the oxidation. |

**Table 12.2-10 Physicochemical Properties and Hazard Characteristics of sulfureted hydrogen**

| Item                       | Sulfureted hydrogen, H <sub>2</sub> S                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Physicochemical properties | It is a colorless gas, with the smell of putrid egg. Molecular formula: H <sub>2</sub> S; molecular weight: 34.08; relative density: 1.19; melting point: -82.9°C; boiling point: -61.8°C. It is easy to dissolve in water, alcohol, petroleum solvent, and crude oil. The upper flammable limit is 45.5%, and lower limit 4.3%; ignition point: 292°C.                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Hazard characteristics     | H <sub>2</sub> S is a kind of nerve poison, suffocating and irritant gas. The main target organs under its toxic effect are the central nervous system and respiration system, and it may also damage many organs, such as heart. The tissue most sensitive to its toxic effect is the part which connects brain and mucous membrane. One person's inhalation of LCL0: 600 ppm/30M, 800 ppm/5M. One (male) person's inhalation of LCL0: 5700 ug/kg. One rat's inhalation of LC50: 444 ppm. One mouse's inhalation of LC50: 634 ppm/1H. Most sulfureted hydrogen in bodies is oxygenized and metabolized, with thiosulfate and sulfate formed to remove toxic substances. In the process of metabolism, glutathione may play an activating role. A little sulfureted hydrogen may undergo methylated metabolism, forming |

| Item | Sulfureted hydrogen, H <sub>2</sub> S                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|      | <p>methanethiol and methyl sulfide with low toxicity, but methanethiol in high concentration may cause anesthesia to the central nervous system. Metabolic products inside bodies may be discharged along with urine within 24 hours, part is discharged along feces and a small amount is breathed out through lungs in the original form. There will be no cumulation inside the bodies.</p> <p>The target organs under the acute toxic effect of sulfureted hydrogen and toxic mechanism may change according to its concentration and contact time. The higher the concentration, the more obvious its inhibitory action on the central nervous system; when the concentration is relatively low, the irritation on mucous membrane would be obvious. After one inhaling 70~150 mg/m<sup>3</sup>/1~2 hours, there will be symptom of irritation on respiratory tract and eye, and after inhaling it for 2-5 minutes, one will suffer the smelling fatigue, not catching any smell any more. After one inhaling 300 mg/m<sup>3</sup>/1hour, there will be symptom of acute irritation on eyes and a bit longer contact will give rise to pulmonary edema. After one inhaling 760 mg/m<sup>3</sup>/15~60 minutes, he or she may suffer from pulmonary edema, bronchitis and pneumonia, as well as headache, dizziness, unstable gait, sicchasia, and emesis. After one inhaling 1000 mg/m<sup>3</sup>/several seconds, he or she will suffer from acute intoxication, and die after having accelerated and paralyzed respiration.</p> |

### 12.2.3 Risk Identification of Equipment and Apparatus

In the production process the potential risks of equipment and apparatus include leak and fire explosion of liquefied petroleum gas, leak and fire explosion of methanol, explosion resulted from breakdown of ClO<sub>2</sub> generator which are caused by out of order of the production equipment and apparatus system; leak and fire explosion caused by damage of various pipe pipes, pumps, and tanks as aging or corrosive perforation. The risk identification of equipment and apparatus involved in production and storage is given in Table 12.2-11.

**Table 12.2-11 Risk identification of equipment and apparatus**

| Type                | Item                                         | Potential risk type                          | Location of potential risk                                                                                        |
|---------------------|----------------------------------------------|----------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| Dangerous chemicals | Pulp and paper making unit                   | Leakage of caustic soda and black liquor     | Caustic soda storage house, pulping workshop, soda recovering vehicle and each apparatus, pumps, connection, etc. |
|                     |                                              | Leakage of sulfuric acid                     | Pipe for transferring sulfuric acid, pumps, etc.                                                                  |
|                     |                                              | Leakage of H <sub>2</sub> O <sub>2</sub>     | H <sub>2</sub> O <sub>2</sub> storage house, solution preparation barrel, , Transportation pumps, pipe, etc       |
|                     |                                              | Leakage of heavy oil                         | Heavy oil tanks, transportation pipe, pumps etc.                                                                  |
|                     | Chemical preparation segment functional unit | Leakage of methanol, fire explosion          | Methanol tanks, transportation pipe, pumps etc.                                                                   |
|                     |                                              | Leakage of sulfuric acid                     | H <sub>2</sub> SO <sub>4</sub> tanks, transportation pipe, pumps etc.                                             |
|                     |                                              | Leakage of ClO <sub>2</sub> , fire explosion | ClO <sub>2</sub> generator, transportation pipe, storage tank, etc.                                               |
| Others              | LP station unit                              | Leakage of petroleum gas, explosion          | Liquefied petroleum gas tanks, compressor, carburetor and various connecting pipes, etc.                          |
|                     |                                              | Leakage of wastewater, wastewater discharge  | Sewage treatment equipment, pipe                                                                                  |
|                     |                                              | Dam collapse                                 | Sludge dumping place                                                                                              |

## 12.3 Sources Term Analysis

### 12.3.1 Maximum Credible Accident

Based on identification of environmental risk, statistical analysis on accidents, data of accidental cases in the same trade, danger of various dangerous substances and their storage capacity in our own enterprise in the country, integrated with consideration of surrounding situation of the project upon which the serious danger is resulted from fire explosion of liquefied petroleum gas tank and methanol storage tank, such that the functional unit of liquefied petroleum gas station in this Risk Assessment is defined as the most credible accident in accordance with leakage and fire explosion of liquefied petroleum gas tank and methanol storage tank.

### 12.3.2 Analysis on Probability of Occurrence of the Maximum Credible Accident

#### 12.3.2.1 Analytical Method

The analytical method is determined in accordance with fault tree.

#### 12.3.2.2 Analysis of Probability of Occurrence of Fire Explosion of Liquefied Petroleum Gas

Analysis with fault tree on liquefied petroleum gas storage tank is shown in Fig. 12.3-1.



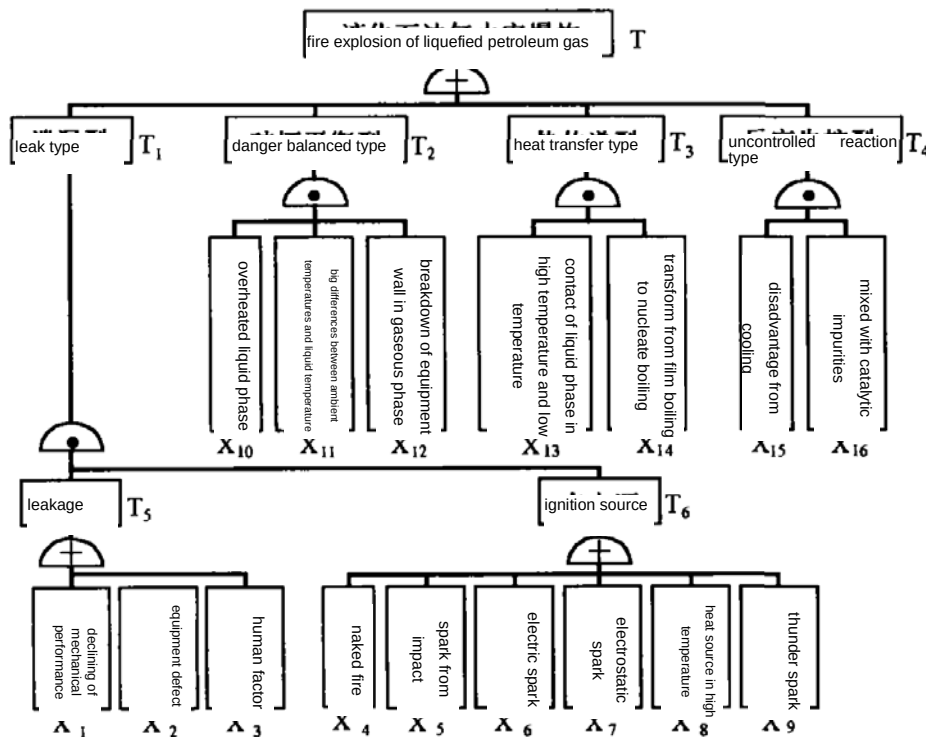


Fig.12.3-1 Fault tree analysis for fire explosion of liquefied petroleum gas

## (1) Minimum cut set analysis

Min. cut sets are {  $X_1, X_4$ ;  $X_2, X_4$ ;  $X_3, X_4$ ;  $X_1, X_5$ ;  $X_2, X_5$ ;  $X_3, X_5$ ;  $X_1, X_6$ ;  $X_2, X_6$ ;  $X_3, X_6$ ;  $X_1, X_7$ ;  $X_2, X_7$ ;  $X_3, X_7$ ;  $X_1, X_8$ ;  $X_2, X_8$ ;  $X_3, X_8$ ;  $X_1, X_9$ ;  $X_2, X_9$ ;  $X_3, X_9$ ;  $X_{10}, X_{11}, X_2$ ;  $X_{13}, X_{14}$ ;  $X_{15}, X_{16}$  }

## (2) Importance degree of structure of the basic event (I)

The sequence of structure importance based on min. cut set is arranged as follows:

$$I_{(1)} = I_{(2)} = I_{(3)} > I_{(4)} = I_{(5)} = I_{(6)} = I_{(7)} = I_{(8)} = I_{(9)} > I_{(13)} = I_{(14)} = I_{(15)} = I_{(16)} > I_{(10)} = I_{(11)} = I_{(12)}$$

From which in the type of explosion of liquefied petroleum gas, the fire explosion in leakage type is the most dangerous one in terms of probability.

## 12.3.2.3 Analysis of Probability of Occurrence of Fire Explosion of Methanol Tank

Analysis with fault tree for methanol storage tank is shown in Fig. 12.3-2.

Due to insufficient data available in calculation of probability for methanol storage tank, calculation of probability of occurrence methanol storage tank is carried out with the analogy similar to fuel storage tank with results obtained:  $A = 8.7 \times 10^{-5}$  time/tank.

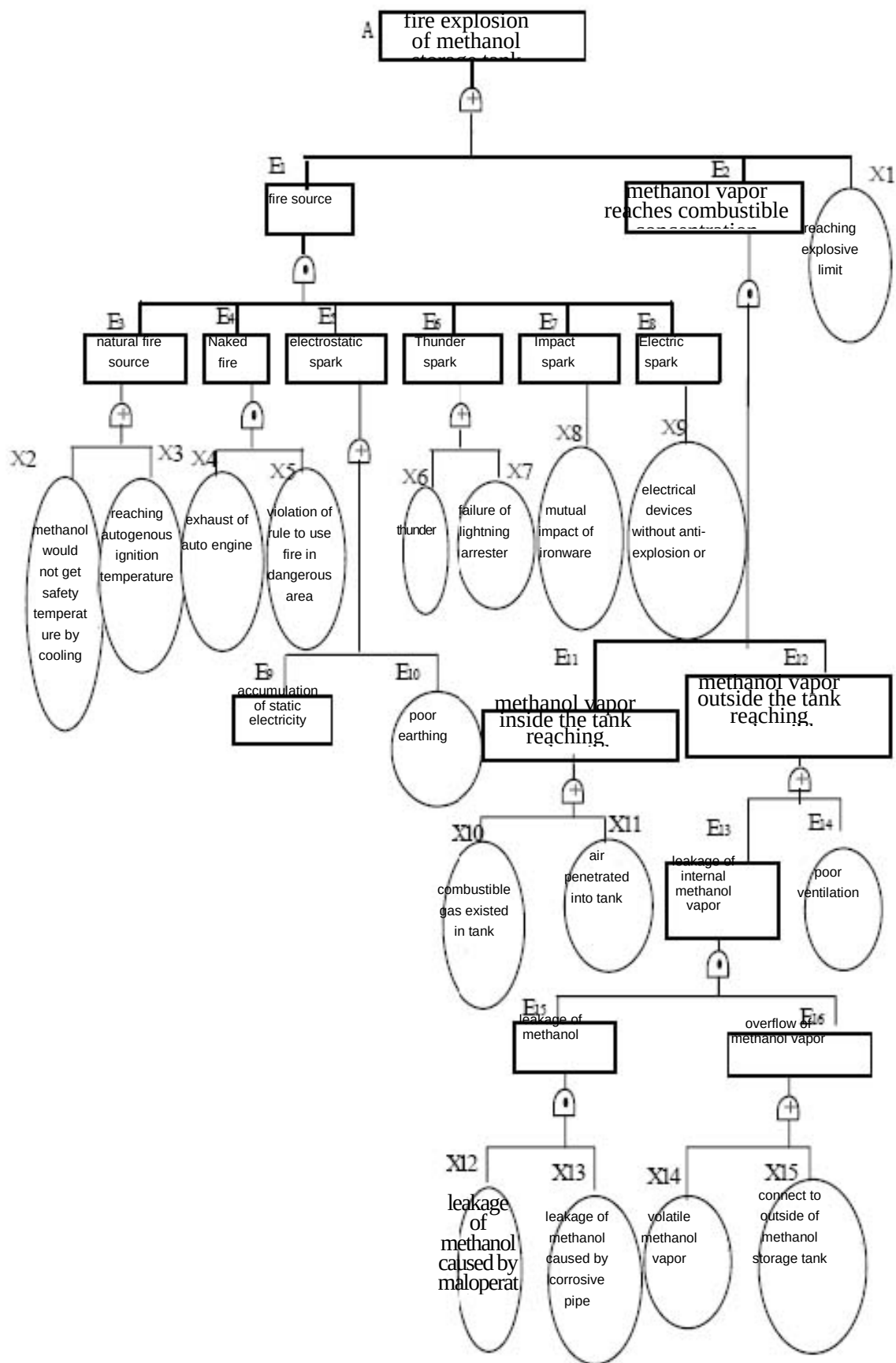


Fig. 12.3.2 Event of fire explosion of methanol tank

## 12.4 Consequence Calculation

### 12.4.1 Consequence Calculation for Fire Explosion

#### 12.4.1.1 Prediction Model

##### (1) Prediction model for fire explosion of liquefied petroleum gas

Fire explosion accident of liquefied petroleum gas in the project is predicted with a model of fire ball and explosion.

##### ① Radius of the fire ball after exploded:

$$R=2665M^{0.327}$$

in which R - radius of fire ball, m;

M - mass of combustible substances in vigorous evaporation, kg.

##### ② Duration of fire ball:

$$t=1.089M^{0.327}$$

in which t - duration of fire ball, s;

##### ③ Radiated heat flux released during fire:

$$Q = \frac{\eta H_c M}{t}$$

in which Q - radiated heat flux released during fire ball burning, w;

H<sub>c</sub> - combustion heat, J/kg;

h - efficient factor,  $h=0.27p^{0.32}$

##### ④ Intensity of incident heat radiation that object received

$$I = \frac{QT_c}{4\pi x^2}$$

in which T<sub>c</sub> - coefficient of conductivity, conservative value taken is 1;

x - horizontal distance between object and a center of fire ball.

##### (2) Prediction model for methanol fire explosion

Fire explosion accident of methanol in the project is predicted with a model of pool fire.

##### ① Calculation of radius and height of pool fire

$$R_f = \sqrt{\frac{S}{\pi}}$$

$$L = 84R_f \left[ \frac{m_f}{\rho_0 \sqrt{2gR_f}} \right]^{0.61}$$

in which S - area of the liquid pool, m<sup>2</sup>;

R<sub>f</sub> - radius of pool fire, m;

L - height of fire, m;

m<sub>f</sub> - combustion rate of methanol, kg·m<sup>-2</sup>·s<sup>-1</sup>;

ρ<sub>0</sub> - air density, kg m<sup>-3</sup>.

② Calculation of heat radiation flux on surface of fire, Q<sub>f</sub>

$$Q_f = \frac{(\pi R_f^2 + 2\pi R_f L) m_f \eta H_c}{72 m_f^{0.61} + 1}$$

in which η - heat radiation coefficient, taken as 0.15;

H<sub>c</sub> - combustion heat, J/kg.

③ Intensity of heat radiation that object received, I

$$I = \frac{Q_f T_c}{4\pi R^2}$$

in which I - intensity of heat radiation that object received;

T<sub>c</sub> - coefficient of conductivity, conservative value taken is 1;

R - horizontal distance between object and a center of fire ball.

#### 12.4.1.2 Determination of Prediction Parameters

(1) Prediction parameter of methanol

① Presume that the methanol storage tank invoke leakage, tank area being set with cofferdam with its area of 200m<sup>2</sup> and height of 1m.

② Presume that cylindrical fire and pool area is constant in pool fire.

The prediction parameter of methanol is given in Table 12.4-1.

Table 12.4-1 The prediction parameter of methanol

| Capacity<br>(m <sup>3</sup> ) | Area of<br>cofferdam<br>(m <sup>2</sup> ) | Density of<br>methanol<br>(kg·m <sup>-3</sup> ) | Density of air<br>(kg·m <sup>-3</sup> ) | Combustion rate<br>(kg·m <sup>-2</sup> s <sup>-1</sup> ) | Combustion<br>heat<br>(J/kg) |
|-------------------------------|-------------------------------------------|-------------------------------------------------|-----------------------------------------|----------------------------------------------------------|------------------------------|
| 200                           | 200                                       | 790                                             | 1.293                                   | 57.6                                                     | 16.7×10 <sup>6</sup>         |

## (2) Prediction parameter of liquefied petroleum gas

The prediction parameter of liquefied petroleum gas is given in Table 12.4-2.

Table 12.4-2 The prediction parameter of liquefied petroleum gas

| Mass of LPG (kg) | Saturated vapor pressure (pa) | Combustion heat (J/kg) |
|------------------|-------------------------------|------------------------|
| 20000            | 1.24×10 <sup>6</sup>          | 4.67×10 <sup>7</sup>   |

## (3) Norm of heat radiation harm

Norm of heat radiation harm under action of fire in stable state is given in Table 12.4-3.

Table 12.4-3 Norm of heat radiation harm

| Incident flux (kW/m <sup>2</sup> ) | Harm to human                           | Harm to equipment                                                                                              |
|------------------------------------|-----------------------------------------|----------------------------------------------------------------------------------------------------------------|
| 37.5                               | 1%death/10s; 100%death/1min             | Total damage of operational equipment                                                                          |
| 25                                 | Severe burning /10s;<br>100%death/1min  | Min. energy needed to cause ignition of<br>wooden material under long-term radiation<br>without fire existed.  |
| 12.5                               | Burning level 1 /10s; 1 %<br>death/1min | Min. energy needed to cause ignition of<br>wooden material and melting of plastics in the<br>existence of fire |

## 12.4.1.3 Prediction Results

Results of risk prediction for methanol and liquefied petroleum gas storage tanks are given in Tables 12.4-4 and 12.4-5.

Table 12.4-4 Results of risk prediction for explosion of liquefied petroleum gas tank

| Degree of harm and<br>damage | 1%death/10s;<br>100%death/1min | Severe burning/10s;<br>100%death/1min | Burning level 1/10s;<br>1%death/1min |
|------------------------------|--------------------------------|---------------------------------------|--------------------------------------|
| Radius of harm (m)           | 44                             | 53                                    | 75                                   |

Table 12.4-5 Results of risk prediction for explosion of methanol tank

| Degree of harm and<br>damage | 1%death/10s;<br>100%death/1min | Severe burning/10s;<br>100%death/1min | Burning level 1/10s;<br>1%death/1min |
|------------------------------|--------------------------------|---------------------------------------|--------------------------------------|
| Radius of harm (m)           | 32                             | 39                                    | 56                                   |

## 12.4.2 Consequence Prediction for Leakage of Methanol

## 12.4.2.1 Estimation of Leakage Rate

In accordance with instruction of *Applied Technology and Methods of Environmental Risk Assessment*, the leakage of storage tanks usually appears as damage of container,

leakage of connection, and leakage of pipe usually at flange and connection. Presume that there is a leakage hole in 100mm in pipe for continuous leaking for 10min; the leakage rate is then estimated accordingly.

The leakage rate of liquid could be calculated using Bernoulli equation of fluid mechanics as follows:

$$Q_0 = C_d A \rho \sqrt{\frac{2(P - P_0)}{\rho} + 2gh}$$

Where in:  $Q_0$  - leakage rate of liquid, kg/s;

$C_d$  - leakage factor of liquid, generally 0.40-0.65;

$A$  - area of crack,  $m^2$ ;

$P$  - density of leaking liquid,  $kg/m^3$ ;

$P$  - pressure of medium inside the container, Pa;

$P_0$  - pressure of environment, Pa;

$G$  - acceleration of gravity,  $g=9.8 m/s^2$ ;

$H$  - fluid level above the crack, m.

The leakage rate of methanol (in liquid form) can be calculated as 40.01kg/s from the view of most disadvantageous angle that  $C_d=0.65$ ,  $h=5m$ .

#### 12.4.2.2 Estimation and Analysis of Intensity of Source

After leakage happened the liquid would spread along ground to a low-lying place or artificial boundary such that a liquid pool formed. Evaporation of liquid in leakage is divided into three kinds: flash evaporation, heat evaporation and mass evaporation; the total evaporation is a sum of the three evaporated amounts, the boiling point of methanol at ambient temperature and conventional pressure is  $64.5^{\circ}C$ , the max. temperature at the environment of project location is  $37^{\circ}C$ , lower than the boiling point, therefore, evaporation of methanol in leakage is nothing to do with flash and heat evaporations, the equation of mass evaporation is:

$$Q_3 = a \times p \times M / (R \times T_0) \times u^{(2-n)/(2+n)} \times r^{(4+n)/(2+n)}$$

in which  $Q_3$  - mass evaporation rate, kg/s;

$a$ ,  $n$  - coefficient of atmospheric stability, see Table 12.4-5;

$R$  - gas constant;

$T_0$  - environmental temperature, k;

U - wind speed, m/s;

R - radius of liquid pool, m.

**Table 12.4-5 Parameter of evaporation mode of liquid pool**

| Condition of stability | n    | $\alpha$               |
|------------------------|------|------------------------|
| Unstable (A,B)         | 0.2  | $3.846 \times 10^{-3}$ |
| Neutral (D)            | 0.25 | $4.685 \times 10^{-3}$ |
| Stable (E,F)           | 0.3  | $5.285 \times 10^{-3}$ |

Each parameter taken is listed in Table 12.4-6.

**Table 12.4-6 Parameter taken**

| p                   | R     | M     | T <sub>0</sub> | u   | r   |
|---------------------|-------|-------|----------------|-----|-----|
| $13.33 \times 10^3$ | 8.314 | 24003 | 22.6           | 3.6 | 5.9 |

Upon calculation, the source intensity of gaseous methanol is 0.1538kg/s.

#### 12.4.2.3 Consequence Prediction for Leakage Event

Evaluation of harm from diffusion of methanol vapor is carried out by a model provided by

Word Bank:

$$C(x, y, z) = \frac{Q}{\pi \delta_y \delta_z u} \exp \left\{ -\frac{1}{2} \left( \frac{y^2}{\delta_y^2} + \frac{z^2}{\delta_z^2} \right) \right\} \quad (\text{Continuous leakage})$$

in which:

Q - continuously discharged mass of material, mg;

U - average wind speed, m/s;

Y - lateral distance, m;

Z - height above ground, m;

$\delta_y, \delta_z$  - coefficient of diffusion in y, z directions.

#### 12.4.2.4 Results of Prediction

The treatment of methanol leaked will be completed within 30min, and then the prediction of axial concentration of methanol vapor along ground is given in Table 12.4-7. Under unfavorable weather conditions, the envelope diagram of methanol concentration exceeding the maximum allowable concentration range for harmful substances in the air of workshop and environmental standard range is shown in Figure 12.5-1.

**Table 12.4-7 Prediction result of ground concentration of methanol after leakage**

| Class D stability, wind speed 3.6m/s                                                                                            |                                         |                            | Class F stability, wind speed 1.5m/s                                                                                            |                                         |                            |
|---------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|----------------------------|---------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|----------------------------|
| Maximum concentration (mg/m <sup>3</sup> )                                                                                      | Time of occurrence (min)                | Distance of occurrence (m) | Maximum concentration (mg/m <sup>3</sup> )                                                                                      | Time of occurrence (min)                | Distance of occurrence (m) |
| 196185                                                                                                                          | 30                                      | 1                          | 472239                                                                                                                          | 30                                      | 1                          |
| The range (m) exceeding half lethal concentration (91543 mg/m <sup>3</sup> )                                                    |                                         |                            | The range (m) exceeding half lethal concentration (91543 mg/m <sup>3</sup> )                                                    |                                         |                            |
| 0~1.7                                                                                                                           |                                         |                            | 0~2.5                                                                                                                           |                                         |                            |
| The range (m) exceeding the maximum allowable concentration (50mg/m <sup>3</sup> ) for harmful substance in the air of workshop |                                         |                            | The range (m) exceeding the maximum allowable concentration (50mg/m <sup>3</sup> ) for harmful substance in the air of workshop |                                         |                            |
| 0~93                                                                                                                            |                                         |                            | 0~127                                                                                                                           |                                         |                            |
| The range (m) exceeding environmental standard (3mg/m <sup>3</sup> )                                                            |                                         |                            | The range (m) exceeding environmental standard (3mg/m <sup>3</sup> )                                                            |                                         |                            |
| 0~482                                                                                                                           |                                         |                            | 0~635                                                                                                                           |                                         |                            |
| Concentration reaching Yaxi Village(mg/m3)                                                                                      | Concentration reaching Haishanba(mg/m3) |                            | Concentration reaching Yaxi Village(mg/m3)                                                                                      | Concentration reaching Haishanba(mg/m3) |                            |
| 2.83                                                                                                                            | 4.05                                    |                            | 4.45                                                                                                                            | 6.49                                    |                            |

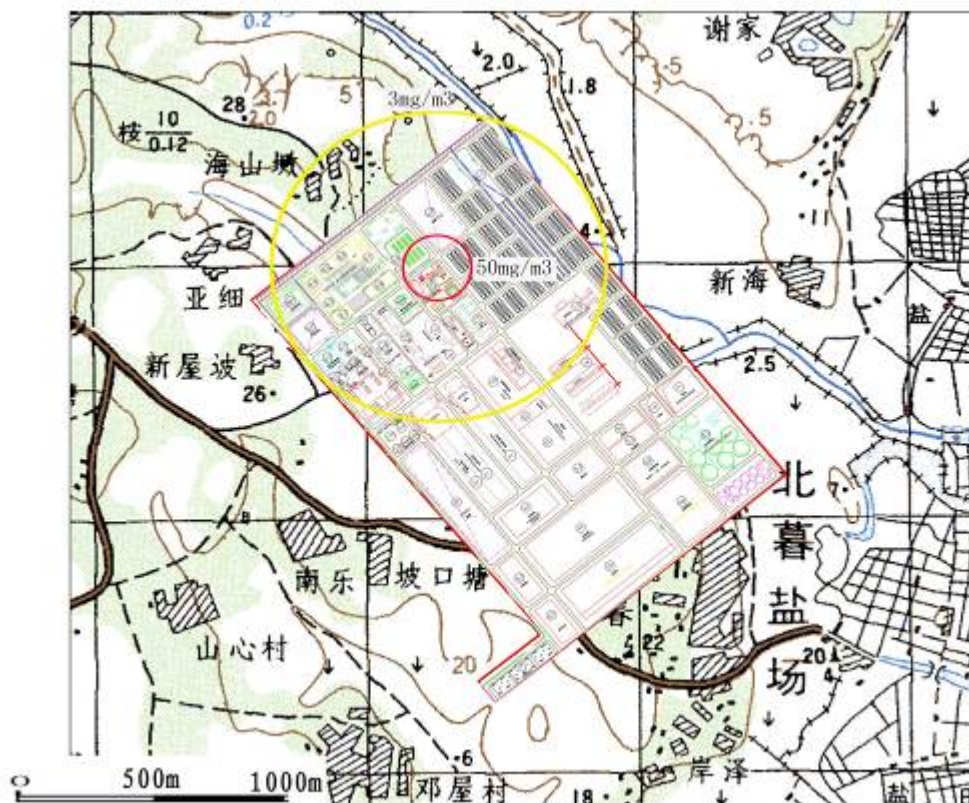


**Figure 12.5-1** Envelope diagram of environmental influence after the leakage of methanol

## 12.5 Quantitative Risk Assessment

### 12.5.1 Assessment standard

There is no acceptable risk value in the industry of paper making, so the risk value of the



petrochemical industry is used analogously as the standard in this assessment. According to the statistical result of the investigation on the petrochemical industry of the whole country by the *Manual of Basic Data for Industrial Safety and Health*, it is determined that the acceptable accident risk value,  $R_L$ , is  $8.33 \times 10^{-5}$  people/a.

### 12.5.2 Calculation of hazard

When there is a fire accident in the liquefied petroleum gas (LPG) tank and methanol tank, sites and locations inside the lethal radius only include the LPG tank farm and ethanol tank farm, people in the residential area in the environment outside the plant boundary involved in the damage radius is 0. Therefore, there will be no death in the external environment caused by an accident.

In case of the accident of methanol leakage, the radius of half lethal concentration occurred under the most unfavorable weather condition is 0~2.5m, so there will be no death in the environment outside the plant boundary caused by an accident.

### 12.5.3 Risk to environment by the largest believable hazard accident

$$R = P \times C$$

Wherein:

R - Risk value

P – Probability of biggest believable accident

C – Damage caused by the biggest believable accident

There will be zero death in the external environment caused by the fire accident in the LPG tank and methanol tank, zero death in the external environment resulted from methanol leakage. Therefore, the damage caused by the biggest believable accident is zero death, with a risk value of 0 person/a.

### 12.5.3 Risk Assessment

$R_{\max}$  is 0 person/a,  $R_L$   $8.33 \times 10^{-5}$  person/a, and  $R_{\max} < R_L$ , so the environmental risk level of this project is acceptable.

## 12.6 Qualitative Risk Assessment

### 12.6.1 Assessment of Risk of Fire Explosion to Environment

If methanol and LPG is caught in fire explosion, it will generate a large amount of irritant, toxic or corrosive gas, e.g. CO and CO<sub>2</sub>, resulting in pollution of the air environment. Yaxi Village and Haishanba are the closest places to plant location, 230m away from the danger source. By analogy of relevant fire explosive, the concentration of toxic and harmful gas with the smoke produced in the accident of fire explosion reaching Yaxi village and Haishanba through diffusion in a range of 200m can be kept at a low level, which will not cause acute intoxication to residents. Therefore, the environmental risk is acceptable.

### 12.6.2 Risk Assessment of Methanol Leakage

It can be seen from Table 12.4-6 that, under the unfavorable weather condition (the atmospheric stability of type F with a wind speed of 1.5m/s), the range exceeding the maximum allowable concentration for harmful substance in the air of workshop is 0-127m when leakage occurs in the pipeline of methanol storage tank and equipment, and such a radius range is within the factory; through the 635m diffusion, the methanol concentration in ambient air is lower than the primary maximum allowable concentration (3.00 mg/m<sup>3</sup>) of methanol in the atmosphere of a residential area specified in *Hygienic standards for the Design of Industrial Enterprises* (TJ36-79). The concentration of methanol in ambient air of Yaxi Village and Haishanba within the range of 635m is 6.49 mg/m<sup>3</sup> and 4.45 mg/m<sup>3</sup> respectively, both higher than the primary maximum allowable concentration of methanol in the atmosphere of a residential area specified in *Hygienic standards for the Design of Industrial Enterprises* (TJ36-79), but far lower than the half lethal concentration (91543mg/m<sup>3</sup>). Therefore, in case of methanol leakage, it would cause a certain degree of impact on the ambient air quality of Yaxi Village and Haishanba, but not cause acute intoxication to residents. Therefore, the environmental risk is acceptable.

### 12.6.3 Risk Assessment over the preparation process of chlorine dioxide

#### 12.6.3.1 Analysis of explosion risk in the preparation process of chlorine dioxide

The proposed project of ClO<sub>2</sub> preparation employs R<sub>10</sub> method. Namely, sulfuric acid is used as the acidifier and methanol as the reducer to reduce sodium chlorate, and the chlorine dioxide and water vapor generated enter into the chlorine dioxide absorption

tower together, where chilled water (7~10°C) is sprayed to absorb chlorine dioxide for preparing chlorine dioxide solution. The solution will be stored in the storage tank of chlorine dioxide and then conveyed to pulping workshop for the bleaching process. Under normal circumstance, there will be no risk of explosion in the preparation process. During the production, however, there is possibility for equipment explosion due to poor control over temperature, pressure, proportioning, etc. The physical damage radius of an explosion accident is usually about dozens of meters, which will not cause casualties to residents in surrounding environmental sensitive points. After explosion, the leaked gas may contain harmful substances such as chlorine dioxide, methanol, etc., which will have certain degree of impact on the ambient air quality in the environmental sensitive points, Yaxi Village and Haishanba. If the sewage produced during explosion accidents is directly discharged into the sea, it will have some certain degree of impact on the quality of sea water.

One of the raw materials used in this process is sodium chlorate, which is an active substance, and it is easy to cause explosion by mere knock or friction when the material contacts or mixes with flammable organics, reducer, phosphorous, sulfur, carbon, and metal powder. Therefore, during the storage and utilization, it should be stored in strict conformity with the related specifications and requirements. In this way, there is extremely small possibility for explosion if it does not mix or contacts with the above materials.

#### 12.6.3.2 Analysis on the storage risk of chlorine dioxide

Chlorine dioxide is not stable, easy to decompose into oxygen and chlorine when affected by heat or light, which may cause explosion. It may also lead to explosion when meeting substances which facilitate oxidization, such as organics. It is safer when chlorine dioxide gas is diluted to below the concentration of 10% (V/V) with air; the concentration of chlorine dioxide solution is about 8~10g/L, which will not produce enough high vapor pressure to cause explosion. Chlorine dioxide in this project is prepared into 9g/L solution for storage, with six storage tanks made of glass fiber reinforced plastic, each holding a volume of 500m<sup>3</sup>. Therefore, chlorine dioxide stored in this project is relatively safe, with a small probability for accidents.

Chlorine dioxide is a type of toxic and corrosive hazardous chemical. It will erode the equipment in case of leakage. If one inhales, ingests or contacts with the substance, it

may lead to serious damage or even death; there may be serious burns in case that one's skin and eye contacts with the substance in fusion. If the leaked chlorine dioxide solution flows into the sea along the rainwater drainage ditch, it will pollute the sea water in the area leading to intoxication or death of aquatic organisms and deterioration of water quality. If the leaked solution flows into the earth's surface, the soil property will go bad and plants may be eroded and die.

#### 12.6.4 Risk Assessment over the accident of smell emission in high concentration

The smell in high concentration mainly comes from the cooking kettle, evaporating pot, dirty condensation water and gas stripping column, etc., and the concentration of TRS in the highly concentration smell is usually 50000~200000mg/Nm<sup>3</sup>. All smell in high concentration is collected and assembled to alkali boiler for combustion. When the boiler fails, the smell will go to the standby burner (fuel torch) at its top. Therefore, there is only a slight probability for having the accident of emitting highly concentrated smell.

#### 12.6.5 Analysis on Other Risks

##### 12.6.5.1 Analysis on Risk of Wastewater Discharge

The project is characterized by a large amount of wastewater needed to be treated. In case the equipment in sewage treatment station is out of order leading to accident of wastewater discharge, high concentration of various pollutants in the wastewater would invoke a definite effect on the environment. The Risk Assessment for prediction of event has been made with results given in Tables 12.6.-1 and 12.6-2.

**Table 12.6-1 Analysis of the impact on water environment by waster water discharge accident**

Max. potential area affected at different concentration (km<sup>2</sup>)

| No.      | COD (mg/L) |        |        |         | SS( mg/L) |        |         | AOX( mg/L) |        |         |
|----------|------------|--------|--------|---------|-----------|--------|---------|------------|--------|---------|
|          | >5         | >4     | >3     | >2      | >10       | >5     | >1      | >0.10      | >0.05  | >0.01   |
| Phase I  | 0.1162     | 0.3384 | 1.8174 | 39.1841 | 0.0046    | 0.0261 | 0.8763  | 0.0483     | 0.2093 | 31.1147 |
| Phase II | 0.1238     | 0.3490 | 1.8872 | 44.4981 | 0.0187    | 0.1019 | 4.8202  | —          | —      | —       |
| Phase    | 0.1301     | 0.3586 | 1.9636 | 47.6637 | 0.0550    | 0.2388 | 37.8913 | —          | —      | —       |

III

**Table 12.6-2 Analysis of the impact on environmental sensitive object by waster water discharge accident**

Max. increased concentration arriving at the sensitive object of environment

| No.          | COD(mg/L)                      |                   |                     | SS(mg/L)                       |                   |                     | AOX(mg/L)                      |                   |                     |
|--------------|--------------------------------|-------------------|---------------------|--------------------------------|-------------------|---------------------|--------------------------------|-------------------|---------------------|
|              | Yingpan<br>mariculture<br>zone | Dugong<br>reserve | Mangrove<br>reserve | Yingpan<br>mariculture<br>zone | Dugong<br>reserve | Mangrove<br>reserve | Yingpan<br>mariculture<br>zone | Dugong<br>reserve | Mangrove<br>reserve |
| Phase<br>I   | 0.425                          | 0.027             | 0.246               | 0.398                          | 0.024             | 0.220               | 0.008                          | 0.001             | 0.005               |
| Phase<br>II  | 0.449                          | 0.029             | 0.269               | 0.607                          | 0.041             | 0.385               | —                              | —                 | —                   |
| Phase<br>III | 0.465                          | 0.031             | 0.284               | 0.916                          | 0.063             | 0.589               | —                              | —                 | —                   |

It can be known from Table 12.6-1 that the maximum range for COD concentration around sewage outlet caused by the accident of wastewater discharge exceeding Class I water quality in *Sea Water Quality Standard* (GB3097-1997) will be 47.6637km<sup>2</sup>, that exceeding Class II water quality 1.9636 km<sup>2</sup>, that exceeding Class III water quality 0.3586km<sup>2</sup>, and that exceeding Class IV water quality 0.1301km<sup>2</sup>; in case of accident, the ranges of suspended substance around sewage outlet over the limits for Class I and Class II sea water quality standard are both very small, causing little impact on the water environment; the water area with AOX>0.01mg/L is 31.1147km<sup>2</sup>, that with AOX>0.05mg/L 0.2093km<sup>2</sup>, and that with AOX>0.10mg/L 0.0483km. This shows that the AOX discharge of the project in case of an accident will have only an impact to the marine environment in a limited range and to a limited extent.

It can also be known from Table 12.6-2 that the accident discharge of waste water would have limited effect on water quality of Yingpan mariculture zone, Dugong reserve and Mangrove reserve, which does not cause the water quality of the area to exceed the corresponding water quality standard specified in Class I in *Sea Water Quality Standard* (GB3097-1997).

In summary, under the circumstance of discharge accident, the wastewater would have limited effect on water quality of environmentally sensitive protection objects, but the impact of COD concentration in sewage is considerably big, requiring further severe management, with prevention equipment to be provided to prevent and put an end to the

accident of sewage discharge.

#### 12.6.5.2 Risk Analysis of Wastewater Leakage

When ground in plant location is not sufficiently solidified, once the transportation pipes break leading to wastewater leakage, the wastewater around the leak source would penetrate into soil in the surrounding areas, which may cause pollution of quality of underground water surrounding the location.

#### 12.6.5.3 Risk analysis for accident in lime mud stockpile

During the operation process, due to the relatively shallow phreatic aquifer, the lime mud stockpile may suffer from problems such as collapse of foundation trench and uneven subsidence of groundwork caused by geological disaster. It may lead to the break of impervious layer under the lime mud stockpile, and thus causing percolate to pollute the ground water.

Poor stability of dam body of lime mud stockpile would lead to collapse and burst of dam, caused by overflow of flooded water. The accident will cause the sludge flow along the terrain into the sea area of Tieshan Port, which will increase the concentration of suspended substance in this sea area, and thus the pollution of water quality.

### 12.7 Risk Precautions

#### 12.7.1 Plane Layout

(1) Distances between various constructive structures and environmentally sensitive sites and enterprise would be required to satisfy with safety protective distance and distance needed to prevent fire, and fire resistant grade of constructive structures on *Code for Fire Protection Design of Building*.

(2) Total plane layout in plant location should meet the requirement for accident prevention, provided with emergent rescue facilities and rescue passage, emergency evacuation, road arrangement, and the requirement for fire-fighting and transportation.

(3) Since the respective radius leading to total damage of production facilities and ignition of wooden material in the case of fire explosion of LPG tank of the project is 44m and 75m, it is proposed that in the plane layout of designing location it is inadvisable to arrange the constructive structures in an range of 50m and freight yards for combustible substances in an range of 50-80m from LPG tank.

(4) Since the respective radius leading to total damage of production facilities and

ignition of wooden material in the case of fire explosion of methanol tank of the project is 32m and 56m, it is proposed that in the plane layout of designing location it is inadvisable to arrange the constructive structures in an range of 35m and freight yards for combustible substances in an range of 60m from methanol storage tank.

#### **12.7.2 Precautions for Transportation and Storage**

(1) Manage the dangerous chemicals of the unit strictly in accordance with the management requirements in State Council of PRC Decree No. 344 *Regulations on the Control over Safety of Dangerous Chemicals* and *Implementation Methods of Regulations on the Control over Safety of Dangerous Chemicals by Guangxi Zhang Autonomous Region* issued by Government of Guangxi Zhuang Autonomous Region Order No. 6.

(2) In transportation of dangerous chemicals with vehicle, it should abide to regulations stipulated by local Public Security Department and Transportation Department with its route for transportation, restriction of parking vehicle at densely populated area or by a place having a naked fire.

(3) Any unit for transportation of dangerous chemicals must be qualified for doing so; any tank and other container for transportation of dangerous chemicals should be directly manufactured by a special production enterprise, and can be used after approved upon inspection; drivers, loaders and transportation guards for transportation of chemicals must aware of chemicals in terms of the property, hazardous characteristics, usage of containers for chemicals to be handled, and emergency action taken in case of accident happening; facilities and protective articles for emergency must be provided.

(4) Requirement for storage house for dangerous substances: The store houses should be structurally complete, dry and well ventilated; the commodities shall be avoided direct sunshine, not to be exposed to the sun, keep away from heat, electric and fire sources; ground, door, windows and shelves should be needed to be clean frequently, kept them clean; clear any weeds dispersed into the storage area of keeping dangerous chemicals in time.

(5) A tank in 5,000m<sup>3</sup> for storage of heavy oil provided in the feasibility study for the project would be altered with two tanks in 3,000 m<sup>3</sup> in this proposal of the evaluation,

connected with each other, an oil dyke in cement structure is provided surrounding the heavy oil tanks area, the capacity of dyke would be designed according to a capacity of single tank, in case the breakdown of oil tank or leakage of valves, it would lead spill of heavy oil directly into the oil dyke which is then pumped into the other tank, such that it would prevent heavy oil from overflowing to surrounding area.

(6) If dangerous chemicals in the same kind would be stored in several tanks (such as sulfuric acid, caustic soda, black liquor,  $\text{ClO}_2$ , etc.), each tank would be connected each other such that in case of accidental leakage the dangerous chemicals could be transferred from one tank in leakage to the other, cofferdam would be provided surrounding the tanks, the capacity of cofferdam designed according to maximum capacity of tank would be constructed with penetration-proof, leakage-proof and corrosion-proof materials. An adequate amount of emergency articles would be provided beside tanks.

(7) Sludge lot should be constructed strictly in accordance with requirements of *Standards for pollution control on the storage and disposal site for general industrial solid wastes* GB18599-2001. In operation, it is required to strengthen the management of pile-up of materials in accordance with requirement in design, workers should check the sludge dam body periodically, restore immediately operational condition if crack and breach of dam body were found.

### **12.7.3 Precautions for Safety in Design of Process Technology**

(1) Design of LPG and chemical preparation stations would be conducted strictly in accordance with *Design Specification for Occupational Safety and Health in Petrochemical Industry* (SH3047-93), *Fire Prevention Code of Petrochemical Enterprise Design* (GB50160-92), *Code for Fire Protection Design of Buildings* (GBJ16-87), *Code for Design of Electric Installations within Explosion and Fire Hazard Atmospheres* (GB50058-92), *Design Code for Detection and Alarm of Flammable and Poisonous Gas in Petrochemical Plant* (SH3063-1999) and so on.

(2) Each set of apparatus should follow the advanced, reasonable, safe and reliable technical process so as to promote safety of apparatus essentially, to prevent and reduce the chances of accident.

(3) Antiknock device (including power distribution unit, electric motor, switch, etc.) should



be provided in places prone to ignition and explosion; cables should meet the requirement for load and electric isolation. Temporary electric devices should be strictly regulated.

#### **12.7.4 Precautions for Safety in Design of Automatic Control**

(1) Enterprise should set up a safety monitoring system. For great hazard source a remote control system should be technically provided as much as possible such that in case an accident happened, leak source can be cut off via the remote control system so as to control the event from the very beginning of the source. A centralized control room, duty room for worker's operation isolated from equipment for technical processing should be provided, by which workers in operation can handle in the control room integrally for monitoring, displaying, continuous controlling and alarming which the safety parameters closely related to production can be automatically adjusted as well to make alarm, and stop the production in emergency state.

(2) Fire alarm and fire-fight integrated system should be provided in the plant location so as to monitor on fire in key places of the location with the main board being placed in the control room.

(3) Combustible gas testers should be provided in storage tank zones and production facility zone; the storage tanks should be provided with liquid level monitoring unit and alarming device.

#### **12.7.5 Precautions in Personnel Configuration and Management**

(1) Strengthen education for personnel in environmental protection and safety production, actively pursue precaution in production, no smoke and fire should be implemented in places of storage and usage of combustible and inflammable substances, special marks for no smoke or fire should be provided in an eye-catching places.

(2) Safety education, training and examination for various workers, persons in special sectors should be strengthened before going to their posts with certificate upon examinations.

(3) A special person assigned would take responsibility for environmental protection upon the establishment of perfect management mechanism so as to monitor the environmental protection of the enterprise.

(4) Establish perfect management system, safety regulation, safety production responsibility, implement them accordingly.

(5) Maintenance, periodical check and repair for equipment should be strengthened so as to maintain equipment in good order.

#### **12.7.6 Precautions for Fire Explosion of Methanol and LPG**

(1) Prevention from mechanical ignition source (impact, friction), high heat ignition source and electric ignition and chemical ignition sources; an antiknock device with a safety membrane should be provided on top of the storage tank, as well as anti-explosion detection and alarming system.

(2) Ensure well grounding of storage tanks, set up a permanent grounding unit; action for anti-electrostatic electricity and flow rate limiting, no high rate in loading tank would be adopted, metallic bulging would not be allowable inside the tank. Personnel should wear anti-electrostatic working clothes and well conductive shoes.

(3) Storage capacity, storage duration, and designing parameter for storage tank should be precisely calculated so as to reduce the chance of accident.

(4) Storage tank and outside transportation pipes should often be examined if any damage and leakage might be found; Counter action should be taken for declining of storage tank performance. Action should be also taken for leak at welded seams, spacers, rivets or bolts.

(5) Cofferdam should be provided around the methanol tank; where a little amount of leak, it should be resolved in time.

(6) Sufficient fire-fighting equipment should be provided in accordance with design for fire-fighting of the plant location.

#### **12.7.7 Precautions against the accident of emission of smell in high concentration**

Standby program should be arranged for treating smell from pulping works. When there is any failure in the alkali kiln, the smell will go to the standby burner (fuel torch) at the top of the boiler.

#### **12.7.7 Precautions for Pollution Caused by Leakage of Dangerous Chemicals and Accidental Discharge of Sewage**

(1) All pipe system should be well designed, manufactured and installed in accordance with standard concerned. Any design and installation of pipe in process should be considered with its variation of heat stress, vibration and creep deformation of pipe,

leakproof seal, as well as expansion joint and pipe clamp, which should be approved by local quality inspection section before put into use.

(2) Pipes for transporting dangerous chemicals should be made from seamless steel pipe, stainless steel pipe based on the composition of raw material; connection of pipes should be welded as much as possible; avoid using joint flange so as to reduce chance of leak; spacer used for joint of flange should be made from material with its property similar to those of media transported, never use material which is prone to be dissolved or corroded by media transported. Transportation pump should adopt leakproof driving pump to avoid leakage of material; pipes for transporting material should be periodically pressure tested.

(3) Collection chamber beside the site for storage and usage of dangerous chemicals with one end leading to sewage disposal station for emergency collection.

(4) Surface solidification should be made for ground of plant zone, collection chamber, sewage drainage ditch and rain drainage ditch.

(5) Set an emergency lagoon for accident

Based on the data provided by the owner, an emergency lagoon would be provided in the design of the project with its capacity of 60,000m<sup>3</sup>; there is collection chamber for any leak in place surrounding the sites for storage and usage of various dangerous chemicals. The leaked materials would then be collected in emergency lagoon for further treatment in sewage disposal station. If any fault happened with equipment in the sewage disposal station, the sewage is temporarily stored in the lagoon.

It is recommended that under a normal condition, the emergency lagoon and each cofferdam for storage tank would be secured empty without any wastewater or other water, evacuated rain water accumulated when raining, in case any accident relating to water polluted the flushing water for clearing leakage or fire fighting should be promptly and securely accumulated into the lagoon for further treatment by sewage disposal unit later on, such that the environmental pollution caused by accidental discharge would be avoided.

## 12.8 Summary

Environment risks in this project cover leakage and fire explosion of methanol and fire explosion of LPG. Results of risk identification have indicated that the most serious dangers come from leakage and fire explosion of methanol storage tank and fire explosion of LPG, being the maximum credible accident. Upon calculation, the maximum radius causing death in the event of explosion of methanol and LPG is 75m, the persons exposed in the death radius are those personnel in the plant location, effect of fire explosion on sensitive points at surrounding area would be rather limited in terms of effect on outside environment; exceeding standard range leeward in case leakage of methanol would reach 500m, causing a certain degree of effect on air quality at Yaxi village and Haishanpai, but far below the concentration causing acute toxicity.

Adopt the project design, safety evaluation for project and various precautions and emergency rescue plan proposed in the evaluation to keep away from the accident, and reduce the effect on surrounding environment, which would be acceptable environmental risks.

## 12.9 Emergency Rescue Plan

### 12.9.1 Purpose

In order to counter the unexpected environment accident and improve the capability to overcome the problems in the event, keep the dangers to human, property and environment to minimum to secure the safety of life and property to maximum, and maintain the stability of society. This emergency rescue plan is only provided to construction unit for reference, but emergency rescue plan against a serious accident should be further worked out in the management of safety.

### 12.9.2 Basis for Formulating the Emergency Rescue Plan

- (1) HJ/T169-2004 *Technical Guidelines for Environmental Risk Assessment on Projects*;
- (2) State Environmental Protection Administration HF [2005] No. 130 *Urgent Notice on Further Strengthening Environment Surveillance and Preventing Pollution Accident*;
- (3) State Environmental Protection Administration HF [2005] No.152 *Notice Regarding Strengthen Management of Evaluation for Environmental Impact and Prevent Pollution Accident*;
- (4) Guangxi Zhuang Autonomous Region Environment Protection Bureau Urgent Notice

on further Strengthening Environment Surveillance and Preventing *Pollution Accident* (2005.11.28).

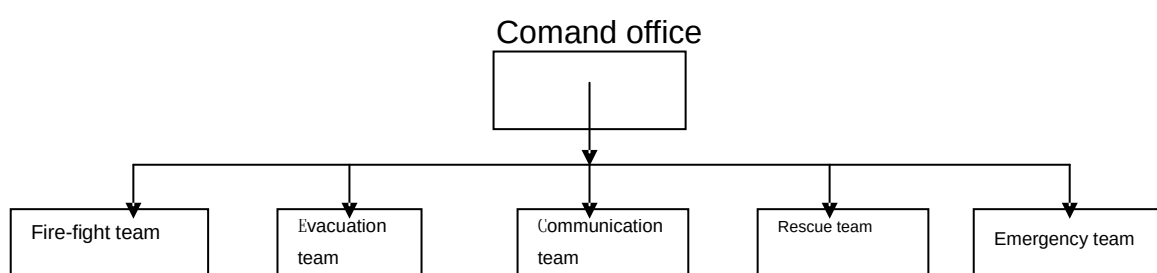
### 12.9.3 Application Range

The plan is applicable to unexpected pollution event caused by both predictable environmental pollution and other events for Stora Enso (Guangxi) Pulp & Paper Co. Ltd.

### 12.9.4 Emergency Plan Zone

Enterprise and the protection objectives in the surrounding environment.

### 12.9.5 Structure of Emergency Organization



### 12.9.6 Staged Response Conditions of the Emergency Rescue Plan

1<sup>st</sup> emergency scale denotes a little leakage of inflammable and combustibile substance and hidden danger prone to cause fire; little leakage of liquid.

2<sup>nd</sup> emergency scale denotes a relatively large amount of liquid leakage and dangerous substance or a relatively a large area of fire happened; disaster could be controlled by its own emergency team of enterprise.

3<sup>rd</sup> emergency scale denotes a large amount of uncontrolled liquid leakage; large area of fire, uncontrollable fire with its own emergency team, danger prone to cause harm to personnel in the enterprise and surrounding environment in accordance with collected data investigated, both Tieshan Port and Beihai City have set up a perfect emergency rescue system, covering *Emergency Rescue Plan for Unexpected Public Event in Beihai City*, *Emergency Rescue Plan for Unexpected Event in Beihai City*, *Emergency Rescue Plan for Accident Caused by Dangerous Chemicals in Beihai City*, *Emergency Rescue Plan for Unexpected Public Event in Tieshan Port*, *Emergency Rescue Plan for Unexpected Environmental Event in Tieshan Port*, *Emergency Rescue Plan for Accident Caused by Dangerous Chemicals in Tieshan Port*, etc. Therefore, this emergency

rescue plan of the project should have a joint response procedure with relevant emergency rescue plans in Tieshan Port and Beihai City, in case in the 3<sup>rd</sup> emergency scale, the external rescue force in Tieshan Port Industrial Zone and Beihai City to control the event for spreading.

In the 3<sup>rd</sup> scale of emergency, in case not endanger personnel's safety of the enterprise the commander at event site could give instruction to emergency team with rescue to prevent the disaster from spreading until the special fire-fighters coming to the site. In case person is in peril of life or emergency team is seriously in peril of safety, on-site commander could propose to the headquarter for evacuation and then arrange evacuation upon the ratification.

#### **12.9.7 Safeguarding of Emergency Rescue**

(1) Funds: allocation of special funds for emergence event of pollution to purchase emergency facilities, equipment and devices and conventional training and drill, should be assured to meet the need of funds for encountering unexpected event of environmental pollution.

(2) Facilities: provision of sufficient articles and outfit for fire-fighting should be provided, and kept conventional maintenance so as to assure the provision of facilities.

(3) Communication and human force: unblocked communication in plant and communication equipment for members of rescue team of emergency organization should be available throughout the day and night so as to ensure the availability of emergency team and rescue facilities and supplies.

#### **12.9.8 Reporting System of Unexpected Environment Event**

Any general case has to be reported to a scheduler on duty upon which the emergency team would come on emergency rescue and then analysis the reasons and report to upper level of the structure within 24 hours.

In case serious event of pollution happened, it should immediately report to a commander in general and work out the reporting of the serious event of environment pollution. The report of event of environment pollution should be implemented in accordance with the regulation of *Interim Measures on Reporting Environmental Pollution and Damage Accidents* issued by State Environmental Protection Administration and reported to the local Government timely. The leader of emergency

organization should first report to the local environment office (Environment Protection Offices of Tieshan Port and Beihai City), such that the local environmental section would further report to the environmental Protection Bureau of Guangxi Zhuang Autonomous Region concerning the condition of pollution, and further information on investigation and handle.

#### **12.9.9 Action for Monitoring Emergent Environmental Event**

The commander on emergency post should immediately enter into the site of event, judge the response scale of the accident. If accident in a little scale, the commander should organize the teams of fire-fighting and emergency to extinguish and rescue; make alarming on fire hydrant in case in the relatively large scale of accident and report to the commander in general. In the event of relatively large accident or in the 3<sup>rd</sup> emergency scale it should be required to ask help from both Emergency Rescue Centers of Tieshan Port and Beihai City, and report to the Environmental Protection Bureau of Tieshan Port.

Under any circumstance of event site, the command post should be well known of the following aspects in event:

- (1) time and location of event;
- (2) category and scale;
- (3) quantity of substances leaked;
- (4) direction of danger known;
- (5) if any rescue activity involved;
- (6) wind direction and wind speed on site;
- (7) the possibility of leakage to peril the outside environment of the environment;
- (8) the possible influence on the environment by leakage or fire explosion.

#### **12.9.10 Emergency Rescue Action**

##### **12.9.10.1 Emergency Rescue Action for the Fire Explosion**

###### **(1) Site of event**

Once the fire spot was found, the people in production or on spot should take decisive measure according to the state of fire; if it is a small fire, extinguish the fire with the nearby fire extinguishing equipment; if the fire went out of control (or a big fire), immediately report to fire brigade (119) and the schedule room while fight against the fire

so as to gain time for special fire-fighter to extinguish.

In the case of fire from storage tank or tanker on roads or railroad sources, it has to extinguish the fire over the distance as far as possible or with remote water gun or water cannon. Cool the container or tank with a large quantity of water until the fire extinguished. Evacuated immediately if safety valve made sounds or storage tank had changed its color. Never stay beside both ends of tank.

## (2) Section of emergency rescue

a. Once the dispatching room has been reported, the scheduler should promptly inform a person in responsibility of the section in event to investigate the state of accident (fire location, substances causing fire and source of fire), give instruction to deal with the prepare counter plan for an emergency, inform the members in command post and fire brigade, medical team to immediately arrive on the site.

b. While extinguishing fire, fire-fighter should find out the persons in toxicity or injury, and safe them from the site immediately, and send them in serious condition to hospital.

c. Wastewater produced in handle of the event could not directly be discharged, but into an emergency lagoon for further treatment.

### 12.9.10.2 Control Measure for Liquid Leakage

(1) Leak of sulfuric acid: in case a pipe invoked leakage, immediately close the outlet valve in front section of the pipe in leakage to prevent further leakage, the leakage rate sulfuric acid is then neutralized with lime in cofferdam before sent to disposal plant via collection chamber and discharged after met with standard.

(2) Leak of heavy oil: control them in oil dyke for treatment timely, clear oil-bearing wastewater on ground to collection chamber for further treatment in sewage disposal plant and discharged after met with standard.

(3) Leak of black liquor or caustic soda: in case pipe invoked leakage, immediately close the outlet valve in front section of the pipe in leakage to prevent further leakage, block the outlet of cofferdam, lead black liquor and caustic soda to other tank connected with the tank in leakage, the leakage rate black liquor and caustic soda is then collected in collection chamber and neutralized and pumped into emergency lagoon, sent to disposal plant for further treatment.

(4) Leak of methanol: eliminate all spot fire sources (no smoke around the leakage zone,



eliminate all naked fire, spark or flame). Ban to contact and stride the leakage rates. All equipment in operation is well grounded. Block the leak under the safety condition. Cover the vapor with foam. Build a dyke in front the leak of liquid in a light leak case for further treatment. Spray atomized water to inhibit the generation of vapor, but vapor in constrained space may be ignited. The treated wastewater is then sent via collection chamber to sewage disposal plant and discharged after met with standard.

#### 12.9.10.3 Control Measure to Cut Off Any Accidental Discharge of Waster Water

##### (1) Abnormal discharge of sewage

In case an abnormal discharge of pollutant happened, the organization of prepared counter plan for abnormal discharge would enter into working condition, starting emergency action, meanwhile, environmental protection section should immediately dispatch a person to find out what was happened on site, to work together with the relevant unit to cope with it, inform the leader on duty at sewage disposal plant and operational workers to pay attention closely to the quality of sewage came from the site, upon which the corresponding action should be taken according to the abnormal condition.

a. When total amount of pollutant in abnormal discharge is low which would not result in impact on the normal operation of sewage disposal system after chemically examined, it would keep the normal operation, but closely watch the water quality of sewage treatment plant accordingly;

b. When total amount of pollutant in abnormal discharge is high which would result in a large impact a valve of emergency lagoon must immediately be opened for collection, pumping in a low rate to treat it so as to avoid heavy burden for biological treatment. Closely watch and monitor the inlet water quality in the disposal plant, adjust the pH value of inlet water, strengthen the monitoring intensity at each controlling point of the sewage treatment system so that the treated water of abnormal discharge from the disposal plant can be ensured to discharge after with standard.

##### (2) Fault of sewage disposal station

In case facility in sewage disposal station is out of order, immediately dispatch a person to fix it, wastewater produced in production process should be led to emergency lagoon with its capacity of 60,000 m<sup>3</sup> which can receive wastewater produced within 11h. Once the duration of maintenance exceeded 11h, production should be immediately terminated,

and resume operation after the facility for disposal of sewage recovered and wastewater in the emergency lagoon was completely treated. Cut off the accidental discharge of wastewater in production.

#### 12.9.10.4 Control Measure in Gas Leakage

In case LPG is in leakage, people in the polluted area should immediately be evacuated to windward side and isolated from the event. Control people from entering. Cut off fire source. Advise members of emergency team to wear a self-sustainable positive pressure respirator and fire protective cloths. Cut off a source in leakage as much as possible. Apply reasonable ventilation to facilitate diffusion of pollutant. Dilute and dissolve with spraying atomized water. If possible, a proper spraying head is provided to burn the escaped gas. The container with leakage should be properly handled, fixed and examined before reused. The wastewater produced would be collected via a collection chamber and then sent to a sewage disposal plant for further treatment, and discharged after met with standard.

#### 12.9.10.5 Emergency Measure for Transportation

In case vehicle in transportation of methanol, sulfuric acid and caustic soda is in leakage it is required to report timely to environmental protection section. If leakage environment is surface of ground, the polluted soil must be monitored for its quality. When the pollutant flows into a river, the affected river should be monitored with analysis for water quality at various segment of the river. Announcement has to be made concerning the range and time of pollution; Action has also to be taken to recover the normal water quality immediately.

#### 12.9.11 Monitoring of Emergency Environment

Inspection on smoke and dust, concentration of CO and CO<sub>2</sub>, air temperature and pollution of soil in surrounding area should be conducted by a relevant environmental protection section, protection measure and proposal have to be made upon the analysis of effect on the surrounding environment; when harmful wastewater from liquid leakage and fire extinguishment flows into sea area in Tieshan Port through discharge ditch, the relevant environment protection section should analyze and monitor the pollution of water body, and raise protection measure and proposal, accordingly.

#### 12.9.12 Close Procedure and Recovery Measure for Emergency Rescue

The conditions to determine the close of emergency rescue: All fire was extinguished without peril of ignition again, all substance leakage has been isolated, giving no effect on environment such that emergency state could be lifted by announcement;

Recovery has to be announced by a person in responsibility to every member of personnel or through broadcast.

Clearance has to be done first for inflammable substance followed by others.

#### **12.8.13 Plan of Emergency Training**

Train on theoretical knowledge acquirement once a year and drill once a half year would be conducted, in addition, a person in charge of each special team would take part in special training organized by environmental surveillance section, fire-fighting section and safety production section.

Project No.: GXHBS- 2006-01-001

# **The 900,000 Ton Pulp and 900,000 Ton Paper and Cardboard Project of Stora Enso (Guangxi) Pulp & Paper Co., Ltd.**

## **Environmental Impact Report**

### **Volume III**

Compiler: Research Institute of Environmental Protection of Guangxi  
Zhuang Autonomous Region

Certificate No.: GHPZJZ NO. 2902

Time of Compilation: October 2008

Note; The document is a translation of the Chinese EIA report submitted for application for the environmental approval for the project according to Chinese regulations. The approval process took place in 2008.

The translated report has been edited by Stora Enso for the purpose of public disclosure. Certain financial information and technical details of the planned investment have been removed from the text.

Project name: The 900,000 Ton Pulp and 900,000 Ton Paper and Cardboard Project of Stora Enso (Guangxi) Pulp & Paper Co., Ltd.

Industry type: Light industry

Document type: Environmental impact report

Entrusting unit: Stora Enso (Guangxi) Pulp & Paper Co., Ltd.

Evaluation unit: Research Institute of Environmental Protection of Guangxi Zhuang Autonomous Region

Legal representative: Li Min

Approved by:

Audited by:

Checked by:

Project leaders: (Senior engineer Certificate No. of Environmental Impact Assessment Engineer A29020020300)

(Senior engineer Certificate No. of Environmental Impact Assessment Engineer A29020041000)

(Senior engineer Certificate No. of Environmental Impact Assessment Engineer A29020030300)

Cooperative unit: Tianjin Research Institute for Water Transport Engineering of Ministry of Communications

Legal representative:

Cooperative unit: Guangxi Beihai Environment Monitoring Station

Legal representative:

## Table of Contents

|                                                                                                                                   |            |
|-----------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>13. Demonstration and Impact Analysis of Water Resources .....</b>                                                             | <b>1</b>   |
| 13.1 Water Intake Sources .....                                                                                                   | 1          |
| 13.2 Overview of the Development and Utilization of Water Resources .....                                                         | 6          |
| 13.3 Analysis on the Rationality of Water Utilization in Construction Projects .....                                              | 6          |
| 13.4 Analysis on Impact of Water Intake .....                                                                                     | 9          |
| <b>14 Cleaner Production and Review on Industrial Policies .....</b>                                                              | <b>16</b>  |
| 14.1 Cleaner Production .....                                                                                                     | 16         |
| 14.2 Review of industrial policy .....                                                                                            | 34         |
| <b>15 Countermeasure for Pollution Prevention and Treatment with Analysis on Its Technological and Economic Feasibility .....</b> | <b>37</b>  |
| 15.1 Environmental protection measures during construction and feasibility analysis .....                                         | 37         |
| 15.2 Countermeasures and measures for pollution prevention and treatment during operation .....                                   | 41         |
| 15.3 Investment for environmental protection .....                                                                                | 72         |
| <b>16 Water and Soil Conservation Scheme .....</b>                                                                                | <b>74</b>  |
| 16.1 Current conditions of soil and water loss .....                                                                              | 74         |
| 16.2 Prediction on soil and water loss .....                                                                                      | 74         |
| 16.3 Prevention and treatment scheme of soil and water loss .....                                                                 | 76         |
| 16.4 Additional measures for water and soil conservation .....                                                                    | 78         |
| 16.5 Quantity and investment of water and soil conservation .....                                                                 | 78         |
| <b>17 Total Emission Control Indices and Regional Reduction Plan of Pollutants .....</b>                                          | <b>81</b>  |
| 17.1 Recommendations on the total emission control indices of pollutants in the project .....                                     | 81         |
| 17.2 Total emission control indices during 11th Five-year in Beihai .....                                                         | 81         |
| 17.3 Solution for total emission indices of pollutants in the project .....                                                       | 82         |
| 17.4 Summary .....                                                                                                                | 85         |
| <b>18 Analysis on the Rationalization of Planning and Layout, Plant Site Selection and General Plan Layout .....</b>              | <b>86</b>  |
| 18.1 Analysis on the consistency with related planning .....                                                                      | 86         |
| 18.2 Analysis on the rationalization of address selection of the project .....                                                    | 93         |
| 18.3 General plan layout .....                                                                                                    | 104        |
| <b>19 Analysis on Economic Profit &amp; Loss of Environmental Impact .....</b>                                                    | <b>108</b> |
| 19.1 Project Economic and Social Benefits .....                                                                                   | 108        |
| 19.2 Environmental Protection Investment and Environmental Benefits Analysis .....                                                | 109        |
| <b>20 Public Participation .....</b>                                                                                              | <b>116</b> |
| 20.1 Objective .....                                                                                                              | 116        |
| 20.2 Working Procedures .....                                                                                                     | 116        |
| 20.3 Identification of Core Public Group .....                                                                                    | 116        |
| 20.4 Time and Major Forms .....                                                                                                   | 119        |
| 20.5 Investigation Results .....                                                                                                  | 119        |
| 20.6 Solutions to Feedback Opinions .....                                                                                         | 131        |
| 20.7 Conclusion .....                                                                                                             | 131        |
| <b>21 Environmental Protection Management and Monitoring System .....</b>                                                         | <b>132</b> |
| 21.1 Environmental management .....                                                                                               | 132        |
| 21.2 Monitoring of Examination & Acceptance of “Three Simultaneousness” of the Project Environmental Protection .....             | 139        |
| 21.3 Environmental Monitoring Plan .....                                                                                          | 140        |
| 21.4 Environmental Monitoring Instrument & Technical Document Management .....                                                    | 149        |
| 21.5 Management of Waste Discharge Outlet .....                                                                                   | 150        |
| 21.6 Quality Assurance Measures to Investigation and Monitoring of Current Situation of Environmental Quality .....               | 152        |
| <b>22 Evaluation Conclusions .....</b>                                                                                            | <b>156</b> |
| 22.1 Industrial Policies & Planning Compliance Analysis .....                                                                     | 156        |
| 22.2 Conclusion of Analysis on the Construction Project .....                                                                     | 156        |
| 22.3 Investigation and Evaluation of Current Environmental Quality .....                                                          | 159        |
| 22.4 Conclusions of Environmental Impact Prediction and Evaluation .....                                                          | 162        |

|                                                                                               |            |
|-----------------------------------------------------------------------------------------------|------------|
| <b>22.5 Water Resources Appraisal and Water Intake Impact Analysis .....</b>                  | <b>170</b> |
| <b>22.6 Conclusion of Clean Production Evaluation .....</b>                                   | <b>170</b> |
| <b>22.7 Pollution Prevention and Control Measures and Economic Feasibility Analysis .....</b> | <b>171</b> |
| <b>22.8 Pollutants Total Quantity Control Index .....</b>                                     | <b>174</b> |
| <b>22.9 Rationality of Project Location, Discharge Outlet and General Layout .....</b>        | <b>174</b> |
| <b>22.10 Project Environmental Economic Profit &amp; Loss Analysis .....</b>                  | <b>176</b> |
| <b>22.11 Public Participation .....</b>                                                       | <b>176</b> |
| <b>22.12 Comprehensive Evaluation Conclusions .....</b>                                       | <b>176</b> |

## Appendices: [not enclosed]

1. Letter of Attorney Concerning Evaluation of Project Environment Impact by Stora Enso (Guangxi) Pulp & Paper Co., Ltd.
2. GHPGG [2006] No. 81, *Advisory Opinions on the Evaluation Outline of Environment Impact of the 900,000 Ton Pulp and 900,000 Ton Paper and Cardboard Project of Stora Enso (Guangxi) Pulp & Paper Co., Ltd.*
3. Environment Protection Bureau of Guangxi Zhuang Autonomous Region: GHGH [2006] No. 203, *Preliminary Suggestions on the Environment Protection of the 900,000 Ton Pulp and 900,000 Ton Paper and Cardboard Integrated Project of Stora Enso Pulp & Paper Co., Ltd. (Chinese-Foreign Joint Venture), Beihai, Guangxi*
4. Environment Protection Bureau of Guangxi Zhuang Autonomous Region: GHGH [2007] No. 387 and GHGH [2008] No. 325, *Reply Letter Regarding the Instructions on the Evaluation Standards with Regard to the Environment Impact Report on the 900,000 Ton Pulp and 900,000 Ton Paper and Cardboard Project of Stora Enso (Guangxi) Pulp & Paper Co., Ltd.*
5. Environment Protection Bureau of Guangxi Zhuang Autonomous Region: GHBH [2008] No. 50, *Reply Letter to the Application for Total Quantity Index on the Emission of Sulfur Dioxide Concerning the 900,000 Ton Pulp and 900,000 Ton Paper and Cardboard Project of Stora Enso (Guangxi) Pulp & Paper Co., Ltd.*
6. BHHZ [2008] No. 88, *Reply Letter from Beihai Environment Protection Bureau on the Total Quantity Index of COD Concerning the 900,000 Ton Pulp and 900,000 Ton Paper and Cardboard Project of Stora Enso (Guangxi) Pulp & Paper Co., Ltd.*
7. The People's Government of Guangxi Zhuang Autonomous Region: GZHBF [2008] No. 1, *Circular of the General Office of the People's Government of Guangxi Zhuang Autonomous Region about Printing and Issuing the Partial Adjustment Scheme of the Planning of the Offshore Sea Water Environment Functional Area in Guangxi*
8. Beihai Municipal People's Government: BZF [2004] No. 60, *Notice on Printing and Issuing the District Planning of Tieshan Port of Beihai*
9. Environment Protection Bureau of Guangxi Zhuang Autonomous Region: GHKGZ

- [2005] No. 275, *Official Reply to Regional Environment Impact Report Concerning the Large-size Port and Industrial Base of Tieshan Port, Beihai*
10. Environment Protection Bureau of Guangxi Zhuang Autonomous Region: GHGZ [2008] No. 73, *Official Reply to the Technical Report on Demonstrating the Revising Scheme for Adjusting the Layout of the Discharge Outlets in Teishan Port Industrial Base*
  11. People's Government of Guangxi Zhuang Autonomous Region: GZF [2004] No. 66, *Opinions of the People's Government of Guangxi Zhuang Autonomous Region on Accelerating the Construction of the Forestry Base for Forest-Pulp-Paper Materials along the Coastal Areas*
  12. The Environmental Protection Bureau of Guangxi Zhuang Autonomous Region: GHGH [2008] No. 75, *The Review Opinions on the Environmental Impact Report of Overall Planning for the Development of the Integrated Industry of Forest-Pulp-Paper in Guangxi from 2005 to 2015*
  13. The Land and Resources Department of Guangxi Zhuang Autonomous Region: GGTZH [2005] No. 530, *Opinions on the Preliminary Site Selection of the Land for the Jointly Funded Integration Forest-Pulp-Paper Project of Beihai, Guangxi*
  14. The Construction Department of Guangxi Zhuang Autonomous Region: *Site Selection Report for Proposed Projects*
  15. Beihai Municipal Bureau of Land and Resources: *Reply Letter to the Preliminary Proposals on the Site Selection for Slag Stockpile of the Pulp and Paper Project of Stora Enso*
  16. Beihai City Planning Bureau: BGH [2007] No. 229, *Reply Letter to the Preliminary Opinion Letter of Proposal on the Site Selection for Slag Stockpile of the Pulp and Paper Project of Stora Enso*
  17. GS Water Administration: [2007] No. 40, *The Review Opinions on Water Resource Demonstration Report for the Water Supply Project of Tieshan Port, Beihai City of Guangxi Coastal Industrial Park Water Supply Project*
  18. Department of Water Resources of Guangxi Autonomous Region: *Reply Letter to Issues In Connection with Water Intake of the Pulp and Paper Project of Stora Enso (Guangxi)*
  19. BTZF [2007] No. 19, *The People's Government of Tieshan Port District, Beihai, Transmits the Notice of State Development and Reform Commission for Printing and Issuing the Guiding Opinions on Adjusting the Structure of the Salt-making Industry Nationwide*
  20. Beihai Municipal People's Government: BZH [2007] No. 37, *Official Reply of Beihai Municipal People's Government on Approving the Detailed Implementing Rules*



*Concerning the Land Requisition and Relocation for the Integrated Forest-Pulp-Paper Project of Beihai*

21. Beihai Xinli Import & Export Trading Co., Ltd.: *Commitment Letter for the Coal Supply to the Integrated Forest-Pulp-Paper Project of Beihai, Guangxi*
22. Analysis Report on Coal Quality (Designed Coal)
23. Analysis Report on Coal Quality (Checked Coal)
24. Nanning Chemical Industry Co., Ltd.: *Letter on Supply of Liquid Alkali*
25. Letter of Intent on the Purchase and Sale of Slag
26. Agreement on the Purchase and Sale of Wood Residues
27. Information Announcement of Public Participation
28. Questionnaire of Public Participation
29. Registration Form for Examination and Approval on Environment Protection of Construction Projects

## 13. Demonstration and Impact Analysis of Water Resources

### 13.1 Water Intake Sources

The proposed project is located in Tieshan Port District, Beihai, and the water for production and living shall be supplied with the water supply system of the district. The water source for Phase I water supply project of Tieshan Port District shall be Hepu Reservoir, and that for Phase II are Hepu Reservoir and Nanliu River.

Hepu Reservoir, a constructed project, mainly consists of the large-sized Xiaojiang River Reservoir (1), connecting the Wangsheng River – Liuhu Lake Reservoir (2) through the large aqueduct of Nanliu River. In addition, through Huhai Canal, it is connected with four medium-sized reservoirs, including Zhakou Reservoir, Qingshui River Reservoir, Shikang Reservoir and Niuweiling Reservoir. This is what is known as Hepu Reservoir Group.

Rivers within the irrigation district of Hepu Reservoir belong to the coastline water system at Southern Guangxi, and most of them flow from north to south. Major ones are Nanliu River and its affluent Xiaojiang River (also known as Majiang River), Changle River, Baisha River, Shikang River, Qili River, Qingshui River, etc. The Nankang Arterial Channel in the irrigation district of Hepu Reservoir is directly connected with Tieshan Port District.

Hepu Reservoir, initiated in October 1958, completed and put into operation in April 1960, controls over a rain collection area up to 1,052.8km<sup>2</sup>. Within the reservoir region, the gross reservoir capacity amounts to 1,250.2 million m<sup>3</sup>, the effective reservoir capacity 532 million m<sup>3</sup>, and the dead reservoir area 220.3 million m<sup>3</sup>. The reservoir is a multipurpose water control project, giving priority to irrigation and integrating water supply and power generation. The designed irrigation area of the reservoir is 701,000mu.

#### 13.1.1 Analysis on inflow amount

##### 13.1.1.1 Runoff of Hepu Reservoir Group and Water Conservation Projects in Irrigation District

###### (1) Runoff of Xiaojiang River Reservoir

Xiaojiang River Reservoir is located in the drainage area of Xiaojiang River, a first-level affluent of Nanliu River. Xiaojiang River, also known as Majiang River, originates from Luoyang Piedmont in Fuwang Town of Peibei County, runs through Fuwang, Jiangcheng, Zhangjia, Anshi, and Jiangning in Bobai County, and finally joins in an edge angle Nanliu River at Xiaomakou Village. The dam site of Xiaojiang River Reservoir includes a drainage area amounting to 919.8km<sup>2</sup>.

The calculation of the runoff of Xiaojiang River Reservoir, based on the flow data actually surveyed for 43 years, adopts the reverse plug flow method of reservoir for reduction, and the correlation of rainfall and runoff for prolonging the series of runoff data missed between 1961 and 1962, thus arriving at the runoff series month by month for 45 years from 1961 to 2005. Based on the frequency calculation in line with the above runoff series for 45 years, the net inflow amount of Xiaojiang River Reservoir is estimated up to 720 million m<sup>3</sup>.

Whereas the average surface evaporation and seepage loss amount to 65 million  $\text{m}^3$  of the reservoir for many years, the natural inflow of Xiaojiang Reservoir is 784 million  $\text{m}^3$ .

#### (2) Runoff of water conservation projects in irrigation district

Xiaojiang River Reservoir is the leading one of Hepu Reservoir Group, thus the main source for water supply in Hepu Irrigation District. Xiaojiang River Reservoir releases part of its water, which runs via Wangsheng River-Liuhe River Reservoir and through the “water conveyance corridor” of Huhai Canal, and supplements the four medium-sized reservoirs of irrigate-form-melon, including Zhakou Reservoir, Shikang Reservoir, Qingshui River Reservoir and Niuweiling Reservoir (when they have vacant reservoir capacity), for carrying out jointed water supply. The outcome of the annual runoff amount at each frequency in Hepu Reservoir Group is shown in Table 13.1-1.

Table 13.1-1 The Outcome of the Annual Runoff Amount of Water-supply Source Projects

| Name of project                         | Area of water intake ( $\text{km}^2$ ) | Average annual runoff amount (100 million $\text{m}^3$ ) | Annual average flow at every frequency (100 million $\text{m}^3$ ) |       |      |      |      |      |      |
|-----------------------------------------|----------------------------------------|----------------------------------------------------------|--------------------------------------------------------------------|-------|------|------|------|------|------|
|                                         |                                        |                                                          | 10%                                                                | 20%   | 50%  | 75%  | 85%  | 90%  | 95%  |
| Xiaojiang River Reservoir               | 919.8                                  | 7.84                                                     | 11.82                                                              | 10.82 | 7.47 | 5.68 | 4.82 | 4.35 | 3.66 |
| Wangsheng River – Liuhe River Reservoir | 133                                    | 1.02                                                     | 1.54                                                               | 1.32  | 0.97 | 0.74 | 0.63 | 0.57 | 0.48 |
| Zhakou Reservoir                        | 54.3                                   | 0.47                                                     | 0.71                                                               | 0.61  | 0.45 | 0.34 | 0.29 | 0.26 | 0.22 |
| Qingshui River Reservoir                | 52                                     | 0.45                                                     | 0.67                                                               | 0.58  | 0.43 | 0.32 | 0.27 | 0.25 | 0.21 |
| Shikang Reservoir                       | 21                                     | 0.16                                                     | 0.24                                                               | 0.20  | 0.15 | 0.11 | 0.10 | 0.09 | 0.07 |
| Niuweiling Reservoir                    | 24.3                                   | 0.22                                                     | 0.33                                                               | 0.29  | 0.21 | 0.16 | 0.14 | 0.12 | 0.1  |
| 36 small-sized reservoirs               | 115.65                                 | 0.99                                                     | 1.49                                                               | 1.28  | 0.94 | 0.72 | 0.61 | 0.55 | 0.46 |

#### 13.1.1.2 Section Runoff of Nanliu River and Pump Station

The hydrological station under the control of Nanliu River within Hepu County is Changle Hydrological Station, with an intake area up to  $6645\text{km}^2$ , taking up 73% of that of the whole drainage area, and amounting to  $9155\text{km}^2$ .

The annual average runoff amount of the section of Changle Hydrological Station of Nanliu River is estimated up to 5.08 billion  $\text{m}^3$ , based on the frequency calculation in line with the annual runoff series actually surveyed by Changle Hydrological Station II from 1954 to 2004. The outcomes of the annual average runoff amount at different frequencies are shown in Table 13.1-2.

Table 13.1-2 The Outcomes of the Annual Runoff Amount of Changle Hydrological Station and Shangba Pumping Section

| Name of project                              | Area of water intake (km <sup>2</sup> ) | Annual average runoff amount (100 million m <sup>3</sup> ) | Annual average flow at every frequency (100 million m <sup>3</sup> ) |      |      |      |      |      |      |      |
|----------------------------------------------|-----------------------------------------|------------------------------------------------------------|----------------------------------------------------------------------|------|------|------|------|------|------|------|
|                                              |                                         |                                                            | 10%                                                                  | 20%  | 50%  | 75%  | 80%  | 90%  | 95%  | 10%  |
| Changle Hydrological Station of Nanliu River | 6645                                    | 50.8                                                       | 82.3                                                                 | 73.9 | 61.3 | 48.9 | 38.4 | 36.1 | 30.4 | 26.1 |
| Shangba Pumping Section                      | 5025                                    | 38.5                                                       | 62.2                                                                 | 55.9 | 46.4 | 37.0 | 29.0 | 27.3 | 23.0 | 19.7 |

### 13.1.1.3 Low Runoff

According to the statistic analysis on data with regard to the monthly inflow amount from 1954 to 2004 surveyed by Changle Hydrological Station II, under the control of Nanliu River, the distribution of inflow in a year within the drainage area is very uneven. The inflow amount in the high water period from April to September takes up about 80% of that of the whole year; while that in the low water period from October to March (the next year) only occupies about 20%. See Table 13.1-3 for detailed average inflow amount in the lowest month under different assurance rate in Changle Hydrological Station.

Table 13.1-3 The Outcome of the Assurance Rate for the Average flow in the Lowest Month

| Name of section | Frequency (P) |      |      |      |      |      |      |      |
|-----------------|---------------|------|------|------|------|------|------|------|
|                 | 1%            | 10%  | 25%  | 50%  | 75%  | 90%  | 95%  | 99%  |
| Changle Station | 68.4          | 49.3 | 40.1 | 31.2 | 23.7 | 18.1 | 15.3 | 10.8 |
| Shangba Section | 51.7          | 37.3 | 30.3 | 23.6 | 17.9 | 13.7 | 11.6 | 8.17 |

## 13.1.2 Analysis on Regional Supply and Demand Balance of Water Resources

### 13.1.2.1 Analysis on the Water Supply Capacity of Hepu Reservoir to the Urban and Industrial Areas

The estimation of the water supply capability of Hepu Reservoir to the urban and industrial areas is based on the precondition that the reservoir shall first satisfy the water consumption and water assurance rates required by departments of agriculture, residents, livestock, environment, and the available water supply of Hepu Reservoir to the urban and industrial area in 2020, the design efficiency year, is calculated through analyzing the supply and demand balance of water resources.

In 2020, the average annual water consumption by agriculture in the irrigation district is estimated up to 605.17 million m<sup>3</sup>, while that by the rural residents and livestock up to 22.03 million m<sup>3</sup>.

Based on the precondition that the reservoir shall first satisfy the water consumption and water assurance rates required by departments of agriculture, residents, livestock, environment, *Demonstration Report on the Water Resources of the Water Supply Projects of Tieshan Port District, Beihai*, formulated by Guangxi Water Resources and Power

Exploration and Design Institute, reaches to the following conclusions, through long-range series of analysis on the balance of water supply and demand:

(1) The average annual water supply of the water source projects of Hepu Reservoir is 735.04 million  $\text{m}^3$ , of which that of the major Xiaojiang River Reservoir (including the supplemented water amount to reservoirs of irrigate-form-melon) amounts to 469.96 million  $\text{m}^3$ , and that of other water sources 265.08 million  $\text{m}^3$ ; and six years are lack of water, thus the average annual volume of water deficiency reaching 30.86 million  $\text{m}^3$ . Based on analysis and calculation, Hepu Reservoir Group may only be capable of supplying water, amounting to 380,000  $\text{m}^3/\text{d}$  in 2020, in addition to that satisfying the water consumption required by agriculture, residents, and livestock in the irrigation district. After the completion of Tieshan Port Water Supply Project Phase II, the port shall demand from Hepu Reservoir as much as 447,000  $\text{m}^3/\text{d}$  water supplies, thus increasing the total water demand together with that of the urban area to 797,000  $\text{m}^3/\text{d}$ . As a result, Hepu Reservoir is not capable of satisfying the water demand of the completed Tieshan Port Offshore Industrial Park and the urban area.

(2) Under the condition of satisfying the water supply, as much as 797,000  $\text{m}^3/\text{d}$ , to Tieshan Port Offshore Industrial Park and the urban area in 2020, and on the basis of the long-range series of analysis on the balance of water supply and demand, the reservoir may ensure water supplies for 33 years, but it may fail in doing so for 10 years. In years suffering water deficiency, the amount of water deficiency with regard water supply to agricultural irrigation, to the urban areas and industrial parks, and to residents and livestock is relatively serious, the depth of water deficiency is being grave, and the greatest annual water deficiency amounting to 608.36 million  $\text{m}^3$ , with the rate of water deficiency up to 63.8%. Therefore, it is necessary to add new water sources in order to satisfy the large scale of water demand, as much as 797,000  $\text{m}^3/\text{d}$ , of the urban areas and industrial parks, thus coming the joint water supply through Hepu Reservoir Group.

(3) In line with the opinions of examination and approval in *Report on the Water-supply Source Planning for Offshore Industrial Parks of Guangxi*, the water in Nanliu River may be utilized for supplementing Wangsheng River Reservoir when the water amount of Hepu Reservoir Group failing to satisfy the long-term water demand of Tieshan Port District, thus supplying water the district by means the regulatory function of reservoir for meeting the requirements of Tieshan Port District for long-term water demand and assurance rate.

(4) Based on the results of analysis on the supply and demand balance of the joint water supply by Hepu Reservoir Group and Nanliu River by 2020, it may be clear that, with the initiation of the water-drawing scheme from Nanliu River, the requirements with regard to each water consumption, production and assurance rate of water supply may be satisfied, thus the annual assurance rate for water supply to farming in the irrigation district amounts

to 85%, and the daily assurance rate for residents, livestock, cities and industrial park above 97%. The average annual pump output of Shangba Pump Station of Nanliu River reaches 39.32 million  $\text{m}^3$ , and the maximum annual amount 131.4 million  $\text{m}^3$ .

#### 13.1.2.2 Analysis on Supply and Demand Balance and Conclusion

The water demand of the proposed projects is about 124,700  $\text{m}^3/\text{d}$ , [ERRATUM number corrected for missing the x10,000 denominator. See table 13.3-1 for the correct figure] and is satisfied by the water supply system of Tieshan Port. At present, the port has completed the phase I water supply work capable of catching water as much as 230,000  $\text{m}^3/\text{d}$  from Hepu Reservoir. The water consumption of the proposed projects shall take up 54.2% of the water supply capability of Tieshan Port Phase I Project. Now, the phase II water supply project of the port is under construction, increasing the daily water supply to 447,000  $\text{m}^3/\text{d}$  after its completion. The water consumption of the proposed projects shall take up 27.9% of the water supply capability of Tieshan Port. Therefore, the water supply system of the port may satisfy the water demand of the proposed projects.

Under the condition that the reservoir meets the water demand by farming, and residents and livestock in the irrigation district, however, Hepu Reservoir may only be capable of supplying 380,000  $\text{m}^3/\text{d}$  water to the urban and industrial areas by 2020. Therefore, new water sources have to be added, namely, to carry out joint water supply based on Hepu Reservoir Group. In accordance with the condition of water sources in the place where projects are located and the requirements for rational allocation and effective utilization, and through feasibility study, a dam pump station may be constructed on Nanliu River; and through the station, part water may be drawn from Nanliu River to Wangsheng River Reservoir, for regulating water supply jointly with Hepu Reservoir. Only in this way may the water demand of Tieshan Port Industrial Park and the city in 2020 when projects are completed.

#### 13.1.3 Reliability of Water Intake

The water intake in the Water-supply Source Project of Tieshan Port District is in keeping with the requirements of national policies concerning the water conservation industry, in accordance with the requirements of the development tasks of Hepu Reservoir Project and the comprehensive utilization planning and the functional division of water concerning Nanliu River, and in line with the needs for developing and constructing Beibu Gulf (Guangxi) Economic Development Zone. The water intake in the construction projects matches with the conditions of water resources of Hepu Reservoir and Nanliu River and is in conformity with the water control policies of optimized allocation and efficient utilization of resources.

The designed amount of water intake of the Water-supply Source Project of Tieshan Port is 447,000  $\text{m}^3/\text{d}$ , the average amount 344,000  $\text{m}^3/\text{d}$ ; and the annual amount of water intake amounts to 125.62 million  $\text{m}^3$ , of which the average annual amount of water intake from Shangba Section on Nanliu River reaches to 39.32 million  $\text{m}^3$ , taking up 1.0% of the

average annual inflow amount (3.85 billion m<sup>3</sup>) of Shangba Pump Station Section on Nanliu River. After the joint operation of Hepu Reservoir and Shangba Section on Nanliu River, the inflow amount of Hepu Reservoir and Nanliu River may fully satisfy the water demand of every sector.

To sum up, it is feasible for the Water-supply Source Project of Tieshan Port District to catch water from Hepu Reservoir and Nanliu River.

## **13.2 Overview of the Development and Utilization of Water Resources**

### **13.2.1 Regional Water Supply and Status of Water Utilization**

In line with related survey and statistics, the total water supply amount of the demonstrated drainage area (the drainage area of Nanliu River in Yulin and the drainage area within Beihai) in 2004 amounted to 2,186 million m<sup>3</sup>, of which that of the surface water reached 1,948 million m<sup>3</sup>, taking up 89.1% of the total; that of the underground water 238 million m<sup>3</sup>, taking up 10.9%. Therefore, it is not difficult to see that the development and utilization of water resources in the region mainly relies on the surface water resources, supplemented with the underground water; the water supply with the surface water is mainly in the form of water storage project, supplemented with water lifting and abstraction.

In 2004, the total water consumption in the demonstrated drainage areas amounted to 2,186 million m<sup>3</sup>. The current water utilization was mainly for irrigation, next for industry, living, and forestry, pasturage and fishery. The water consumption of the farming in the region was 1,415 million m<sup>3</sup>, that of the industry 297 million m<sup>3</sup>, that of living 242 million m<sup>3</sup>, that of forestry, pasturage and fishery 166 million m<sup>3</sup>, that of environment 25 million m<sup>3</sup>, and that of construction, the tertiary industry and other sectors 41 million m<sup>3</sup>, respectively taking up 64.73%, 13.59%, 11.07%, 7.59%, 1.14% and 1.18% of the total amount of water consumption respectively.

### **13.2.2 The Extent of Development and Utilization of Current Water Resources**

In accordance with survey and statistics, the total amount of water supply through surface water in the demonstrated drainage areas in 2004 was up to 1,948 million m<sup>3</sup>, taking up 25.2% of the total amount of water resources in the drainage area of Nanliu River, 22.1% of that of the corresponding water supply area. The rate of development and utilization of water resources is comparatively high. However, most of the overall indexes of water utilization concerning the industry and life of urban citizens were higher than the average levels of Guangxi, and such indexes concerning farming, forestry, pasturage and fishery were also close to the average levels of the province at the same period. Thus, it is clear that there is also great potential for further exploration in the demonstrated areas.

## **13.3 Analysis on the Rationality of Water Utilization in Construction Projects**

### **13.3.1 Analysis on the Current Level of Industrial Water Utilization in Tieshan Port District**

Water for industrial use in Tieshan Port District is mainly from Hepu Reservoir. According to related survey and statistics on data collected by Beihai Municipal Development and Reform Commission, the industrial projects planned in Tieshan Port Industrial Park and amount of water consumption are shown in Table 13.3-1. The amount of water consumption of industrial projects is directly adopted in accordance with the design outcomes of projects, which have taken into consideration of adopting the current advanced production processes both in China and abroad, thus the amount of water consumption reaching state-of-the-art level either across China or throughout the world. As for some projects with no design reports at present, analogy shall be employed for determining the norm for water conservation through making reference to the advanced production levels of corresponding industries. The amount of water consumption excludes the amount for cooling seawater in Beihai Fire Power Plant.

Table 13.3-1 Industrial Projects of Tieshan Port of Beihai and Prediction on Water Consumption

| No.   | Name of project                                               | Construction scale                                                                                                                                                                              | Total investment<br>(RMB 100<br>million Yuan) | Water<br>consumption<br>(10,000 m <sup>3</sup> /d) |
|-------|---------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|----------------------------------------------------|
| 1     | Forest-pulp-paper project                                     | Annual output: 900,000t pulp and 900,000t paper and cardboard                                                                                                                                   | ---                                           | 12.47                                              |
| 2     | Beihai Power Plant                                            | Total installed capacity of phase I and phase II is 1.80 million KW; the 600,000 KW unit of phase I has already been put into operation.                                                        | ---                                           | 5                                                  |
| 3     | Project of oil & gas storage of Tieshan Port                  | 726,000m <sup>3</sup> storage tanks are built in phase I and phase II; one attached 50,000t and one attached 100,000t oil & gas wharf will be respectively built.                               | ---                                           | 0.8                                                |
| 4     | Beihai Refinery new site transformation petrochemical project | First phase 200000t polypropylene, 3 million tons crude oil commercial storehouse and Weizhou island crude oil wharf and pipeline project; the later phase 8 million tons refinery construction | ---                                           | 6                                                  |
| 5     | Wuhai Kaidi coal carbamide                                    | Annual outputs of 1.6 million tons of urea and 1.5 million tons of new building materials                                                                                                       | ---                                           | 8                                                  |
| 6     | Beihai Tieshan Port equipment manufacture project             | Manufacturing marine engineering equipments, tanked transportation equipment, engineering mechanical equipments and containers, etc.                                                            | ---                                           | 1                                                  |
| 7     | Tieshan Port heavy oil chemical project                       | 1.2 million t/a heavy oil chemical                                                                                                                                                              | ---                                           | 1                                                  |
| 8     | Beihai Tieshan Port ship repair and building project          | Constructing repair and building facilities such as 20000-30000t shipyard                                                                                                                       | ---                                           | 0.25                                               |
| 9     | Beihai Tieshan Port oceangoing ship project                   | Constructing repair and building facilities such as 20000-50000t shipyard                                                                                                                       | ---                                           | 0.3                                                |
| 10    | Beihai Tieshan Port public wharf                              | Annual handling capacity 12 million tons                                                                                                                                                        | ---                                           | 1.34                                               |
| Total |                                                               |                                                                                                                                                                                                 | ---                                           | 36.16                                              |



Through the engineering analysis on projects in the table above, it is clear that the water consumption of the proposed projects goes up to **124,700m<sup>3</sup>/d**. At present, the phase I work of the water supply project from Hepu Reservoir to Tieshan Port District with a total amount of water supply amounting to 230,000 m<sup>3</sup>/d, Hepu Reservoir, the project established under the approval of Guangxi Zhuang Autonomous Region, has been completed and put into production at the end of 2006. The phase II work, with a total amount of water supply up to 217,000 m<sup>3</sup>/d, is planned to accomplish and put into production by the end of 2008. Therefore, it is clear that the accomplished Water Supply Project of Tieshan Port shall be capable of satisfying the volume of water needed for the construction projects.

### 13.3.2 Evaluation on the Rationality of Water Utilization in Construction Projects

The index of Level A norm in *Norm of Water Intake – Part 5: Pulp, Paper and Paper Board Production* (GB/T18916.5-2002) is 90 m<sup>3</sup>/Adt. In *Policies for Developing Paper-making Industry* (2007), State Development and Reform Commission puts forward the requirements, such as “the consciousness of water conservation are to be enhanced in the whole industry and great effort must be made in developing and promoting new technologies, processes and equipment for water conservation and increasing the ratio of water recycling. On the basis of strictly enforcing *Norm of Water Intake: Pulp, Paper and Paper Board Production*, water consumption by unit product shall be reduced gradually and steadily. The amount of water intake of unit product in newly-established projects shall be further reduced more than 20% on the original Level A norm.”

The water consumption of a proposed project shall be 124,700 m<sup>3</sup>/d, and the amount of water intake be 33.3 m<sup>3</sup>/Adt. From the results of comparison in Table 13.3-2, the amount of water intake takes up 37.0% of the norm index of Level A as specified in *Norm of Water Intake – Part 5: Pulp, Paper and Paper Board Production* (GB/T18916.5-2002), and 46.2% of the index required in *Policies for Developing Paper-making Industry*. Therefore, the water consumption of proposed construction projects is reasonable.

Table 13.3-2 Comparison between the Amount of Water Intake of the Proposed Construction Projects and the Norm Index

|                                                                                                       | Amount of water intake (m <sup>3</sup> /Adt)                                                                                                                                                 |
|-------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 900,000 ton/year bleached chemical                                                                    | 33.3                                                                                                                                                                                         |
| <i>Norm of Water Intake – Part 5: Pulp, Paper and Cardboard Production</i> (GB/T18916.5-2002) Level A | 90                                                                                                                                                                                           |
| <i>Policies for Developing Paper-making Industry</i>                                                  | The amount of water intake of unit product in newly-established projects shall be further reduced more than 20% on the original Level “A” norm (namely, no more than 72 m <sup>3</sup> /Adt) |
| Conclusion of comparison                                                                              | Reasonable                                                                                                                                                                                   |

## 13.4 Analysis on Impact of Water Intake

The water consumption of the proposed construction projects shall be **124,700m<sup>3</sup>/d** after being completed, taking up 27.9% of the amount of water supply to the whole Tieshan Port Industrial Park, and the water demand of projects is to be supplied uniformly by the zone, while the sources of water intake shall be supplied by Hepu Reservoir and Nanliu River. Thus, the analysis on the impact of water intake of projects is, on the whole, same to that on the impact of water intake of Tieshan Port Industrial Park. Therefore, analysis on the impact of the water intake of Tieshan Port is conducted here and further on that of the water intake of the proposed projects.

### 13.4.1 Impact on Regional Water Resources

#### 13.4.1.1 Impact on Hydrological Regime

(1) The impact of the Water-supply Source Project of Tieshan Port District on the water level of Hepu Reservoir

Hepu Reservoir, with Xiaojiang River Reservoir as its main body, connects with Wangsheng River-Liuhu Lake Reservoir through the large of aqueduct of Nanliu River, thus forming a reservoir group. In addition, it also includes four medium-sized reservoirs of irrigate-form-melon, i.e. Zhakou Reservoir, Shikang Reservoir, Qingshui River Reservoir and Niuweiling Reservoir, and 36 small-sized reservoirs of irrigate-form-melon as well. The reservoir was originally designed as a multipurpose water control project giving priority to irrigation and integrating water supply and power generation as well as flood control, and navigation.

As the water supply to the urban areas not being increased, the current allocation principles are as follow: Under the precondition of ensuring the safety of the dam, storing and releasing adjustment shall be planned and implemented with regard to the water volume entering reservoir, by means of the adjusting capability of storage of Xiaojiang Reservoir and other reservoirs of irrigate-form-melon, thus the reservoir may be put into full play in terms of its function for controlling flood over downstream of Nanliu River and its benefits. The water supply dispatching of the reservoir shall first satisfy the water demand of farming irrigation and in the urban areas, and next the water for generating power. Or put it another way, water shall be stored as much as possible and discarded as little as possible, for generating more power, under the precondition that the safety of the reservoir be ensured.

The originally designed irrigation area of Hepu Reservoir was 2.1 million mu, of which farmland amounted to 884,000 mu and available uncultivated land 1.216 million mu. In 2000, conforming to the principles promoted in SN [1999] No. 459 Document of Ministry of Water Resources, *Notice on Conducting the Extended Construction of Supporting*

*Facilities in Large-sized Irrigation District and the Compilation of Planning for Reconstruction of Water Conservation*, Guangxi Water Resources and Power Exploration and Design Institute carried out new and comparatively detailed survey analytic demonstration over the scale of the irrigation district under Hepu Reservoir. The conclusion reached hereby as the following, the farming lands decreased greatly for that Beihai, Hepu County and other towns within the irrigation district were areas gaining rapid economic development and thus the urban and industrial areas and fundamentals facilities such as highways and the like occupied large pieces of land; after re-verification, the designed irrigation area totally under the control of the irrigation district of Hepu Reservoir was 874,900 mu, and after the deduction of such areas irreclaimable for being used for urban development and road construction, the irrigation area for scaled development in the irrigation district was up to 701,000 mu, of which paddy field took up 434,600 mu, irrigated land 266,400 mu. Namely, the final designed irrigation area was 701,000 mu. Therefore, the water for irrigation up to the reservoir has been greatly reduced compared with the original design, and the water volume saved from the shrunk irrigation land is mainly considered for the water supply to the urban area. Provided that no new task is increased for urban water supply, the remained water shall be used for generating power in the main channel power station or increasing the surplus water in reservoir.

After the addition of the Water Supply Project of Tieshan Port District, the water demand of power station must subject to the demand of water supply to the urban area and for irrigation, the surplus water in the reservoir shall be reduced greatly, thus the overall utilization of water resources being improved.

For the fact that the addition of task for supplying water to Tieshan Port District changes nothing with regard to the normal impounded level and the maximum flood level of the reservoir, thus the Water-supply Source Project of Tieshan Port District produces little impact to the water level of Hepu Reservoir.

(2) The impact of the Water-supply Source Project of Tieshan Port District on the hydrological regime of Huhai Canal

Huhai Canal is the corridor of water conveyance, namely, the main channel for Hepu Reservoir, mainly for satisfying the water demands of the uses for farming, industry, urban residents and offshore fishermen, and next for generating power by making use of hydropower and navigation via its canal system. The designed passing flow amount of the canal is  $56.0\text{m}^3/\text{s}$ , and the expanded flow amount is  $70\text{m}^3/\text{s}$ .

Since the designed irrigation area in the irrigation district of Hepu Reservoir has been deduced from original 2.1 million mu to 701,000 mu, the designed water consumption of irrigation planned in the irrigation district reaches to  $41.38\text{m}^3/\text{s}$ . The designed maximum flow capacity of water intake is  $6\text{m}^3/\text{s}$  in the Water Supply Project of Tieshan Port District. After the addition of water supply to Tieshan Port District, the passing flow amount of

Huhai Canal is still within the designed scope. Furthermore, the layout of the control gate of the canal is based on the principle that no hindrance shall be caused against the passing capability of the canal. Namely, the width of the gate chamber shall be arranged in line with the original width and designed as flat-bed gate. Therefore, the water depth and flowing velocity of Huhai Canal mainly subject to the allocation of Xiaojiang River Reservoir Group. As a result, the water intake of the Water-supply Project of Tieshan Port District shall cause little impact on the hydrological regime at the upstream and downstream of Huhai Canal.

### (3) Impact of the pump station of Nanliu River to the hydrological regime of the river

For the purpose of satisfying the requirements of every water consumer and for the assurance rate of water utilization in Year 2002, it is considered that water shall be pumped out of Shangba Section on Nanliu River and into Hepu Reservoir, thus water supply may be carried out by making use of the balancing storage of Hepu Reservoir and the corridor of water conveyance of Huhai Canal. In line with the analysis and calculation of balance of water volume, the designed pumping scale of the pump station of Nanliu River arrives at  $6 \text{ m}^3/\text{s}$ . The average annual pumping amount from Nanliu River is 39.32 million  $\text{m}^3$ , and the maximum annual pumping amount 131.40 million  $\text{m}^3$ .

In accordance with the series of analysis and calculation on the runoff actually surveyed by Changle Hydrological Station of Nanliu River from 1954 to 2004, it was clear that the annual average runoff amount of Shangba Section was 3.85 billion  $\text{m}^3$ , the year with the lowest water being 1963, and the annual runoff amount of Shangba Section 1.28 billion  $\text{m}^3$ . The Water Supply Project of Tieshan Port needs to pump water of 39.32 million  $\text{m}^3$  from Nanliu River annually on average, which takes up 1.02% of the annual average runoff amount of the pumping section. See details in Table 13.4-1. Therefore, the long term average amount of water intake of the Water Supply Project of Tieshan Port has little influence on the average flow and flow speed of Nanliu River.

Table 13.4-1 Proportion of the Annual Amount of Water Intake of Nanliu River in the Annual Inflow Amount (unit of water quantity: 100 million  $\text{m}^3$ )

| Item                   | Jan. | Feb. | Mar. | Apr. | May  | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | Low term average |
|------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------------------|
| Amount of water intake | 0.03 | 0.03 | 0.03 | 0.04 | 0.03 | 0.04 | 0.04 | 0.04 | 0.02 | 0.02 | 0.03 | 0.03 | 0.39             |
| Amount of inflow       | 12.5 | 13.3 | 15.8 | 37.2 | 47.3 | 67.2 | 71.6 | 87.4 | 49.5 | 28.0 | 17.9 | 12.0 | 38.5             |
| Proportion %           | 0.24 | 0.22 | 0.19 | 0.11 | 0.06 | 0.06 | 0.06 | 0.04 | 0.04 | 0.07 | 0.17 | 0.25 | 1.02             |

#### 13.4.1.2 Impact on the Capacity of Water Environment of Nanliu River

The maximum flow amount of water intake of the Water Intake Project of Nanliu River is  $6 \text{ m}^3/\text{s}$ , and the average flow amount of water intake  $1.25 \text{ m}^3/\text{s}$ . It is shown clearly in Table 13.4-1 that the average annual amount of water intake produces little impact on the amount of runoff, but posing certain impact on the runoff amount during low water period

with less inflow from November to April the next year. And during this period, the decreased proportion of flow amount is bigger than that in the other months. However, the Water Intake Project of Nanliu River adopts the lowest average flow amount up to  $13.7\text{m}^3/\text{s}$  in water intake with the assurance rate 90% as the requirement for the water consumption in the downstream, namely, the Water Intake Project of Nanliu River may only draw the part of water beyond the flow amount for use of biological environment, and pumping shall not be taken into consideration when the inflow is less than the base flow of the water for biological environment. Therefore, the flow velocity of Nanliu River does not change considerably prior or subsequent to the water intake, and at the place 5.5km deeper than the catching section, there are inflow from another relatively big tributary, known as Wuli River, which covers a drainage area up to  $1222\text{km}^2$ , and has the annual average runoff amount up to 939 million  $\text{m}^3$  and the runoff amount in year with low water about 489 million  $\text{m}^3$  (P=95%). Therefore, the water intake from Nanliu River only causes certain impact on its reaches from Shangba Water Intake Section to the tributary Wuli River, but only of a slight degree.

To sum up, after the completion of the planning of water intake project, by the planning efficiency year 2020 the water environment capacity of the reaches of Nanliu River from Shangba Water Intake Section to the tributary Wuli River during the high water period does not change considerably compared with the natural river channel; the water environment capacity of such reaches will shrink slightly compared with the natural river channel, but still capable of satisfying the basic requirements of the geological environment.

### 13.4.2 Impact of Water Intake on other Consumers

#### 13.4.2.1 Impact on the navigation of River Channels

Nanliu River used to an important waterway connecting Yulin, Bobai, Pubei and Hepu. In line with the statistics of 1955, the available transportation capability is 4685t/310 ships, carrying goods up to 1359t. In 1959, illuminant navigation marks were set up along the whole line, making navigation at night possible, and there were passenger ships running up and down the river. Later, due to increased water and soil losses in the upstream, the riverbed became shallow with sedimentation, reducing the flow amount during the low water period, thus navigation was gradually interrupted along the upper reaches from Bobai. After 1970, the local people constructed a simple Shahe Dam to cut Nanliu River by the waist, thus upper reaches from Shahe River was deprived of shipping. In accordance with the current situation of Nanliu River and the development of highway networks, it seems of no great significance to make the river navigable again; moreover, in line with *Official Reply of Guangxi Zhuang Autonomous Region on Approving the Technical Grade Table for Channels below Level 5 (including Level 5) in Guangxi* (GZH [1998] No. 5),

Nanliu River has not been listed as a channel for navigation, thus water supply projects of the project basically has little impact on the navigation function of the river channel.

#### 13.4.2.2 Impact on the Water Consumption of Other Water Consumers of the Water-supply Source Hepu Reservoir

Through the multi-scheme combinations and optimized allocations and comparison of the water sources surrounding Beihai, the design of the Water-supply Source Project of Tieshan Port of Beihai is recommended to adopt the constructed joint-allocation through Hepu Reservoir Group and Pumping water from Nanliu River. Under the condition that the water demands of farming irrigation and rural resident and livestock and water for the environmental use within river channels are satisfied, by 2020 the project may meet the requirement of water supply, as much as 350,000 m<sup>3</sup>/d, to the urban area of Beihai and Lianzhou Town of Hepu County, in addition to the demand of water consumption of Tieshan Port District, up to 447,000 m<sup>3</sup>/d. It is shown clearly in the long-range series of analysis and calculation on the balance of water supply and demand that the annual assurance rate for water for farming irrigation is up to 85%, satisfying the requirement for water supply by irrigation; the water demand of the urban area and the industry is satisfied to the assurance rate as high as 97%. Therefore, after the addition of water supply task to Tieshan Port District, the implementation of the joint adjustment through Nanliu River and Hepu Reservoir shall enable the rational allocation and highly efficient utilization of water resources, thus the water demand of every sector is satisfied to a better extent. The project of water intake results in no significant impact on Hepu Reservoir and the water consumption of every water consumer.

#### 13.4.2.3 Impact on the Irrigation District of Zongjiang Bridge Gate at the Downstream

Zongjiang Bridge Gate, located along the downstream of Nanliu River in Hepu County, is a large-sized gate giving priority to irrigation and integrating navigation, road transportation, urban water supply, etc. The upper area of rain collection of the gate site reaches 8,365km<sup>2</sup>, the average annual flow amount being 211m<sup>3</sup>/s; and the designed irrigation area is 86,200 mu, the maximum annual irrigation up to 75,300 mu, while the current available irrigation area is 72,400 mu, and the actual irrigation area is 52,000 mu.

##### (1) Analysis on inflow amount

The annual average runoff amount of the section of Changle Hydrological Station of Nanliu River is estimated up to 5.08 billion m<sup>3</sup>, based on the frequency calculation in line with the annual runoff series actually surveyed by Changle Station II from 1954 to 2004. See Table 13.4-2 for the outcomes of average annual runoff amount at different frequencies and runoff outcomes of Zongjiang Bridge Gate.

Table 13.4-2 The Outcomes of the Section of Zongjiang Bridge Gate of Changle Hydrological Station, Nanliu River

| Name of project              | Water collection area (km <sup>2</sup> ) | Annual average runoff amount (100 million m <sup>3</sup> ) | C <sub>v</sub> | C <sub>s</sub> /C <sub>v</sub> | Annual average flow at every frequency (100 million m <sup>3</sup> ) |       |      |      |      |      |      |
|------------------------------|------------------------------------------|------------------------------------------------------------|----------------|--------------------------------|----------------------------------------------------------------------|-------|------|------|------|------|------|
|                              |                                          |                                                            |                |                                | 5%                                                                   | 10%   | 20%  | 50%  | 75%  | 90%  | 95%  |
| Changle Hydrological Station | 6645                                     | 50.8                                                       | 0.34           | 2                              | 82.3                                                                 | 73.9  | 61.3 | 48.9 | 38.4 | 30.4 | 26.1 |
| Zongjiang Bridge Gate        | 8365                                     | 70.5                                                       |                |                                | 118.3                                                                | 105.6 | 91.5 | 68.3 | 56.1 | 41.1 | 35.0 |

## (2) Analysis on water consumption

The current water demand of Zongjiang Bridge Gate is mainly for the uses of farming irrigation, drinking of urban and rural residents and livestock, industry, etc.

After completion of the project, i.e. Tieshan Port Water Supply Project Phase II, it is estimated that, by 2020 (provided P=75%), the water for irrigation demanded by Zongjiang Bridge Gate along the downstream of Nanliu River amounts to 97.84 million m<sup>3</sup>/a, that for rural residents and livestock is 3.64 million m<sup>3</sup>/a, and that for the industry 7.24 is million m<sup>3</sup>/a; whereas the total water consumption is as much as 108.72 million m<sup>3</sup>/a.

## (3) Analysis on balance of supply and demand

The balance analysis here selects 1963, the year with the lowest water and years with low water of P=75% for calculation on balance of water volume, and the results are shown in Table 13.4-3 as follows.

Table 13.4-3 The Outcomes of Calculation on Balance of Water Volume in the Irrigation District of Zongjiang Bridge Gate (unit: 10,000 m<sup>3</sup>)

| Item          | Jan. | Feb. | Mar. | Apr. | May   | Jun.  | Jul.  | Aug.  | Sep.  | Oct.  | Nov.  | Dec. | Total  |
|---------------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|------|--------|
| Inflow amount | 5904 | 5515 | 6052 | 4507 | 10540 | 10058 | 55186 | 41043 | 24734 | 11404 | 18726 | 6401 | 200071 |
| Water demand  | 91   | 91   | 605  | 1321 | 1645  | 1287  | 460   | 1355  | 1824  | 1422  | 684   | 91   | 10872  |
| Surplus water | 5813 | 5424 | 5447 | 3186 | 8895  | 8771  | 54726 | 39688 | 22910 | 9982  | 18042 | 6301 | 189199 |

From the results of balance of water amount, the water volume of Zongjiang Bridge Gate is sufficient. The annual average water intake amount by Tieshan Port Industrial Park from Nanliu River is only 39.32 million m<sup>3</sup>, taking up 1.96% of the inflow amount and 2.07% of the amount of the surplus water. Thus, it results in no significant impact on the irrigation district of Zongjiang Bridge Gate.

## 13.4.2.4 Impact on the Power Generation in the Power Plants

In line with *Revised Report on the Planning of Comprehensive Utilization and Control of Nanliu River of Guangxi Zhuang Autonomous Region*, the planned cascade reservoirs of the main stream of Nanliu River altogether include eight ones, Ma'anshan, Tongluowan, Jiangnan, Shuiming, Xinwudi, Shahe, Suzhong, and Quanshui. At present, except that

Shahe Cascade Reservoir at the upstream from Shangba Pump Station on Nanliu River has been established and put into operation, all the remained have not constructed. What's more, there is only Quanshui Cascade Reservoir at the downstream from Shangba Pump Station, but it is not taken into consideration to construct confided by its development conditions. Therefore, the water intake of Shangba Pump Station causes little impact on the power generation in power plants.

#### 13.4.2.5 Impact on Environmental Water Consumption in Downstream Channel

When the water volume of Hepu Reservoir fails to meet the water demand of Tieshan Port District, the Water-supply Source Project of Tieshan Port District shall consider to draw water from Nanliu River, then the first thing to take into account is to release downward the base flow of the biological environment, thus ensuring that the basic requirements of eco-environmental water consumption. The monthly average flow amount with the lowest water at  $13.7\text{m}^3/\text{s}$  and with the assurance rate at 90%, shall be adopted in the water intake at Shangba Pumping Section of the Water Supply Project of Tieshan Port. The operation of the project shall follow the allocation principles below: when the inflow at the water intake section of Nanliu River is less than or equal to the environmental base flow, the pump station shall not draw any water; when it is more than the environmental base flow, the pump station may draw out part water exceeding the base flow. Provided that the operation mode may be stuck to strictly, the base flow required by the biological environment downstream of the diversion section of Nanliu River may be effectively ensured. Thus, the water intake of the construction projects causes no significant impact on the water for environmental use in the downstream channels.

#### 13.4.3 Conclusions of Analysis on the Impact of Water Intake

Base on the overall analysis, the designed maximum pumping flow at Shangba Section of the Water-supply Source Project of Tieshan Port District is  $6.0\text{m}^3/\text{s}$ , and the average annual pumping amount  $1.25\text{m}^3/\text{s}$ , taking up only 1.02% of the annual average inflow amount of Shangba Pumping Section. Thus, the Water-supply Source Project of Tieshan Port District results in no significant impact on regional water resources, water ecological environment and other water consumers. The water intake of the proposed projects completely depends on the water supply system of Tieshan Port Industrial Park, so the water intake of those projects shall also cause no significant impacts on regional water resources, water ecological environment and other water consumers.



## 14 Cleaner Production and Review on Industrial Policies

### 14.1 Cleaner Production

Cleaner production is a tactic measure for implementing the strategy of sustainable development, and it aims at applying the strategy for preventing and controlling pollution continuously throughout the production process. Improve the management and promote the technology progress to enhance the resource utilization ratio and reduce the emission of pollutants, thus reduce the harm caused by pollution to human beings and environment. The core of cleaner production is starting from the headstream and focusing on prevention and control, achieving at the integration of economic and environmental benefits thorough controlling over the whole process.

State Environmental Protection Administration has, in “HK (1997) No. 232 document”, pointed out that the evaluation of the environment impact of the construction projects shall include contents in connection with cleaner production and evaluation shall be carried out over techniques and products in line with the requirements of cleaner production. Therefore, the evaluation on the level of cleaner production of the proposed projects shall be carried out in accordance with the indexes (see Table 14.1-1 for details) in *Cleaner Production Standard – Production of Kraft Chemical Wood-Pulp, Paper Industry* (HJ/T340-2007) and *Cleaner production Standard – Coal-fired Power Plants* (HJ/T xx-2003) (exposure draft), and meanwhile carry out across comparison with enterprises with advanced level of cleaner production both in China and abroad, thus illustrating the level of cleaner production of the project.

Table 14.1-1 Cleaner Production Standard – Manufacturing Techniques of Kraft Chemical Wood-Pulp

| Level of cleaner production index                                                     | Level 1                                                                                        | Level 2                                                                                                | Level 3                                                                         |
|---------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| I. Requirements for production technique and equipment                                |                                                                                                |                                                                                                        |                                                                                 |
| 1. Wood debarking                                                                     | Dry skinning, recycling utilization of washing water                                           |                                                                                                        |                                                                                 |
| 2. Cooking                                                                            | Continual or indirect boiling with low energy consumption                                      |                                                                                                        |                                                                                 |
| 3. Washing                                                                            | Multi-sectioned backwashing                                                                    |                                                                                                        |                                                                                 |
| 4. Screening                                                                          | Closed pressure screening                                                                      | Pressure screening                                                                                     | Improved traditional screening                                                  |
| 5. Bleaching                                                                          | Oxygen delignification, elemental chlorine free (ECF) or totally chlorine-free (TCF) bleaching | Oxygen delignification, ECF or multi-sectional bleaching with chlorine dioxide replacing part chlorine | ECF or multi-sectional bleaching with hydrogen peroxide replacing part chlorine |
| II. Indexes of utilization of resources and energy                                    |                                                                                                |                                                                                                        |                                                                                 |
| 1. Amount of water intake ( $\text{m}^3/\text{Adt}^{(1)}$ )                           | $\leq 50$                                                                                      | $\leq 70$                                                                                              | $\leq 90$                                                                       |
| 2. Overall energy consumption (Energy purchased) kg (standard coal) /Adt              | $\leq 500$                                                                                     | $\leq 550$                                                                                             | $\leq 650$                                                                      |
| 3. Consumption of fibrous materials (absolute dry) (refined wood and wood chip) t/Adt | $\leq 2.25$                                                                                    | $\leq 2.35$                                                                                            | $\leq 2.45$                                                                     |
| III. Indexes for pollutants produced                                                  |                                                                                                |                                                                                                        |                                                                                 |
| 1. Amount of waste water produced ( $\text{m}^3/\text{Adt}$ )                         | $\leq 45$                                                                                      | $\leq 60$                                                                                              | $\leq 80$                                                                       |
| 2. Amount of $\text{COD}_{\text{Cr}}$ produced (kg/ Adt)                              | $\leq 55$                                                                                      | $\leq 70$                                                                                              | $\leq 100$                                                                      |
| 3. Amount of $\text{BOD}_5$ produced (kg/ Adt)                                        | $\leq 20$                                                                                      | $\leq 25$                                                                                              | $\leq 35$                                                                       |

Table 14.1-1 (continued) Cleaner Production Standard – Manufacturing Techniques of Kraft Chemical Wood-Pulp

| Level of cleaner production index                                    | Level 1 | Level 2 | Level 3 |
|----------------------------------------------------------------------|---------|---------|---------|
| 4. Amount of SS produced (kg/Adt)                                    | ≤15     | ≤20     | ≤25     |
| 5. Amount of AOX produced (kg/Adt)                                   | ≤1.0    | ≤2.0    | ≤2.6    |
| IV. Indexes of overall utilization of resources                      |         |         |         |
| 1. Rate of comprehensive utilization of lime mud (%)                 | ≥98     | ≥90     | ≥85     |
| 2. Rate of utilization of water recycling (%)                        | ≥85     | ≥82     | ≥80     |
| 3. Rate of extraction of black liquor (%)                            | ≥99     | ≥96     | ≥95     |
| 4. Rate of alkali recovery (%)                                       | ≥97     | ≥95     | ≥92     |
| 5. Rate of overall utilization of stock residue (saw-dust, etc.) (%) | 100     | 100     | 100     |
| 6. Rate of overall utilization of sludge (%)                         | 100     | 100     | 100     |

### 14.1.1 Pulping and Paper-making

#### 14.1.1.1 Elements of Cleaner Production

The key element for controlling pollution in the pulping and paper-making industry is the cleaner production, and the principles of cleaner production are as follows:

- a. High levels of products and technological equipment;
- b. Use clean raw materials;
- c. Energy and water conservation;
- e. Control the emission of water pollutants.

The application of technologies of cleaner production is not only beneficial to the environment, but also facilitating to reduce production cost and improve labor productivity.

#### 14.1.1.2 Major Measures of Cleaner Production the Proposed Projects Adopted

See Table 14.1-2 for the concrete major measures of cleaner production the proposed projects adopted:

Table 14.1-2 Major Measure of Cleaner production

| Department                                     | Scheme of cleaner production                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Production line of pulping and alkali recovery | (1) Recycling the water for washing wood chips; cleaned waste water for supplement water.                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                | (2) Leftovers, like smashed wood block, saw dust, etc., shall be sent to multi-fuel circulating fluidized bed kiln for combustion, thus saving the consumption of coal and reducing the emission of solid wastes.                                                                                                                                                                                                                                                                                                                                                |
|                                                | (3) Highly efficient scrubbing equipment is used in uncolored pulp scrubbing section and back-flow scrubbing mode is adopted for scrubbing to improve the concentration of the pulp going out of the scrubber and reduce fresh water consumption for pulp scrubbing.                                                                                                                                                                                                                                                                                             |
|                                                | (4) A/D0-EOP-D1-P four-section ECF bleaching is adopted for the bleaching section; ClO <sub>2</sub> and hydrogen peroxide are selected as bleaching agent to reduce AOX emission and the generated AOX per ton of pulp is only 0.22kg.                                                                                                                                                                                                                                                                                                                           |
|                                                | (5) Further close the system, reduce the transpiration of heat and the emission of foul gases.                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                                                | (6) Improve the concentration of pulp made in the section of bleaching and the proportion of backwashing, and reduce water consumption. The excessive hot water during the reclaiming system of white water and alkali generated in the section of pulp treatment shall be recycled thus reducing the use of fresh water.                                                                                                                                                                                                                                        |
|                                                | (7) The station of alkali recovery and evaporation shall full make use of the heat in the condensed water and other byproducts, thus increasing the reuse of condensed contaminated condensate and reducing the emission of waste water in the evaporation station.                                                                                                                                                                                                                                                                                              |
|                                                | (8) Pre-hanging filter reduces the consumption of fuel and emission of TRS in limekiln.                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|                                                | (9) The recovery boiler without disk evaporator is used for alkali recovery, thus avoiding the immediate contact evaporation of black liquor and greatly reducing the emission of sulfured hydrogen.                                                                                                                                                                                                                                                                                                                                                             |
|                                                | (10) The limekiln adopts the advanced compact cooler for carrying out flash evaporation, thus realizing the recycling of thermal energy and reducing the consumption of fuel of the kiln.                                                                                                                                                                                                                                                                                                                                                                        |
|                                                | (11) CD-Filter is used for causticization, thus improving the generating rate of white liquor and enhancing the deslagging effect.                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                                                | (12) The hexa-effective falling film evaporator and the stripping system for heavy contaminated condensate enables the rate of alkali recovery up to 98%, fully making use of the heat in the condensed water. Recovery of condensed water may save the consumption of fresh water across the whole factory.                                                                                                                                                                                                                                                     |
| The paper production line                      | (1) The screening process for pulp of high concentration shall be adopted, making the concentration of pulp up to 5% and reducing the water consumption.                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                                | (2) Penta-segmented sand separator and tri-staged pressure screen shall be used for cultural paper, for reducing the loss of pulp during the purifying and sieving process.                                                                                                                                                                                                                                                                                                                                                                                      |
|                                                | (3) The technology of single-row dryer (equipped with turbulence bar), such as SymRun and TopDuorundrying, and closed air casing and the heat pump system and the heat recovery system are also equipped, for improving thermal efficiency and reducing heat consumption.                                                                                                                                                                                                                                                                                        |
|                                                | (4) Compression is made in the form of Tandem NipcoFlex, thus improving the dryness (above 45%) of paper entering the drying section and reducing steam consumption.                                                                                                                                                                                                                                                                                                                                                                                             |
|                                                | (5) Recycled water shall used within workshop as much as possible, and the white water for paper making shall be recovered by means of closed circulation and white water recovery technology, thus reducing the consumption of fresh water.                                                                                                                                                                                                                                                                                                                     |
|                                                | (6) The concentrated white water removed from paper shall be directly used in the sizing system, and the spaying water at wet end system in paper machine and other white water shall all be integrated into the disc white water recovery machine for reclaiming white water and pulp. And thus the paper-making white water shall be recycled after treatment, the reusing rate go up more than 90%.                                                                                                                                                           |
|                                                | (7) The technology of frequency conversion is adopted in most electric machines, for reducing energy loss.                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                                                | (8) The steam dome at the dry section is completely closed and is equipped with ventilating vacuum rollers, and the makeup air casing and heat recovery system may enhance the efficiency of heat recovery, thus increasing the amount of evaporated water each unit area in the drying cylinder and saving steam as a result. The condensed water engendered in the steam system at the dry section of paper machine shall be partly recovered after being cooled, then may be used as spraying water in the paper machine or the infusing water for chemicals. |

### 14.1.1.3 Level of Technology and Equipment

Stora Enso has the successful experiences in cooperating with leading overseas suppliers and controlling manufactures of pulping and paper-making machinery, such as METSO, VOITH, ANDRITZ, JAGENBERG, ABB, GL&V, SIMENS, etc.; meanwhile, the Company also has an in-depth knowledge concerning the manufacturing technologies and equipment of similar products across the world. In order to further improve the production efficiency and quality of products, conserve energy, and reduce emission of waste water, Stora Enso also plans to import a whole set of state-of-the-art equipment, for adopting the world's leading technologies and equipment in the production system.

#### (1) Pulping production line

##### 1) Washing and screening sections

The proposed project shall adopt the DD washer or pressure washer. The main principle hereof is the displaced washing, enabling paste to go through an evenly dispersed pulp layer under high concentration. High washing efficiency and concentration of outflow pulp after compression result in sound washing effect, low washing factor and water consumption.

The screening system of the proposed project consists of two pressure knotters, pulp residue washer and tri-segment pressure screen, forming a closed pressure screen system.

##### 2) **Cooking** section

Advanced G2 or Low Solid digester is adopted for the proposed project. Wood chips are first digested with steam and after pre-soaking, low temperature **cooking** (low steam consumption) is conducted. The production rate of crude pulp after **cooking** is high, back-flow scrubbing is conducted at the bottom of digester for the pulp, the scrubbing efficiency is high, which reduces the scrubbing load of later section and further reduces the consumption of bleaching chemicals.

##### 3) Bleaching section

The proposed project adopts the bi-staged oxygen delignification under medium consistency, ECF bleaching technology. In the fore-stage of ECF bleaching, the application of bi-staged oxygen delignification may reduce the Kappa value of pulp, which shall be reduced to 10 after such treatment. In addition, in the bleaching section, the amount of chlorine bleaching agent may be reduced effectively, and the chlorinated organic pollutants may be decreased for avoiding the happening of load (especially AOX, TOCL).

A four stage ECF bleaching sequence, ----- is adopted, *comprising the use of  $\text{ClO}_2$  in the first stage followed by alkaline stage using peroxide and oxygen, then a second  $\text{ClO}_2$  bleaching stage followed by a final peroxide bleaching stage.*

$\text{ClO}_2$  is a kind of high-quality bleaching agent with a high selectivity, thus it may bleach paper pulp to a very high whiteness. The paper pulp, undergoing the hot acid treatment, will blend with  $\text{ClO}_2$ , which is more efficient than the traditional bleaching method with  $\text{ClO}_2$ .

The reaction mechanism of  $\text{ClO}_2$  is different from that of  $\text{Cl}_2$ .  $\text{ClO}_2$  depends mainly on its oxidation, through which it may reduce or even form no free chlorine and hypochlorous acid, under the condition that pH value is controlled appropriately, thus reducing or even forming no organic chloride. The second stage is for alkaline extraction, mainly for removing matters, dissolvable in alkali, formed during the treatment of acid delignify. The addition of  $\text{H}_2\text{O}_2$  and  $\text{O}_2$  may strengthen the phenolic group in the ionized lignin, thus helping dissolving lignin. And alkali is mostly used for neutralizing organic acid, and other matters. The third stage is for the makeup bleaching with  $\text{ClO}_2$ , reaching higher whiteness, under the circumstance of no significant damage to alpha cellulose. The fourth stage, which is the last section, adopts hydrogen peroxide bleaching (P) and the total chlorine dioxide consumption of the bleaching section will be lower than the consumption when chlorine dioxide (D) is used for the last-stage bleaching. The other advantage when hydrogen peroxide bleaching (P) is selected for eucalyptus wood bleaching process is that low pulp yellow return rate is ensured.

Medium consistency bleaching is adopted in ECF bleaching process, which is able to remarkably reduce water consumption for bleaching.

#### 4) Alkali recovery system

The main body of the alkali recovery system of the proposed project consists of a hexa-effective falling film evaporator unit with its supporting facilities and a stripping system for heavy contaminated condensate. This equipment is characterized by its advantages, like sound heat conductivity, low steam consumption, anti-encrustation of evaporating components and large variation scope of load rate, and it may help produce black liquor with high concentration (75-80%). The concentration of black liquor entering the evaporation station ranges from 15% to 17%, that of the black liquor coming out of the station ranging from 75% to 80%, and the latter shall be conveyed immediately back into alkali recovery kiln for combustion.

Alkali recovery kiln uses the kind without disk evaporator for burning black liquor and reclaiming energy. During the causticization section, the green mud and white mud vacuum filter is introduced for reducing the loss of alkali. The washed lime mud is pre-dried before entering the energy-conserving limekiln is used for recovering lime.

#### (2) Paper-making production line

##### 1) Pulp preparation stage

After undergoing the first-order and four-stage screening/cleaning (the 4-staged shall be selected for top-grade packaging paperboard and the 5-staged for top-grade printing paper), sand removal under low concentration, decontamination and screening with 3-staged pressure screen, pulp shall be conveyed to the paper machine as furnis. The washing of pulp shall be carried out under the medium concentration about 10%, for conserving water and energy.

##### 2) Pulp system

The adoption of advanced sizing system (for instance, Optifed or WEPTM), diluted water headbox (Optiflo or Module JetTM), and standing twin-wire former improves the grade and output of finished products and reduces the consumption of water.

The compression section combines a process of press with large-roll-diameter, a process of shoe press and a process of light press, which may best satisfy the requirement for quality of the top-grade coating cardboard. The large nip compression may not only improve the dryness of the paper sheet in the compression section, but also ensure the bulk and stiffness of finished paper.

The technology of single-row dryer (equipped with turbulence bar), such as SymRun and TopDuorundrying, and closed air casing and the heat pump system and the heat recovery system are also equipped, for improving thermal efficiency and reducing heat consumption. Compression is made in the form of Tandem NipcoFlex, thus improving the dryness (above 45%) of paper entering the drying section and reducing steam consumption.

---

The adoption of AC variable frequency drive reduces the consumption of power.

### 3) Coating system

----

### 4) Recovery system of white water

The white water in the pulp treatment workshop is mainly from the shaping and compression section. The project adopts the circulation way, and after being recovered into the white water chest, the white water shall mainly be conveyed to the screening section, broke system, high concentration trough, pulp preparation tank, and other places, mainly functioning as the diluting agent. The surplus shall be moved to the pulp-making workshop. In this way, the emission hereof may be reduced, the recovery rate going beyond 90%.

### (3) Auxiliary production workshop

Chlorine dioxide shall be prepared with R<sub>10</sub> method, and the production process may only need the supplementation of NaClO<sub>3</sub>, H<sub>2</sub>SO<sub>4</sub> and CH<sub>3</sub>OH. In the R series of technologies for preparing chlorine dioxide, the yielding rate of products is high, and the consumption of resources and energy each unit product is the lowest (about 7t steam/t product). The power consumption is far below than that in the technologies like Kesting, Holst, etc. In addition, the byproduct of R<sub>10</sub> method is mainly Na<sub>2</sub>SO<sub>4</sub>, which may be immediately recovered for using in the alkali recovery system; moreover, H<sub>2</sub>SO<sub>4</sub> may also be recovered for utilization.

The overall level of technologies and equipment of the project ranks top across the world, and its technical scheme is advanced and mature. With modernized auto control system equipped, such as DCS and QCS, the project is guaranteed with high-quality products.

#### 14.1.1.4 Indexes of resources and energy consumption

Indexes of resources and energy consumption for the proposed project are shown in details in Table 14.1-3 and Table 14.1-4.

Table 14.1-3 Indexes of Resources and Energy Consumption for Phase I of the Proposed Project

| Indexes of resources and energy consumption                                           | 900,000 ton/ year bleached chemical pulp | HJ/T340-2007 primary standard | <i>Paper Industry Development Policy</i> |
|---------------------------------------------------------------------------------------|------------------------------------------|-------------------------------|------------------------------------------|
| 1. Amount of water intake (m <sup>3</sup> /Adt)                                       | 33.3                                     | ≤50                           | 45                                       |
| 2. Overall energy consumption (energy purchased) kg (standard)/Adt                    | 414                                      | ≤500                          | 500                                      |
| 3. Consumption of fibrous materials (absolute dry) (refined wood and wood chip) t/Adt | 1.885                                    | ≤2.25                         | --                                       |

Table 14.1-3 Indexes of Resources and Energy Consumption for Phase II and III of the Proposed Project

| Indexes of resources and energy consumption           | Phase II of top-grade cardboard project | Phase III of top-grade cultural paper project | Oji Paper Kasugai Factory (Japan, international excellence) | Oji Paper Nantong Co., Ltd. (design index, international excellence) | <i>Paper Industry Development Policy</i> |
|-------------------------------------------------------|-----------------------------------------|-----------------------------------------------|-------------------------------------------------------------|----------------------------------------------------------------------|------------------------------------------|
| 1. Amount of water intake (m <sup>3</sup> /Adt)       | 16.23                                   | 15.25                                         | 20.0                                                        | 17                                                                   | 30                                       |
| 2. Overall energy consumption (kg standard coal/ Adt) | 652                                     | 600                                           | 800.1                                                       | 712.7                                                                | 680                                      |

In accordance with related data and the macro calculation of the gross output and total energy consumption in Chinese papermaking industry, the overall energy consumption by every ton paper is 1.88 ton standard coal. In several large-sized paper plants, the overall energy consumption per ton paper is 1.67 ton standard coal.

To sum up, the indexes of resources and energy consumption for the proposed pulp-making projects reach the primary standard of the indexes specified in *Cleaner Production Standard – Production of Kraft Chemical Wood-Pulp, Paper Industry* (HJ/T340-2007), namely, reaches the international advanced level concerning cleaner production; the indexes of resources and energy consumption for the papermaking work of the proposed project also reaches the international advanced level concerning cleaner production. Meanwhile, it should meet the requirement of advanced level index in the industrial admission conditions in *Paper Industry Development Policy* (Announcement of the National Development & Reform Commission of the People's Republic of China No. 71 of 2007)

The following measures for conserving energy and water to be taken in the proposed project are listed as follow:

(1) Measures for energy management

- a. A system for energy management shall be established in the enterprise, equipped with fulltime and part-time managing personnel;
- b. Energy measuring instruments shall be well-equipped, for facilitating management of energy conservation. These instruments shall be equipped up to a rate reaching the requirements under *Guides for Providing and Managing of the Measuring Instruments of Energy in Enterprise* (GB/T17167-1997).

(2) Measures for energy conservation

- a. In the layout of the general plan, workshops shall be arranged appropriately, and technological process and logistic transportation shall be made smooth and short, thus reducing the length of pipelines and the inner transporting distance in workshops.
- b. Calculations shall be made accurately in terms of balance of load, heat, water and materials, thus making the selected equipment and the capability hereof in line with the production scale.
- c. Products of energy conservation and new materials of heat preservation shall be selected.
- d. Advanced technologies and equipment shall be adopted, for instance continuous cooking, closed heat screening, compressed washing, oxygen-alkali bleaching, etc.
- e. Advanced technologies and equipment for alkali recovery shall be employed, for instance, hexa-effective plate evaporator, single-drum and low-odour alkali recovery furnace, disc pressure filter, pre-hanging white mud filter, lime recovery instrument equipped with warm-up and drying system for white mud, etc.
- f. The adoption of advanced sizing system (for instance, Optifeed or WEPTM), diluted water headbox (Optiflo or Module JetTM), and standing twin-wire former improves the grade and output of finished products and reduces the consumption of water.
- g. Compression is made in the form of Tandem NipcoFlex, thus improving the dryness (above 45%) of paper entering the drying section and reducing steam consumption.
- h. The technology of single-row dryer (equipped with turbulence bar), such as SymRun and TopDuorundrying, and closed air casing and the heat pump system and the heat recovery system are also equipped, for improving thermal efficiency and reducing heat consumption.
- i. The adoption of AC variable frequency drive reduces the consumption of power.
- j. Recycled water shall used within workshop as much as possible, and the white water for paper making shall be recovered by means of closed circulation and white water recovery technology, thus reducing the consumption of fresh water.
- k. Measuring and detecting instruments shall be installed for data recording.
- l. The substation shall be adjacent to the load center, the switching room being near the load center of equipment as much as possible; the low voltage electric transformer shall be



the S11 series of products of low loss.

m. Stress shall be put on measuring energy consumption, the place for incoming line of high voltage being installed with high voltage meter and each loop for outgoing line of low voltage being equipped with electrical meter. The laying and selection of electric line shall take into full consideration the requirements of energy conservation.

n. Centralized compensation shall be employed for compensating the low voltage side of transformer with reactive power auto compensation instrument, thus the power factors at the low voltage side may be increased to 0.95.

o. Efficient illuminant lamps shall be used for lighting.

### (3) Measures for energy conservation in buildings

a. In plane design, main buildings shall be ensured with as much sunlight as possible.

b. The plane and facade design of buildings shall be neat and normal, and the exterior walls of buildings shall be furnished with coating materials of saturated warm tone, for absorbing the radiant heat from the sun.

c. Under the precondition that the exterior walls of buildings are satisfied with their requirements for natural light, the window area shall be minimized and steel windows with reliable quality shall be selected, for reducing the gap length in window.

d. Exterior walls and object planes of buildings shall undergo computation in the next design period, for ensuring the resistance of heat conduction above the minimum thermal resistance regulated by the local department for energy conservation. For instance, the prefabricated heat preservation and insulation plate may be selected.

e. Ground in buildings, like warehouses of raw materials and finished products, etc., shall be installed with damp-proof course, and the coverage of such ground shall be made with microporous moisture absorption materials, for preventing the ground from condensation and dampness.

### (4) Heat preservation for equipment and pipelines

Sound heat preserving measures shall be taken over all equipment and pipelines requiring such treatment for minimizing the loss of heat energy.

#### 14.1.1.5 Indexes for Pollutants Produced

The indexes for pollutants produced each unit product in the proposed project are shown in details in Table 14.1-5 and Table 14.1-6. Please refer to Table 14. 1-7 for the pollutant COD<sub>Cr</sub> emission indexes of unit product of the proposed project.

Table 14.1-5 Indexes for Pollutants Produced in the Pulp-making Work of the Proposed Project

| Indexes for pollutants produced                            | Proposed project<br>(900,000 ton/ year bleached chemical pulp) | HJ/T340-2007 primary<br>standard |
|------------------------------------------------------------|----------------------------------------------------------------|----------------------------------|
| 1. Amount of waste water produced<br>(m <sup>3</sup> /Adt) | 30.0                                                           | ≤45                              |
| 2. Amount of COD <sub>Cr</sub> produced (kg/ Adt)          | 42.3                                                           | ≤55                              |
| 3. Amount of BOD <sub>5</sub> produced (kg/ Adt)           | 14.3                                                           | ≤20                              |
| 4. Amount of SS produced (kg/ Adt)                         | 15.1                                                           | ≤15                              |
| 5. Amount of AOX produced (kg/ Adt)                        | 0.37                                                           | ≤1.0                             |

Table 14.1-6 Comparison of Indexes for Pollutants Produced in the Papermaking Work of the Proposed Project

| Content                                                 | Amount of waste water produced (m <sup>3</sup> /Adt) | Amount of COD <sub>Cr</sub> produced (kg/ Adt) |
|---------------------------------------------------------|------------------------------------------------------|------------------------------------------------|
| 450,000 ton/year top-graded packaging cardboard project | 13.9                                                 | 17.4                                           |
| 450,000 ton/year top-graded cultural paper project      | 11.97                                                | 15.2                                           |
| Oji Paper Kasugai Factory (international excellence)    | 18.2                                                 | 17.5                                           |
| Shandong Huaitai (international excellence)             | 16                                                   | 15.2                                           |
| Jiangsu Gold East Paper                                 | 10                                                   | 13.2                                           |
| Jiangsu UPM-Kymmene                                     | 10                                                   | 10.8                                           |

Table 14.1-7 Pollutant COD<sub>Cr</sub> Emission Indexes of the Unit product of the Proposed Project

|                                        |                                                                |                                                      |
|----------------------------------------|----------------------------------------------------------------|------------------------------------------------------|
| COD <sub>Cr</sub> Emission ( kg/ Adt ) | Phase I Project<br>( 900000t/year bleached chemical pulp )     | Control target: 3.0 kg/ Adt                          |
|                                        |                                                                | <i>Paper Industry Development Policy</i> : 10kg/ Adt |
|                                        | Phase III Project<br>( 450000t/year top-grade cultural paper ) | Control target: 1.1 kg/ Adt                          |
|                                        |                                                                | <i>Paper Industry Development Policy</i> : 4 kg/ Adt |

It is shown clearly in Table 14.1-5, Table 14.1-6 and Table 14.1-7 that all the indexes for pollutants produced in the pulp-making work, phase I project of the proposed project are lower than the primary standards in the indexes under *Cleaner production Standard – Production of Kraft Chemical Wood-Pulp, Paper Industry* (HJ/T340-2007), namely, reach the international advanced level concerning cleaner production; by comparison, the indexes of pollutants produced in phase II and III project of the proposed project reach the international advanced level also. After the proposed project is completed and brought into effect, pollutants COD<sub>Cr</sub> emission indexes of unit products are lower than the requirement of advanced level index in the industrial admission conditions in *Paper Industry Development Policy* (Announcement of the National Development & Reform Commission of the People's Republic of China No. 71 of 2007 )

The indexes for pollutants produced in the papermaking work of the proposed project also reach the international advanced level concerning cleaner production. The reason here is that the proposed project adopts the cleaner production measures controlling at the headstream. Besides the measures listed in Table 14.1-2, the following ones are also included:

(1) Biomass energy is utilized for reducing the amount of pollutant produced.

The raw materials of production in the proposed project – eucalypt results in bark, sawdust, and other waste in the stocking process, but which may be used in the circulating fluidized bed kiln; meanwhile, the biological sludge (the main components are fiber, lignin, organism resulted from biodegradation, etc.) produced in the sewage disposal station may

also be conveyed to the circulating fluidized bed kiln for combusting after being mixed with fuel. In this way the consumption of coal may be reduced from 5% to 10%.

(2) The coal-fired kiln uses the sulfur coal and is supported with the in-furnace desulphurization system for lime stone.

The fuel of the multi-fuel circulating fluidized bed kiln in the planed project shall use the low sulfur coal (the content of sulfur  $<0.8\%$ ), and the in-furnace desulphurization system for lime stone shall also be equipped for supporting, thus the desulphurization rate may go beyond 82%; elctrostatic precipitator + fiber bag precipitating system processing is adopted for boiler flue gas and the precipitation efficiency is above 99.7%.

The black liquor generated in the cooking section in the proposed project shall be recovered for combustion, thus helping not only to reduce the emission of pollutant, but also to recover heat energy for supplying steam and power to the whole factory.

#### 14.1.1.6 Indexes for overall utilization of resources

The indexes for overall utilization of resources in the proposed project are shown specifically in Table 14.1-8

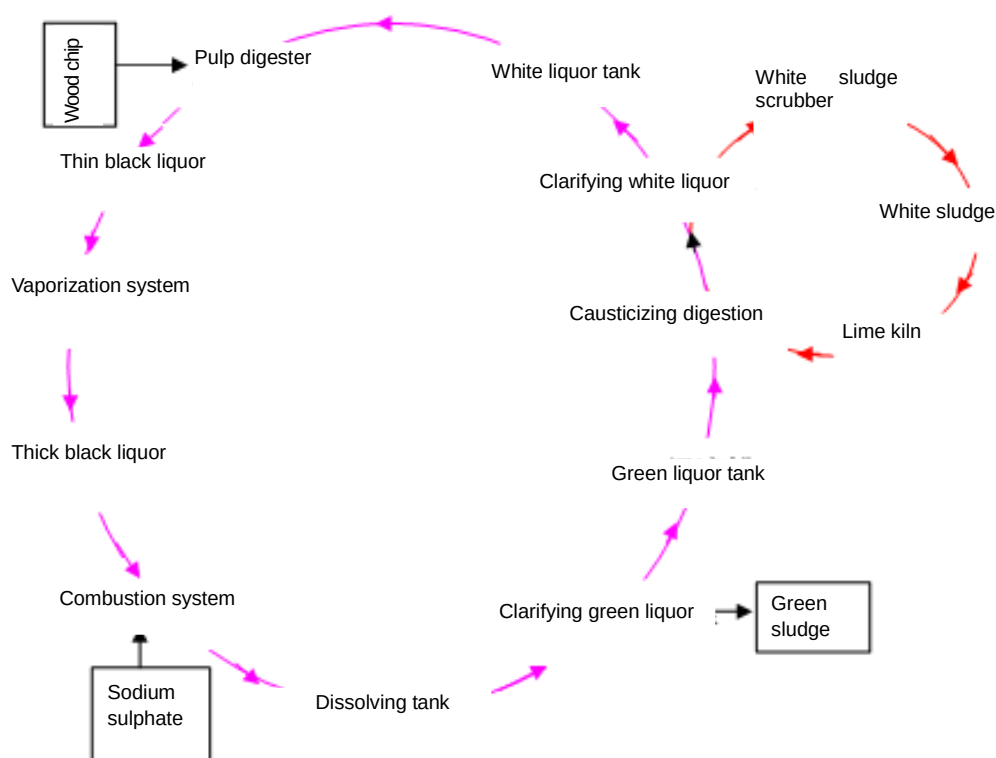
Table 14.1-8 Indexes for overall utilization of Resources in the Proposed Project

| Indexes for overall utilization of resources                                      | Proposed project | HJ/T340-2007 primary standard |
|-----------------------------------------------------------------------------------|------------------|-------------------------------|
| 1. Rate of overall utilization of white mud (%)                                   | 100              | $\geq 98$                     |
| 2. Rate of water recycling (%)                                                    | 89               | $\geq 85$                     |
| 3. Extraction rate of black liquor (%)                                            | 99               | $\geq 99$                     |
| 4. Recovery rate of alkali (%)                                                    | 98               | $\geq 97$                     |
| 5. Rate of overall utilization of stock residue (referring to saw-dust, etc.) (%) | 100              | 100                           |
| 6. Rate of overall utilization of sludge (%)                                      | 75               | 100                           |

The proposed project fully utilizes the advanced production equipment, technical advantages and recycles resource to allow indices of comprehensive resource utilization to meet the Class I standards of indices in *Cleaner production standard – Production of Kraft Chemical Wood-pulp, Paper industry*, HJ/T340-2007, i.e. reaching the international advanced level of clean production. Its process of circular economy is as follow:

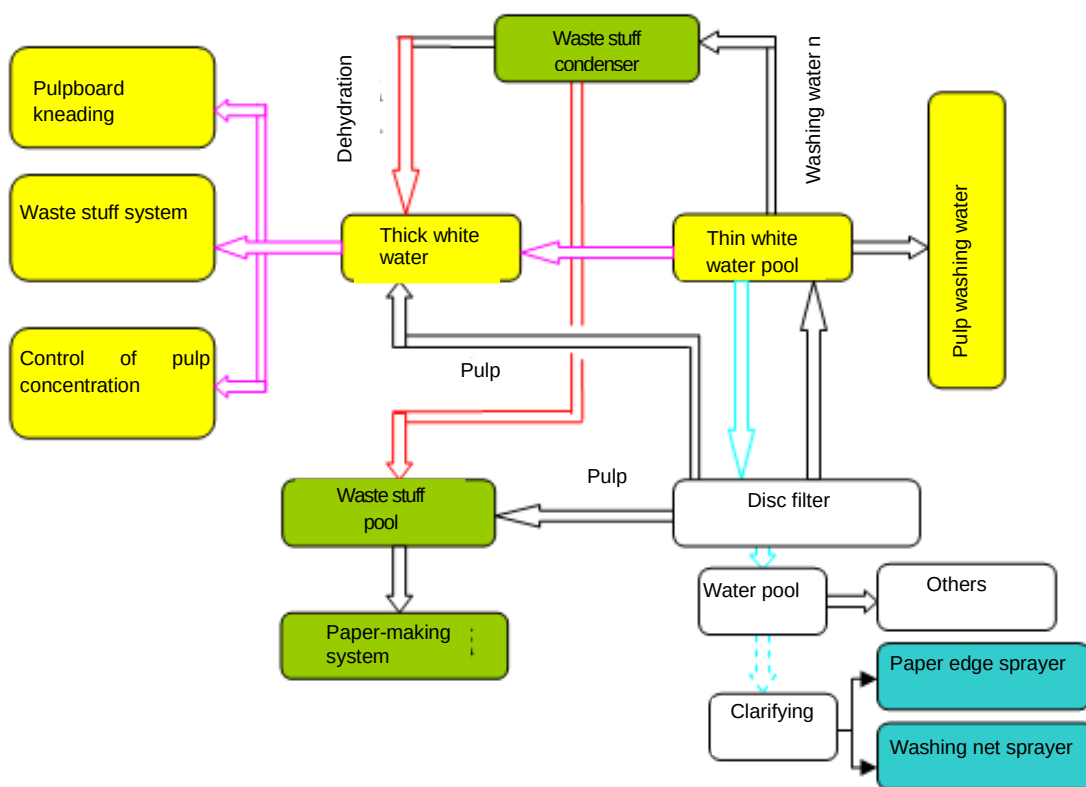
### (1) Alkali recovery

The black liquor produced by pulping is sent to alkali recovery system for burning. The recovery system will supply the steam and electricity for whole plant; the causticizing section will recover the chemicals to allow the chemicals required for steaming to be recycled between steaming system and alkali recovery system.



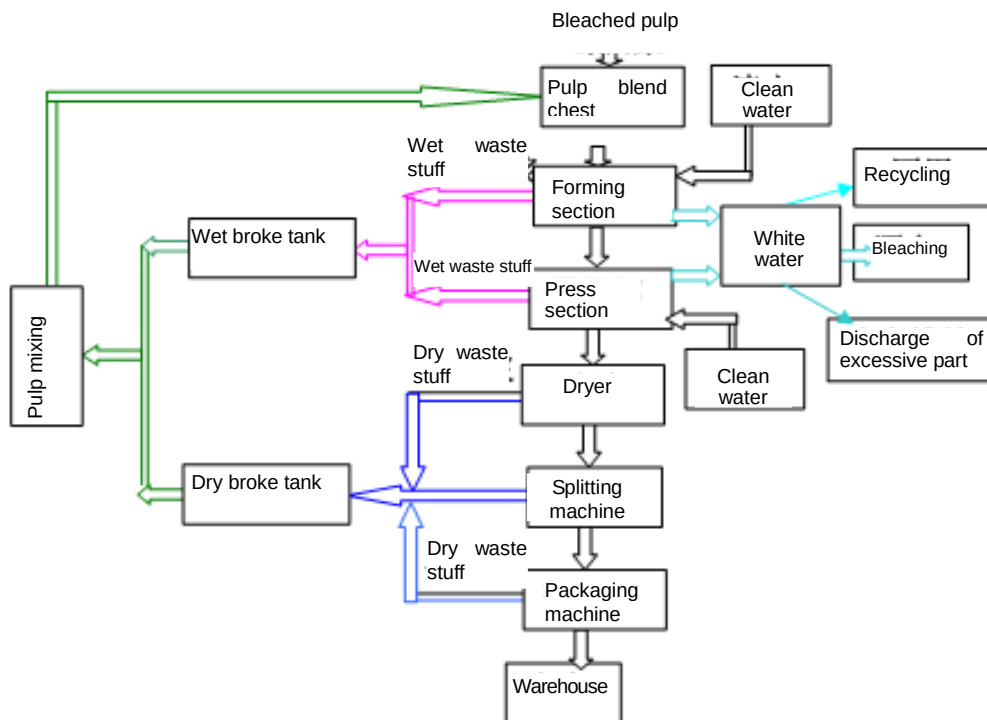
### (2) Recovery of white water

After recycling the white water from pulping workshop to white water tower, it is mainly transported to screening section, flow headbox, pulp broke system, pulp tank for dilution. The recovery of white water from paper-making workshop is the major measure to reduce discharged waste water and fiber loss. The filtered white water is supplied to external white water tank and pulp washing pump for diluting the stock. The rest will be drained to white water pool and be supplied to the users after filtration by white water treatment device. Different levels of white water and returning location area are as following: Ultra cleaning white water can be used as the spraying water at various wet ends or the diluting water for some chemicals; the cleaning white water can be used as the diluting water for refining and control of pulp concentration, the washing water for wire section and etc. the cloudy white water can be used as washing water and diluting water for various paper broke and pulping, the diluting water for short circulation of stock and washing water for individual screening machines.



### (3) Broke recovery of pulp board workshop

The dry waste stuff from drying section and packaging section enters into the pulp mixing tank together with wet edge-trim from forming section and press section, after it is slushed in a mix chest and diluted with white water. And then, the broke in the pulp mixing tank is sent to furnish preparation chest for recover the broke with the recovery rate of 100%.



### 14.1.2 Self-contained thermal power plant

#### 14.1.2.1 Elements of clean production

Its principles of clean production are as follow:

- Advanced process technology and equipment;
- Application of clean raw materials;
- Energy saving and water saving;
- Control emission of gaseous contaminations.

#### 14.1.2.2 Main clean production measures to be taken for the project of proposed self-contained thermal power plant

The scale of the self-contained thermal power plant for the proposed project is the configuration of 4-boiler and 3-generator. In phase project I, alkali recovery boiler and its supporting 100MW steam turbo-generator will be installed with the black liquor as its fuel; in phase project II, 2x220t/h circulating fluidized bed boilers (one for operation and one for backup) and their supporting 50MW steam turbo-generators will be installed with the coal, wood chips and sludge as fuel; in phase project III, additional 1x220t/h circulating fluidized bed boiler and auxiliary 50MW steam turbo-generator will be installed with the coal, wood chips and sludge as its fuel. Please refer to Table 14.1-9 for detailed resource indexes such as thermoelectric ratio and thermal efficiency of the self-contained thermoelectric power stations of the proposed phase I, phase II and phase III projects.

Table 14.1-9 Overview of Resource Indexes of the Self-owned Thermoelectric Power Stations of the Proposed Phase I, Phase II and Phase III Projects

| Project phase     | Thermoelectric ratio (%) | Annually average total thermal efficiency (%) |
|-------------------|--------------------------|-----------------------------------------------|
| Phase I project   | 367                      | 67.1                                          |
| Phase II project  | 266                      | 64.1                                          |
| Phase III project | 241                      | 62.3                                          |

It can be known from the table that the self-contained thermoelectric power stations of the proposed phase I, phase II and phase III projects all comply with the stipulation that “the annually average thermoelectric ratio of the thermoelectric units with a single unit capacity below 50 – 200 megawatt should be greater than 50% and the average total thermal efficiency of the whole year should be >45%” in JJC [2000] No. 1268 *Stipulations on developing thermoelectric joint production* issued by the National Development & Planning Commission, the National Economy & Trading Commission, the Ministry of Construction and the State Bureau of Environmental Protection.

The details of main clean production measures to be taken for the proposed self-contained thermal power plant are shown in table 14.1-10

Table 14.1-10 Main clean production measures

| Department                         | Scheme of clean production                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Self-contained thermal power plant | (1) The circulating fluidized bed coal burning boilers are used for high-efficiency and low-temperature combustion, increasing the utilization rate of resource and reducing the discharge of pollutants.                                                                                                                                                                                                                                                                                                                                                                                                                             |
|                                    | (2) The dry removing method for separating and removing ashes is applied to remove the ashes of the boilers. The flying dust is treated in the dry-type enclosed and positive pressure dust removing and dust discharge scheme with dense-phase pneumatic force; After having been cooled down by slag cooler, the bottom slag will be directly lifted and transported to the slag storage hopper and then will be transported out of factory for comprehensive utilization. Not only the residual heat in the bottom slag of boiler is utilized and but also the water to be used for hydraulically removing the dust will be saved. |
|                                    | (3) The method to add limestone in the boiler for desulfurization is applied, with the desulfurization rate up to 82.3%.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|                                    | (4) The static dust cleaner with dual-chamber and four-electrical-field is applied to remove the dust, with the efficiency of dust removing up to 99.75%.                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|                                    | (5) The counter flow type hyperbolic natural ventilation cooling tower is applied to save the resources.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

#### 14.1.2.3 Level of process technology and equipment

##### (1) Selection of boilers

The proposed project will apply the circulating fluidized bed (CBF) boilers. The combustion technology of circulating fluidized bed is a new and proven clean coal burning technology with high efficiency and low pollution. It has a stable combustion, high efficient and scientific combustion mode and has many advantages which other combustion methods can't compare.

The most critical difference between circulating fluidized bed boiler and the combustion system of coal-powder boiler and coal-fired chain grate boiler: the high slip velocity between gases and solids in the boiler leads to the good mixing of solid particles in the longitudinal and lateral directions inside the bed and the core of circulating fluidized bed

boiler – external materials circulating loop can allow the coal and limestone powder to get sufficient time of fluidized combustion and reaction desulfurization. That is to say that the material layer is in the fluidized bed under strong gas flow. The combustion of relatively large coal particles is completed at the bottom of combustion chamber. The particles with medium size return to the bottom of combustion chamber due to formation of floccules. While being burned, relatively fine coal particles are simultaneously brought out of the furnace cavity by hot fume.

A gas-solid separator is set at the outlet of furnace cavity and can collect the solid particles and send them back to the combustion chamber via re-feeding device, forming a recycling combustion system to significantly increase the combustion efficiency of boiler. Above 99% of fixed carbon can be burned off, with the combustion efficiency up to 97-99% and combustion temperature is controlled at 800-900°C, which can contain the high-efficiency and low-temperature combustion selection of dust cleaner.

The common dust cleaners have two types: electrostatic dust cleaner and bag-type dust cleaner.

The electrostatic dust cleaner can handle the large-volume, high-temperature, high-pressure or corrosive gases. It can efficiently remove the ultra fine dust particles with high efficiency for dust removal. The dust removing efficiency of multiple electrical fields dust cleaner can reach 99.9%. Due to the simple inner structure, low air speed and resistance, the pressure loss will be low when the dust is passed through dust cleaner. In addition, the static dust cleaner has the advantages of such as maintenance and low maintenance cost. The bag-type dust cleaner is also proven to be high-efficiency. When the filter bag is in a good condition, the dust removing efficiency can also reach 99.9%., with good adaptability to coal types. However, it is difficult to ensure the service life of filter bag and result in the inconvenience the frequent replacement of filter bags is a trouble. So, there are many limitations for its application in thermal power plant requiring high-load and continuous operation.

Combining the features of the above two dust cleaners, adopt dual-chamber and four-electrical-field static dust cleaner in the proposed project, whose removing efficiency can be ensured to exceed 99.75%. This process not only the emissions of smoke and dust can be reduced, but also the coarse and fine dusts can be separated and removed for the comprehensive utilization of flying coal ashes.

### (3) Selection of desulfurization scheme

The proposed project will realize the desulfurization by adding limestone powder in the boiler.

By using the powder and granule absorber, adsorbent or catalyzer, dry desulfurization can remove SO<sub>2</sub> in exhaust gas whose largest advantage is that no waste-water and waster-liquor will be discharged in the treatment and the desulfurization efficiency can reach above 82.3%.

#### 14.1.2.4 Indices of resource and energy consumptions

3 sets of 220t/h circulating fluidized bed boilers (two for operation and one for backup) of self-contained thermal power plant for the proposed project will be equipped with 2 sets of 50MW single-extraction condensing steam turbo-generator sets. The utilization indices of resource and energy are shown in table 14.1-11.



Table 14.1-11 Utilization indices of resource and energy of the project of proposed self-contained thermal power plant

| Resource index                              |                                                                       | Proposed project                                | Clean production standard for coal-fired power plant | Note                                                           |
|---------------------------------------------|-----------------------------------------------------------------------|-------------------------------------------------|------------------------------------------------------|----------------------------------------------------------------|
| Fuel                                        | Standard coal consumption rate of power generation (g/kW.h)           | Phase II project 353<br>Phase III project 349   | $\leq 446$                                           | Assessment base value for coal consumption of power generation |
|                                             | Standard coal consumption rate of heat supply (kg/10 <sup>4</sup> kJ) | Phase II project 41.1<br>Phase III project 37.3 | —                                                    | —                                                              |
| Annual average gross thermal efficiency (%) |                                                                       | Phase II project 64.1<br>Phase III project 62.3 | >45                                                  | —                                                              |
| Annual average ratio of heat and power (%)  |                                                                       | Phase II project 266<br>Phase III project 241   | >50                                                  | —                                                              |

\* Note: The Cleaner Production Standard. - Coal-fired Power Plant (Draft for Comment), HJ/T xx-2003, is applicable to the clean production of coal-fired power plant.

The energy-saving and water-saving measures to be taken for the proposed self-contained power plant include:

- (1) Select the high-efficiency steam turbine and apply the DCS control system to reduce the steam and coal consumption and increase the economical efficiency of operation.
- (2) The fast cooling system is used for the steam turbine, to shorten the cooling time after stoppage and increase the availability of generator sets.
- (3) The low-consumption and energy-saving dry-type transformer is applied in whole plant, to reduce the transformer loss and save the electricity the plant.
- (4) The variable frequency or soft-start facilities will be applied in a part of equipment according to load conditions and automatic adjustment will be applied on the basis of liquid level for energy-saving effects.
- (5) The layout of water-delivery system will reduce the turns of rubber belt machine to the best to reduce the number of transfer stations and lower the energy consumption.
- (6) After application of the water for air compressor in main workshop, the cooling water for auxiliary equipment in main workshop, dust removing air compressor, water circulating pump and motor is used, they will be recovered to circulating water system to supplement circulating water.
- (7) The recycled circulating water and sewage will be supplemented for water of greening, makeup water for the sealing of water seal tank and washing water for main workshop and coal-delivery system, to reduce the water consumption.
- (8) The preset water level and hydraulic control valves are set in the water makeup pipes for the industrial water pool, fire protection water pool and living water pool, to reduce the water consumption.
- (9) The dry dust system is applied for comprehensive utilization of ash and slag and significant reduction in water consumption.

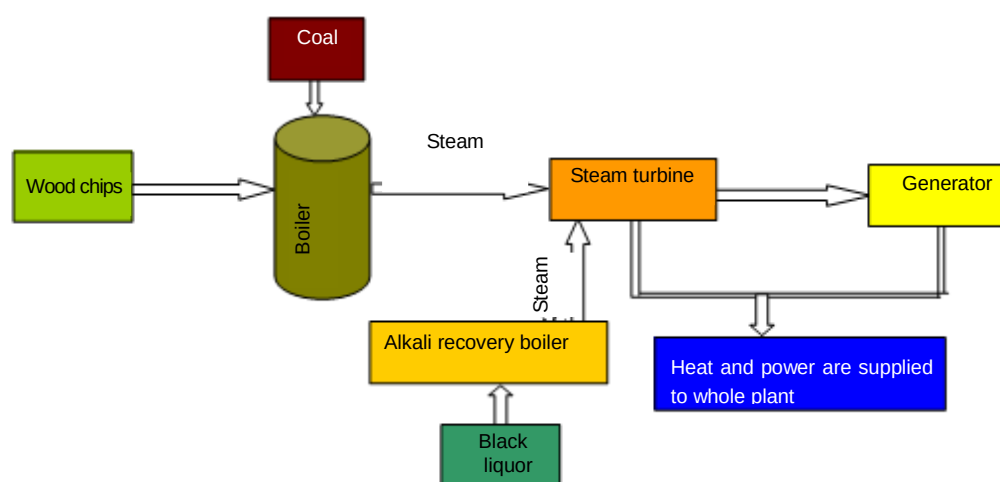
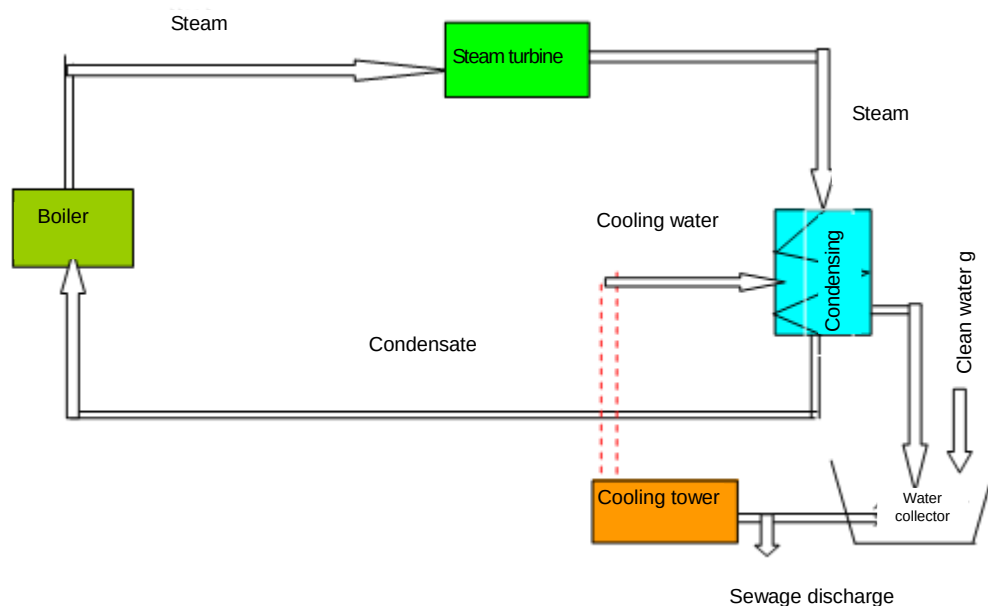
#### 14.1.2.5 Indices of comprehensive utilization of resources

The circulating cooling system is applied in the proposed self-contained thermal power plant with the water recycling rate up to 98.4% and 100% comprehensive utilization of ash and slag, meeting the Class I standard requirements in the Cleaner Production Standard. - Coal-fired Power Plant (Draft for Comment), HJ/T xx-2003 and reaching the international advanced level.

### 14.1.2.7 Discussion of circular economy

#### (1) Recycling of cooling water

The steam of power generation steam turbine enters into the condenser. The clean condensate is used for multi-fuel boiler. The cooling water is collected in collecting tank and be recycled after the cooling in cooling tower.



#### (2) Recovery of energy

The wooden wastes and etc. are sent to the multi-fuel circulating fluidized bed boiler for burning and recovering recycling the heat; the alkali recovery boiler burns the black liquor to supply high-pressure steam; the drying section of pulpboard machine conducts air cushion drying. The hot water and steam drying the pulp will be discharged after the heat is recovered recycled by preheated air of heat exchanger; thermal power plant realizes the heat-electricity co-generation for supplying the electric energy and simultaneously utilizing the air extracting steam to supply the power to whole plant.

### 14.1.3 Summary and recommendation

In summary, the proposed project has a relatively large construction scale of single production at present in the world. Its technology level and production equipment have an advanced level at present in the world. According to the analysis and comparisons in the

aspects of index of resource and energy consumptions, characteristic indices index of production technology, indices of resource comprehensive utilization, indices of pollutant generations and the requirements of production process and equipment for the proposed project, the conclusion can be drawn that the proposed project basically achieves contains the international advanced level of clean production can be drawn.

To allow the continuous improvement of clean production level, the following recommendations are given:

- (1) The white water pool should have enough capacity to reduce the overflow of white water or the addition of clean water due to the unbalance of system;
- (2) The selected main equipment should have reach the present international advanced level and the second-hand equipment are not allowed;
- (3) According to the requirements in of ISO14001, the operation environment management system can should be established and operated to complete the environment management system in the company.
- (4) The Select the good heat insulation materials should be selected and strictly control the construction should be strictly controlled to reduce the heat loss;
- (5) After the project is put into production, strengthen management should be strengthened to ensure the normal operation of desulfurization and dust removing facilities.

## **14.2 Review of industrial policy**

The proposed project is located in Beihai City, Guangxi, with the production capacity of 900,000t pulp and 900,000t paper and paperboards, comply with the related national industrial policy.

### **14.2.1 Comply with the requirements in the Tenth-Five-Year and 2010 Special Plan of National Forest-Paper Integrated Engineering Construction**

No. [2004]9 of Development and Reform Industry by the National Development and Reform Commission issues the Tenth-Five-Year and 2010 Special Plan of National Forest-Paper Integrated Engineering Construction. In the plan which specified that the Chinese pulping and paper-making enterprises should follow the development mode of forest-paper integration. In the scale merit, a single production line of chemical wood pulp generally should have possess the 500,000t and or higher annual capacity; annual capacity of a single paper-making production line should have exceed 100,000t annual capacity; the detailed arrangement layout of national forest-paper integration engineering construction focuses on the development in the east-south coastal regions including Guangxi.

### **14.2.2 Comply with Policies on Development of Paper Making**

It is indicated in the Policies on Development of Paper Making (2007) issued by the National Development and Reform Commission implicates that: the general layout of the development of paper-making industry should be adjusted as per from north to south and form a new rational layout of industry. The south of the Yangtse River is the major region for the development of paper-making industry. The Focus the forest-paper integration engineering construction should be dominated to speed the development of pulping and paper-making industry. The east-south coastal region is the major region for our forest-paper integration engineering construction; the wood and bamboo resource in the south-west region should be rationally utilized and the resource advantage should be converted to the economic advantage. Both develop both wood pulping and bamboo pulping should

be developed.

It is encouraged to development the commercial wood pulp projects. In the pulping projects depending on the supply of wood stock in domestic market, the paper-making forest bases should be planned and synchronously constructed synchronously or approve the construction projects of forest bases for paper-making stock should be approved in advance.

In the provinces with focused development and adjustment of pulping and paper-making, compose the medium- and long-term development plan of paper-making industry should be prepared, whose contents should comply with the general requirements of national policies on the development of paper-making industry and it should be reported to the national investment administration for reference. The Overall Plan for the Development of Forestry-pulp-paper Integration Industry of Guangxi from 2005 to 2015 has been worked out in Guangxi Zhuang Autonomous Region.

The starting scale of a single production line in the new and expansion pulping projects is required to reach: 300,000t annual capacity of chemical wood pulp, 100,000t annual capacity of chem-mechanical wood pulp, 100,000t annual capacity of chemical bamboo pulp and 50,000t annual capacity of non-wood pulp; the starting scale of a single production line in the new and expansion paper-making projects is required to reach: 300,000t annual capacity of newsprint, 100,000t annual capacity of culture paper, 300,000t annual capacity of carton paperboards and white paperboards and 100,000t annual capacity of other paperboard projects. The projects of tissue paper, special paper and paperboards and the modifications of existing production lines are not limited by the access conditions of scale.

#### **14.2.3 Within the encouragement catalogue in Guiding Catalogue of Industrial Structure Regulation (2005 version)**

The proposed project will have the eucalyptus wood for pulping and paper-making, within belonging to the encouragement of catalogue 'forest-paper integrated wood pulp, paper and paperboard production comply with economics of scale' in Guiding Catalogue of Industrial Structure Regulation (2005 version), No. 40, by the National Development and Reform Commission.

#### **14.2.4 Comply with the aims objectives and requirements of national economic and social development of Guangxi**

In the contents of Outline of the 11th Five-Year Plan for National economic and Social Development of Guangxi Zhuang Autonomous Region about optimizing the industrial structure and promoting industrialization progress, it is specified to make making a great advantage of the subtropical forest resource in Guangxi, following the requirements of continuous development, make making efforts to develop the forest-pulp-paper integration industry, establishing the integration industry system of forestation, pulping, paper-making and processing, speeding the preparations to construct the large pulping and paper-making projects in the coastal regions. The construction of the project can increase the profits of the enterprises and promote the economic development in Beihai.

### 14.2.5 Summary

The implementation of 'forest-paper integration' is the development direction of Chinese paper-making industry in 21st century. With a plenty of forest resources, Guangxi is one of the most suitable regions suitable for developing the forest-pulp-paper integration projects in China and it is the major region for developing the fast-growing and high-yield commercial forest bases emphasized by national government. Since 2002, the implementation of base construction has been started initiated in a large scale in Guangxi and it which will become constructed to be the largest forest-pulp-paper integration base in China. The proposed project conforms to the related national and local industrial policies.

## 15 Countermeasures for Pollution Prevention and Treatment with Analysis on Its Technological and Economic Feasibility

### 15.1 Environmental protection measures during construction and feasibility analysis

#### 15.1.1 Prevention and treatment measures for effects on air environment during construction

During construction, the dust and the automobile exhaust gas are the major pollutants to ambient air. For the pollution from automobile exhaust gas, it is required that discharge of the exhaust gas of all vehicles should comply with the standards and no significant effect will be caused generally; for the dust caused by construction works, the following measures should be taken to reduce the pollution:

(1) In the operating period and operating process easy to cause flying dust, the method of spraying water is taken to reduce the pollution of total suspended particles. As long as the increasing frequency of water spraying is increased, the concentration of total suspended particles in the air can be significantly decreased. The investment for this measure is 150,000 RMB. It is feasible in either technology or economy.

(2) The vehicles for transporting the building materials such as sand and stone should not be excessively loaded excessively to prevent the drops along the road and consequent secondary flying dust.

(3) If under strong wind occurs, the building materials easy to cause dust-flying building materials dust should be covered during transportation.

(4) The vehicles for material transportation must be periodically inspected and the damaged carriage vehicles should be repaired in time. It is not allowed that spill of building materials occurs on the way in the way during transportation.

(5) When vehicles drive out of the construction site, the mud on the vehicle body should be cleaned out, especially on the **tires**, for which a water pool can be constructed. When vehicles go out of the construction site, they can slowly pass through it the pool to clean most mud on the **tires**. And according to the conditions, the high-pressure water spraying can be applied to clean out the residual mud on the vehicle body and tires, efficiently preventing the sludge in construction site from being brought onto the urban roads and avoiding the severe secondary pollution of flying dust in local environment.

(6) The kitchens of the canteens in living area should be installed with oil smoke cleaning processor. With 5 canteens and 10 ovens for each one, there are total 50 ovens. If the exhaust hood of each oven has  $2\text{m}^2$  projection area at on the oven face for calculation, the required total projection area of exhaust hoods at oven faces is about  $100\text{m}^2$ . If the investment for each square meter is calculated as 1000 RMB for calculation, the investment and oil smoke system is as about 100,000RMB. It is leading to relatively low and feasibility in the economy and technology.

(7) Environmental protection filter materials should be applied to reduce the pollution of toxic and harmful gases to the environment in the location.

(8) For the construction sites with volatile toxic and harmful gases such as painting sites, ventilation should be strengthened and control construction time should be controlled.

### 15.1.2 Prevention and treatment measures for effects on water environment during construction

During construction, the oil separation pool, sink pool and settling tank will be set for the waste-water. After a period of static settlement, the waste-water will be used as the spraying water for spraying to reduce dust reduction and washing the vehicle tires.

Estimation of investment estimation: oil separation pool and 3 detritus and sink pools, which have been calculated included in the measures for water and soil conservation.

During the construction of the project, there are average 1000 workers operating simultaneously every day. As per, whose daily water consumption of is calculated as 200L per worker and the water discharge calculated as 80% of water consumption, the discharged volume of sanitary waste-water is about 160m<sup>3</sup>/d. The temporary waste-water treatment facility is set for to treat the waste-water up to the meet standard and subsequently it, which will be discharged into the sea via temporary pipes.

The Build sanitary waste-water treatment facility is constructed with capacity of 160m<sup>3</sup>/d. It is recommended to apply the full set of waste-water treatment facilities. These waste-water treatment facilities, which have been practiced, conducted for many years with the proven and stable technology. They are and widely applied in many residential areas with the investment of about 1000 RMB/m<sup>3</sup> or so. The complete underground waste-water treatment facilities basically don't occupy the ground surface area and have no building. The technology will combine the sludge adsorption and advanced contact oxidation technique. The quality treated water will meet the national emission standard. These facilities have a long service life and can continuously operate for more than 15 years. The technical parameters of equipment are shown in table 15.1-1, in comparison with a set of complete waste-water treatment facilities.

The discharge volume of sanitary waste-water discharge during the construction of the proposed project is 160m<sup>3</sup>/d. The investment is about 160,000 RMB.

**Table 15.1-1 Table of technical parameters of Model LF-W-DSY**

| Item              | Input water | Output water |
|-------------------|-------------|--------------|
| BOD <sub>5</sub>  | 100~200     | 20           |
| COD <sub>cr</sub> | 200~400     | 70           |
| SS                | 200~450     | 30           |

### 15.1.3 Prevention and treatment measures for effects on sound environment during construction

The effective measures to control noise pollution include: reducing reduce the noises at noise sources, restricting the sound diffusion and blocking sound reception.

(1) Noise prevention and treatment for the workers on site

Control of noise sources: the low-noise equipment should be selected as construction machinery as far as possible; the fixed equipment and the machinery such as excavators

and transportation trucks should be equipped with silencer at the air inlet and outlet; the equipment with large vibrations should be equipped with vibration reduction devices and the damping materials can be used as well; strengthen maintenance and servicing service of equipment should be strengthened.

Control of propagation diffusion ways: the porous sound-absorbing materials should be applied to establish sound separation barriers, sound separation hoods and sound separation chambers as many far as possible around the noise sources with high sound level such as concrete mixing machines; the temporary sound barrier should be established at the edge of construction site or in the relatively centralized place of noise-making equipment with relatively centralized equipment causing noises.

Protection of workers: it is inevitable that the construction machinery have an effect on the workers in construction site. The sound protection helmets, ear shields and ear plugs should be used.

#### (2) Protection measures for office and living areas and residential areas

It is shown in the above analysis that the construction will have an effect on sensitive objects such as Yaxi Village. Therefore, the construction time should be strictly controlled. Except for the special requirements of construction process, no don't arrange continuous day and full-time continuous construction will be arranged. The construction, whose period should be controlled within during 8:00 – 12:00 and 14:00 – 22:00. If the night construction is necessary due to the special requirements of construction process, the related procedures should be performed approved by at the environmental protection administration and inform the surrounding residents should be informed of the reasons for night construction, construction dates and the length of construction period in the form of bulletins.

Estimation of investment estimation: 150,000 RMB for sound separation facilities, 120,000 RMB for protection equipment and totally 270,000 RMB are required.

### **15.1.4 Prevention and treatment measures for effects on population health during construction**

#### (1) Sanitation and cleaning in construction area

Before construction, disinfectant should be used for killing mosquitoes, flies and mice in construction area, for the excavation and leveling jobs in construction site. It can efficiently control the source of natural infection and control and reduce the occurrence and spread of diseases.

#### (2) Health quarantine, preventive immunization and sanitation and epidemic prevention

Health quarantine: the health check should be made on the persons preparing for entering into the construction area, get the health conditions and infectious status of workers to enter into construction area, to find and prevent infectious persons from bringing new bacteria into construction area. If the infectious persons are identified as not suitable for entering they aren't allowed to enter into construction area preventing the diseases from being caused and infecting and prevailing among workers.

Periodic health medical checkup: during construction, the health medical checkup should



be periodically performance on workers periodically to get their health conditions at any time, prevent and control the occurrence and spreading of diseases in time and ensure their the health.

Preventive immunization: according to the diffusion way of diseases in construction site, the major preventive measures such as drug prophylaxis against malaria, vaccination against hepatitis B and etc. will be taken for workers. In addition, sufficient tetanus immunizing agent will be stored at medical station in construction area for rescuing the traumatic persons infected by tetanus in time. As the construction area is located in the country, a certain amount of rabies vaccines should be stored for backup.

### (3) Management and supervision of food sanitation

The related local special organizations will be commissioned to strengthen the management and supervision of food sanitation in construction area. The complete 'sanitation license' system will be established. The health medical checkup will be periodically performance on the operators in dining room and operation and sales persons for subsidiary foodstuffs periodically. The 'health license' system will be implemented. Strictly inspect and control the purchasing channels of raw materials such as vegetables, meats and etc. and salt will be strictly inspected and controlled. The frequent inspection and supervision of food sanitation will be performance on various food and beverage houses in construction area. If food intoxication is found, the efficient control and protection measures should be immediately taken immediately to prevent the development of pollution source.

### (4) Protecting the quality of drinking water

Proper treatment should be carried out for drinking water which can only be used as living water after it reaches the national sanitation standards. The workers should be educated to have a good sanitation habit and not **drink un-boiled water to prevent infection.**

#### 15.1.5 Prevention and treatment measures for pollution of solid wastes

(1) Prevention and treatment measures for pollution of construction wastes, waste soils and household garbage (kitchens, camps, rubbish) in construction site

**①Before construction, the approval document of disposal should be handled at related** organization according to the regulations. The construction wastes should be disposed in the place specified in the approval document of disposal. It is not allowed to place them in cultivated land, forest land and river channel at random. The surrounding of specified disposal site should be protected and no random piling is allowed. Simultaneously, the drainage protection should be taken to avoid causing soil and water loss.

**②The** household garbage produced by the persons in construction site should be collected every day and be sent to the urban garbage disposal plant by the municipal environmental sanitation administrative department, avoiding the effects on the environment in the surrounding of construction site.

## (2) Disposal cost of solid wastes for the project

During the construction of the project, the produced solid wastes are mainly the construction wastes. In comparison with the amount of construction wastes produced by other construction sites, it is proposed to send the 43,000t construction wastes produced by the project to the solid wastes disposal plant specified by the municipal construction department in Beihai. If the disposal price of solid wastes is 6 RMB/ton, the total disposal cost during the construction of the project is 258,000 RMB.

The output of garbage is about 500kg/d. If the disposal price is 0.5 RMB/kg, then annual disposal cost is 88,500 RMB.

## 15.2 Countermeasures and measures for pollution prevention and treatment during operation

### 15.2.1 Countermeasures and measures for waste-water pollution prevention and treatment

The proposed project will be implemented in three phases and the most waste-water comes from: (1) Waste-water produced in the production process of pulping (bleaching, alkali recovery); it is as the major waste-water source. It is characterized with pollution of COD<sub>Cr</sub> and BOD<sub>5</sub> and should be discharged after it is treated after having been treated up to standard; (2) Waste-water produced in the production process of paper-making (stock purification, screen section, press section, coating section), which is mostly excessive white water. It also accounts for a large proportion in the total amount of waste-water. It and can be discharged after it is treated after having been treated up to standard; (3) Acid and alkali waste-water discharged from by thermal power plant intermittently can be intermittently discharge It can be discharged after neutralization; (4) Drainage of cooling water, which is the 'clean' waste-water. The waste-water sources and quality and water flow in individual phases are shown in table 15.2-1 - 15.2-4.

Table 15.2-1 Overview of quality and flow of waste-water in phase I project of the proposed project [removed]

Table 15.5-2 Quality and flow of additional waste-water in phase II project [removed]

Table 15.5-3 Quality and flow of additional waste-water in phase III project [removed]

*Technical details removed, see summary table 15.5-4 for information*

Table 15.2.4 Pollution loads at inlet and outlet of waste-water treatment station for the proposed project

| Content                                 |          | Water discharge<br>(m <sup>3</sup> /d) | COD <sub>Cr</sub> |        | BOD <sub>5</sub> |        | SS   |        | AOX    |        | Dioxin<br>(pgTEQ/L) | Ammonia-nitrogen |       | Total nitrogen |       | Total phosphor |        | pH  | Color |
|-----------------------------------------|----------|----------------------------------------|-------------------|--------|------------------|--------|------|--------|--------|--------|---------------------|------------------|-------|----------------|-------|----------------|--------|-----|-------|
|                                         |          |                                        | mg/L              | t/d    | mg/L             | t/d    | mg/L | t/d    | mg/L   | t/d    |                     | mg/L             | t/d   | mg/L           | t/d   | mg/L           | t/d    |     |       |
| Phase project I                         | Intake   | 76260                                  | 1410              | 107.5  | 477              | 36.4   | 504  | 38.4   | < 7.47 | < 0.57 | < 6.19              | --               | --    | --             | --    | --             | --     | --  | --    |
|                                         | Effluent |                                        | < 100             | < 7.63 | < 20             | < 1.52 | < 50 | < 3.82 | < 5    | < 0.38 | < 6.19              | < 6              | 0.46  | < 8            | 0.61  | < 0.8          | <0.06  | 6—9 | <50   |
| Phase project II<br>(after completion)  | Intake   | 93938                                  | 1250              | 117.4  | 431              | 40.6   | 544  | 51.15  | < 6.07 | < 0.57 | < 5.03              | --               | --    | --             | --    | --             | --     | --  | --    |
|                                         | Effluent |                                        | < 90              | < 8.46 | < 20             | < 1.88 | < 30 | < 2.82 | < 4    | < 0.38 | < 5.03              | < 6              | <0.56 | < 8            | <0.75 | < 0.8          | <0.08  | 6—9 | <50   |
| Phase project III<br>(after completion) | Intake   | 109158                                 | 1136              | 124.0  | 398              | 43.5   | 551  | 60.19  | < 5.22 | < 0.57 | < 4.32              | --               | --    | --             | --    | --             | --     | --  | --    |
|                                         | Effluent |                                        | < 90              | < 9.82 | < 20             | < 2.18 | < 30 | < 3.28 | < 3.5  | < 0.38 | < 4.32              | < 6              | <0.65 | < 8            | <0.87 | < 0.8          | < 0.09 | 6—9 | <50   |

Note: 1. The control standard follows the relevant requirements on *Discharge Standard of Water Pollutants for Pulp and Paper Industry* (release version), GB3544-2008.

2. The color unit is the dilution multiple.

### 15.2.1.1 Analysis on characteristics of waste-water

Most of waste-water of the proposed project comes from the pulping workshop and paper-making workshop, which are respectively called as pulping waste-water and paper-making waste-water. The waste-water of paper-making industry is one of the waste-water types hardest to treat. And the hardest one to treat in paper-making industry is the pulping waste-water.

Pulping waste-water: mostly come from the sections such as bleaching and alkali recovery. The major pollutants include: (1) Reduction materials, mostly coming from bleaching section, such as **lignin** and its **derivatives**, inorganic salt and etc. The COD<sub>cr</sub> is set as the index; (2) Biodegradable substances including hemicellulose, resin acid, simple saccharides, ethanol, organic acid and putrid substances, mostly coming from alkali recovery section. The BOD<sub>5</sub> is set as the index; (3) Suspended substances, such as fibers, inorganic raw materials and etc. SS is set as the index. The reason for being difficult to treat the pulping waste-water is that it contains **lignin** and its **derivatives** which are difficult to biodegrade. In the proposed project, **lignin** and its **derivatives** come to the larger part from the pulp line bleaching section. The waste-water from the bleach plant is the major component of pulping line waste-water; the largest part of waste-water produced by the alkali recovery section is the evaporator surplus condensate. The COD<sub>cr</sub> component in that type of waste-water is the acid substance easily biodegraded in the biological process.

Paper-making waste-water comes mostly from the surplus white water in the paper-making process, where the pollutants are simpler than those of pulping waste-water, mostly including fine fibers, fillers and dyes, etc. Wherein, the soluble COD<sub>cr</sub> has the relatively good biochemical characteristic; SS has an excellent physical **settling properties**.

### 15.2.1.2 Feasibility analysis on waste-water treatment up to standard

Both production waste-water and sanitary waste-water of the proposed project are sent to waste-water treatment station in the plant for treatment. The waste-water treatment station of the proposed project is designed with the capacity of 145000m<sup>3</sup>/d. The physicochemical\_+ biochemical two-stage + physicochemical treatment process is applied. The process flow is shown in Fig. 10.1.1. The treated waste-water should meet the relevant requirements of GB3544-2008, the *Discharge Standard of Water Pollutants for Pulp and Paper Industry* (release version), i. e. pH 6 – 9, **color** 50, COD<sub>cr</sub> 100mg/L, BOD<sub>5</sub> 20mg/L, SS 50mg/L, ammonia-nitrogen 12mg/L, total nitrogen 15mg/L, total phosphorus 0.8mg/L, AOX 12mg/L (pulping production line discharge), dioxin 30 pgTEQ/L (pulping production line discharge), complying with deep sea sewage discharge standard.

As the pulping waste-water is one of waste-water types difficult to degrade, the biochemical method is applied at present in China and overseas. The biochemical

treatment is effective in removing BOD5 and SS. It is indicated in foreign research data that after secondary bio-chemical treatment, the removal rate of BOD5 is more than 90%, and the maximum rate can reach 98%, the removal rate of COD<sub>Cr</sub> is 60--85% and that of SS is 85--95%. It shows in practice that when the waste-water is treated by the single biochemical method, the discharge requirement of COD<sub>Cr</sub> <100mg/l can't be met, because the treated waste-water still contains colored **lignin** and its **derivatives**. These residual substances have a poor biochemical characteristic and are difficult to remove by single biochemical treatment. If the chemical coagulation method (adding flocculating agent) is applied after biochemical treatment, a good effectiveness can be obtained.

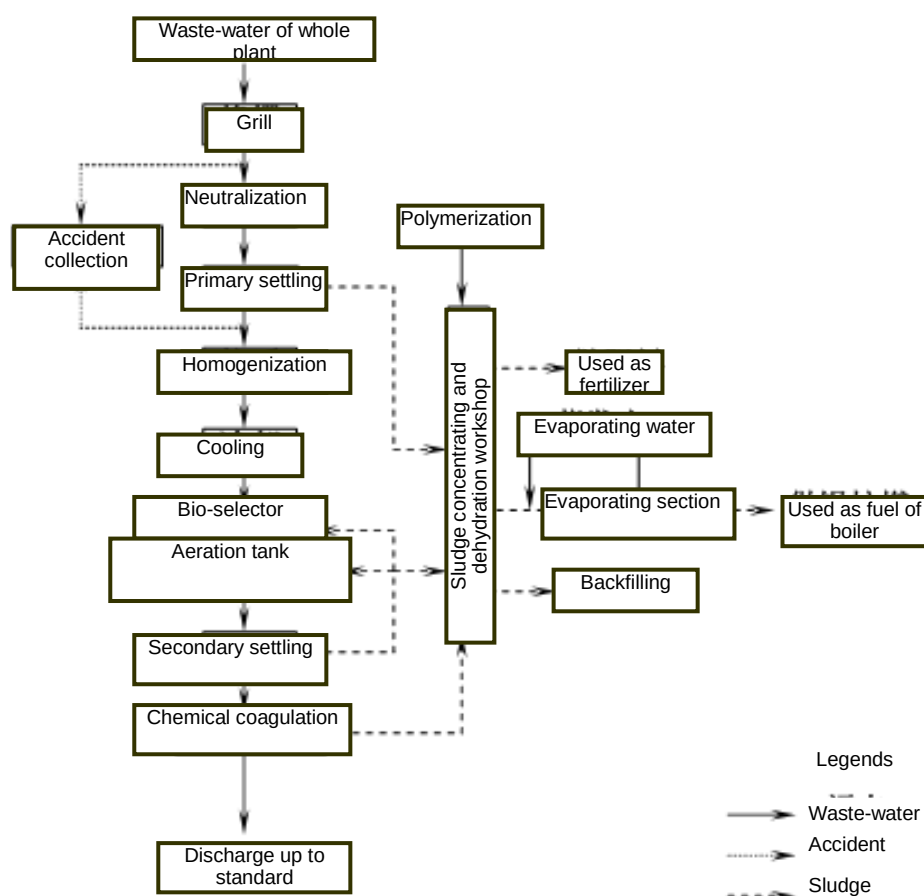


**Fig. 15.2-1 Process flow of waste-water treatment station in phase I project**

(1) Feasibility analysis on standard complying waste-water treatment of phase I project

1) Feasibility analysis on standard complying AOX and dioxin at the discharge of pulping production line

a. Feasibility analysis on standard complying AOX at the discharge of pulping production line

Compared with the AOX generation in current pulping factories of the same kind in

China and abroad, as the adopted bleaching technologies are different, the volumes of generated AOX in waste water are different. When a --- four-stage ECF bleaching is adopted, *comprising the use of  $\text{ClO}_2$  in the first stage followed by alkaline stage using peroxide and oxygen, then a second  $\text{ClO}_2$  bleaching stage followed by a final peroxide bleaching stage.* the volume of generated AOX is about 0.22kg/ADt.

In consideration of the requirement of controlling AOX in waste water discharged from pulping production line in GB3544-2008, the *Discharge Standard of Water Pollutants for Pulp and Paper Industry* (release version) ( $\text{AOX} \leq 12\text{mg/L}$ ), the volume of waste water discharged from the pulping production line of this project is 47230m<sup>3</sup>/d. When chlorine dioxide bleaching (D) is adopted for the last section, the concentration of AOX in waste water is 19.9mg/L. When hydrogen peroxide bleaching (P) is adopted for the last section, the concentration of AOX in waste water is 11.8mg/L. Therefore, --- the four-section ECF bleaching is to be adopted for the bleaching section of this project to meet the requirement of GB3544-2008, the *Discharge Standard of Water Pollutants for Pulp and Paper Industry*.

b. Feasibility analysis on standard complying dioxin at the discharge of pulping production line

The four-section ECF bleaching as above is to be adopted for the bleaching section of this project.

Among the chemicals listed in Appendix C of Stockholm Convention, only PCDD and PCDF are firmly believed as the chemical substances generated in bleaching process using elemental chlorine. Among 17 PCDD/PCDF derivatives replaced by chlorine at position 2, position 3, position 7 and position 8, only two derivatives, 2,3,7,8-TCDD and 2,3,7,8-TCDF, are believed being generated in chemical pulping process using chlorine gas for bleaching.

Therefore, the technical solution recommended by U.S Environmental Protection Administration is that chlorine dioxide bleaching is adopted to replace chlorine gas bleaching, combined with modern pulping technology, including lignin removal with oxygen and very good uncolored pulp scrubbing technology.

U.S Environmental Protection Administration issued in 1998 a dioxin discharge standard for the waste water from bleaching workshop, requiring 2,3,7,8- TCDD less than 10 pg/L and 2,3,7,8 – TCDF less than 31,9 pq/L. According to the toxic equivalent factor revised by WHO, the limit value of discharged dioxin in waste water from bleaching workshop is 13.19 pqTEQ/L, which is the most strict required limit value for dioxin in pulping and bleaching waste water in the world. As ECF bleaching technology and modernized pulping technology are adopted, the pulping industry in U.S.A has already completely met the requirement of this stipulation.

According to the experiences of the enterprises of the same kind in U.S.A and other foreign countries, the dioxin in the waste water from pulping production line of this project

will be lower than 10 pg TEQ /L, which meets the requirement of the dioxin control limit value 30 pgTEQ/L in GB3544-2008, the *Discharge Standard of Water Pollutants for Pulp and Paper Industry* in China.

## 2) Conditions of treatment process of waste-water treatment station in phase I project

In phase project I, i.e. bleaching sulfate pulp plant with annual capacity of 900,000t, its waste-water sources with waste-water quality and flow are shown in table 10.1.1. All waste-water will be sent to the waste-water treatment station in phase project I for treatment. The designed treatment capacity of the waste-water treatment station in phase project I is 100000m<sup>3</sup>/d. Three-stage treatment process is applied. The treatment flow is shown in Fig. 15.2-1. Main buildings and equipment are shown in table 15.2-5 and Table 15.2-6 respectively.

Table 15.2-.5 Overview of main buildings of waste-water treatment station in phase project I

| No. | Name                                                | Specification | Note |
|-----|-----------------------------------------------------|---------------|------|
| 1   | Neutralization tank                                 | ----          | ---- |
| 2   | Primary settling tank                               | ----          | ---- |
| 3   | Homogenization tank                                 | ----          | ---- |
| 4   | Accident tank                                       | ----          | ---- |
| 5   | Bio-selector and aeration tank                      | ----          | ---- |
| 6   | Secondary settling tank                             | ----          | ---- |
| 7   | Floatation clarifying tank (tertiary settling tank) | ----          | ---- |

Table 15.2-6 Overview of main equipment of waste-water treatment station in phase project I

| No. | Name of equipment                 | Quantity | Unit | Note |
|-----|-----------------------------------|----------|------|------|
| 1   | Cooling tower                     | ----     | /    | ---- |
| 2   | Sludge presser                    | ----     | /    | ---- |
| 3   | Multi-stage fan                   | ----     | /    |      |
| 4   | Aeration system                   | ----     | /    |      |
| 5   | Peripheral driving sludge scraper | ----     | /    |      |
| 6   | Online pH meter                   | ----     | /    |      |
| 7   | Online COD meter                  | ----     | /    |      |
| 8   | Online SS meter                   | ----     | /    |      |
| 9   | Flow meter                        | ----     | /    |      |

Description of treatment process flow of waste-water treatment station in phase project I:

In phase project I, the production waste-water of whole plant enters into neutralization tank through mechanical grill. Where the acid and alkali waste-water produced in production process is neutralized in neutralization tank. The pH value of waste-water is adjusted to be about 7. Then the neutral waste-water enters into primary settling tank whose diameter of primary settling tank is 65m and peripheral depth of water is 4. Its design flow is of 1.0m/h. After suspended substances deposit in primary settling tank, the waste-water flows into



homogenization tank which has a capacity of 25000m<sup>3</sup>. The designed dwell time is 8 hours. In this tank, the surface mixer or aeration head is installed to ensure the oxygen content of waste-water, prevent the settlement of residual solids and adjust the vertical concentration of waste-water to be homogeneous. Before both neutralization tank and homogenization tank, the online waste-water monitoring devices are installed. Once the quality of waste-water flowing into the above two tanks exceeds the standard, it will be pumped into accident collection tank. The waste-water out of homogenization tank is pumped into cooling tower to ensure that the temperature of waste-water entering into secondary treatment is lower than 35 °C. The cooled waste-water enters into bio-selector. Simultaneously, the return sludge enters into bio-selector and the absent nitrates and nutrient phosphates are added. The function of bio-selector is to provide an environment promoting growth for active sludge and suppressing the growth of filamentous organisms, to improve the settlement performance of sludge. Its output water will flow into aeration tank by gravity. In this point, most of soluble and biodegradable organic pollutants are removed. After aeration tank, there are two parallel secondary settling tanks. After settling in secondary settling tank, the waste-water is sent to three-stage treatment. The three-stage treatment, including includes chemical flocculation and two floatation 25m-diameter clarifying tank with diameter of 25m. After three-stage treatment, the waste-water will be discharged into deep sea.

The sludge of primary settling tank, secondary settling tank and final settling tank are respectively sent to sludge concentrating tank for dehydration treatment respectively. The sludge of primary settling tank is sent to circulating fluidized bed boiler for burning. The excessive sludge of secondary settling tank is sent to evaporating workshop for further dehydration treatment and then sent to alkali furnace for burning. The sludge of final settling tank is sent out of the plant for backfilling.

The sanitary waste-water in phase project I is mixed with process waste-water via the independent waste-water collection system and then drained into waste-water treatment station for treatment. It will be discharged into deep sea after it is up to standard.

The rain-water drainage system in phase I project includes two independent systems: the clean rain-water collected on the roof of buildings directly enters into sealed rain-water drainage system and then be directly discharged into the sea. The rain-water which is collected from other areas in the plant including the unused lands between individual workshops of plant, roads in the plant and equipment area will be directly drained into rain-water clarifying tank and then discharged into the sea after the oil components and suspended substances are separated. If the rain-water is contaminated by some chemicals or oils, it should be led to the spillage and leakage collection tank and then sent to waste-water treatment station for treatment.

## ②Feasibility analysis on waste-water treatment up to standard in phase project I

For the treatment of pulping waste-water, the biochemical method basically is applied at present in China and overseas. The biochemical treatment is useful in removing BOD<sub>5</sub> and SS. The removing rate of BOD<sub>5</sub> can reach above 90% (even 98%) and that of SS can reach 90%-95%.

In chemical flocculation reagents are added that can react with water to form flocculent hydrate in the waste-water allowing the agent to be evenly distributed in waste-water by fast mixing and then form floccules via slow reaction. There are two (settling or air floatation) methods available for the solid-liquid separation between floccules generated in chemical flocculation reaction and water. The features of settling separation are low investment, large area, long retention time, simple operation and management and low failure rate and high water content in the sludge with relatively low handling efficiency; the air floatation is a forced solid-liquid separation method. Its main features includes a high separating speed, high efficiency, low water content in the sludge and small building foot print area, but it requires relatively high investment and more complex operation and management. The chemical flocculation process is applied by more and more pulping enterprises recently.

In June 2004, Sweden Environmental Protection Management Group (SEM) and Websurf Company performed treatment test on the waste-water in waste-water treatment station of Shandong Senbo Pulp and Paper Co., Ltd. The raw water for the test is the output water after secondary settling tank. The added flocculating agents are the aluminum salt and ferric salt and the coagulant is polyacrylamide. The test result shows that it can be realized that COD<sub>Cr</sub> in output waste-water with the addition of flocculating agent can be less than 100mg/l. According to the investigation conducted by assessment unit recently for the waste water treatment station of the current project of Shandong Shengbo Pulp and Paper Co., Ltd., the treatment technological process adopted for that waste water treatment station is completely consistent with that of this project, i.e. chemical flocculation three-stage treatment process is added after two-stage (initial sedimentation basin + biochemical treatment) treatment. The system has already operated for half a year and COD<sub>Cr</sub> in output waste-water can remain steadily below 100mg/l. An online detection system is installed for the effluent from the waste water treatment station of the current project of Shandong Shengbo Pulp and Paper Co., Ltd., which is connected with Shandong Provincial Environmental Protection Bureau.

According to test of pure pulping waste-water conducted by OJI Paper Co., Ltd. tested the pure pulping waste-water. When the , flocculating agents ( $\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$ ) in different doses are added into the waste-water after two-stage (primary settling tank + biochemical) treatment for coagulation precipitation, it can be found that the effectiveness of removing COD<sub>Cr</sub> is very ideal. The concentration of COD<sub>Cr</sub> in raw water is 323mg/l. The detailed test data are shown in table 15.2-7.

Table 15.2-7 Removing rate of COD<sub>cr</sub> in waste-water with the addition of flocculating agents in different doses

| Dose of flocculating agent (ppm)                                                                                                                                                                                                                          | 30   | 50   | 70   | 100  | 150  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|------|
| Item                                                                                                                                                                                                                                                      |      |      |      |      |      |
| Concentration of COD <sub>cr</sub> in treated waste-water (mg/l)                                                                                                                                                                                          | 240  | 166  | 133  | 123  | 99   |
| Removing rate (%)                                                                                                                                                                                                                                         | 25.7 | 48.6 | 59.8 | 65.9 | 70.6 |
| Note: The concentration of added flocculating agent (Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> ·18H <sub>2</sub> O) solution is 8%. In the table, the added dose of flocculating agent is converted to the mass of Al <sub>2</sub> O <sub>3</sub> . |      |      |      |      |      |

As shown in the above test result, if the sufficient dose of sufficient (such as Al<sub>2</sub> (SO<sub>4</sub>)<sub>3</sub>·18H<sub>2</sub>O) is added into the pulping waste-water after two-stage treatment, it can be realized that COD<sub>cr</sub> will be less than 100mg/l in output waste-water.

Further more, if it is compared with the conditions of the current domestic project (with annual capacity of 1,000,000t bleaching sulfate pulp) of Hainan Jinhai Pulp & Paper Co., Ltd., the details are shown in table 15.2-8.

Table 15.2-8 Comparison between the conditions of the proposed project and the current project of Hainan Jinhai Pulp &amp; Paper Co., Ltd.

| No. | Contents                                                          | Proposed project                                                                                                                           | Hainan Jinhai Pulp & Paper Co., Ltd.                                                                                                      |
|-----|-------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Construction contents and capacity                                | Annual capacity of 900,000t bleaching sulfate pulp                                                                                         | Annual capacity of 1,000,000t bleaching sulfate pulp                                                                                      |
| 2   | Quality condition of input water of waste-water treatment station | COD <sub>cr</sub> 1410 mg/l,<br>BOD <sub>5</sub> 477 mg/l,<br>SS 504 mg/l                                                                  | COD <sub>cr</sub> 1480—2380 mg/l,<br>BOD <sub>5</sub> 636—818mg/l,<br>SS 320—1620 mg/l                                                    |
| 3   | Capacity of treatment process of waste-water treatment station    | Handling capacity: 100000m <sup>3</sup> /d. The physicochemical_+ biological two-stage + physicochemical three-stage treatment is applied. | Handling capacity: 70000m <sup>3</sup> /d. The physicochemical_+ biological two-stage + physicochemical three-stage treatment is applied. |
| 4   | Emission Discharge standard of waste-water                        |                                                                                                                                            |                                                                                                                                           |

Note: The data of Hainan Jinhai Pulp & Paper Co., Ltd. comes from the environmental protection acceptance report of its current project.

The treatment process flow of waste-water treatment station in the current project of Hainan Jinhai Pulp & Paper Co., Ltd. is shown in Fig. 15.2-2.

**Fig. 15.2-2 Process flow of waste-water treatment station in the current project of Hainan Jinhai Pulp & Paper Co., Ltd. [removed]**

Compare Fig. 15.2-1 with Fig. 15.2-2, the treatment flow of the waste-water treatment station of Hainan Jinhai Pulp & Paper Co., Ltd. has a one more section of biological contact tank than that of the proposed project.

According to the completion of environmental protection acceptance performance on the current project of Hainan Jinhai Pulp & Paper Co., Ltd. by State Environmental Protection Administration from November 25th, 2005 to December 2nd, 2005, the detection result of output water quality of its waste-water treatment station is that discharge concentration of  $\text{COD}_{\text{Cr}}$  is 94 - 119mg/L. The  $\text{COD}_{\text{Cr}}$  handling efficiency of individual treatment units is: 36%  $\text{COD}_{\text{Cr}}$  in primary settling tank, 66.4%  $\text{COD}_{\text{Cr}}$  in aeration tank (with bio-selector), 11.4%  $\text{COD}_{\text{Cr}}$  in biological contact tank and 71%  $\text{COD}_{\text{Cr}}$  in chemical reaction tank. The total handling efficiency of waste-water treatment station is 94.5%  $\text{COD}_{\text{Cr}}$ .

Compared with the acceptance data of Hainan Jinhai Pulp & Paper Co., Ltd., when the quality of input waste-water into waste-water treatment station of the proposed project contains 1410mg/l  $\text{COD}_{\text{Cr}}$ , the  $\text{COD}_{\text{Cr}}$  handling efficiency will reach 78.5% after the waste-water is treated in primary settling tank and aeration tank (with bio-selector) and the waste-water quality can contain 303.2mg/L  $\text{COD}_{\text{Cr}}$ . After the waste-water is treated by chemical flocculation settling, a further 30-70% removal rate of  $\text{COD}_{\text{Cr}}$  will be realized so that the quality of output waste-water will satisfy the  $\text{COD}_{\text{Cr}}$  discharge standard requirements of remaining steadily lower than 100mg/L.

#### b. Feasibility analysis on standard complying of other indexes

The acceptance data of Hainan Jinhai Pulp & Paper Co., Ltd. are compared in the same way, pH 6.02—6.94, color 5, BOD5 7.4—7.5mg/L and SS 1.9—2.4mg/L. It can be seen that the standard requirements of pH 6—9, color 50, BOD5 20mg/L and SS 50mg/L for the waste water of this project are feasible.

In this project, only small amounts of nitrogen and phosphorus nutrient salt are added into the biological selector to meet the requirement of bio-chemical reaction. Therefore, the effluent from the waste water treatment station will contain small amounts of ammonia-nitrogen, total nitrogen and total phosphorus. The indexes of the chemicals contained in the waste water discharged from this project are determined as follows: ammonia-nitrogen 6mg/L, total nitrogen 8mg/L and total phosphorus 0.8mg/L via investigating the quality of the water discharged after three-stage treatment in the waste water treatment stations of the enterprises of the same kind in China and abroad combined with the requirements of local discharge standard of the place where this project is located.

The treatment cost per m<sup>3</sup> waste water is CNY 1668, according to the calculation of the designed waste water treatment station (including power expense, wages and welfare, sludge treatment expense and chemical expense, etc.). Compared with the operation expense of the waste water treatment station of the current project of Shandong Shengbo Pulp & Paper Co., Ltd., the treatment cost per m<sup>3</sup> waste water will be CNY 2.0. The operation cost of the waste water treatment station of the project to construct is economically feasible.

To sum up, the effluent of the waste water treatment station of the phase I project of the project to construct meets the relevant requirements of GB3544-2008 "Water pollutant discharge standard for pulping and paper making industry" (release version): pH 6—9,

color 50, CODcr 100mg/L, BOD5 20mg/L, SS 50mg/L, ammonia-nitrogen 12mg/L, total nitrogen 15mg/L and total phosphorus 0.8mg/L; therefore, it is technically and economically feasible.

c. Analysis on the effect of removing AOX in waste water

The AOX in waste water from pulping and paper making enterprises is mainly from pulp bleaching section and most AOX can be removed after the waste water is treated in waste water treatment station. Compared with the acceptance data of the current project of Hainan Jinhai Pulp & Paper Co., Ltd., after being treated in a process of physical-chemical + two-stage biochemical + physical-chemical treatment, the AOX removal rate can be 89.3% and the concentration in effluent is less than 2mg/l. After phase I project of this project is completed, it can be ensured that the AOX content of the effluent from the waste water treatment station can be stabilized at less than 5mg/l.

(2) Feasibility analysis on waste-water treatment up to standard in phase project II

In phase project II, a production line with annual capacity of 450,000t high-grade packaging paperboards with its supporting facilities will be added.

Additional waste-water sources with quality and flow of waste-water are shown in table 15.2.2. The waste-water will also be totally sent to waste-water treatment station in phase project I for treatment and then discharged to the sea after it is treated after having been up to standard.

While phase project II is constructed, the waste-water treatment station in phase project I will be expanded to increase its design handling capacity to 125000m<sup>3</sup>/d. The expansion conditions of waste-water treatment station are shown in Fig. 15.2-3, with the expansion part represented in shadow in the figure. Additional buildings and equipment in phase project II are respectively shown in table 15.2-9 and Table 15.2-10 respectively.

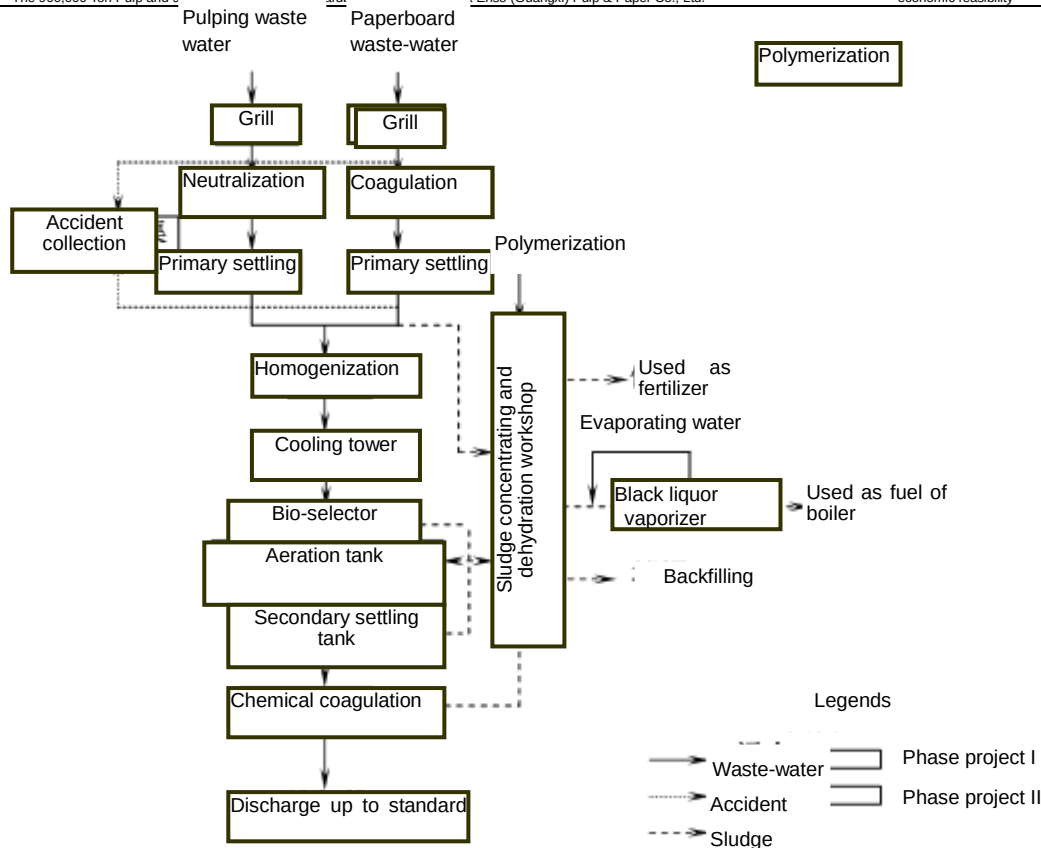


Fig. 15.2-3 Process flowchart of waste-water treatment station in phase project II

Table 15.2-9 Overview of additional main buildings of waste-water treatment station in phase project II

| No. | Name                       | Specification | Note |
|-----|----------------------------|---------------|------|
| 1   | Coagulating tank           | ---           | ---  |
|     | Primary settling tank      | ---           | ---  |
| 2   | Secondary settling tank    | ---           | ---  |
| 3   | Floatation clarifying tank | ---           | ---  |

Table 15.2-10 Overview of additional main equipment of waste-water treatment station in phase II project

| No. | Name of equipment | Quantity | Unit | Note |
|-----|-------------------|----------|------|------|
| 1   | Cooling tower     | 1        | ---  | ---  |
| 2   | Aeration system   | 1        | ---  | ---  |

## (a) Expansion of waste-water treatment station in phase project II

In phase project II, the waste-water treatment station will be expanded on the basis of phase project I. A new set of one-stage treatment process will be added. The clarifying flocculation process will be applied to treat the process waste-water coming from packaging paperboard workshop with its supporting equipment. The design flow of the additional primary settling tank is 1300m<sup>3</sup>/h and its diameter is 45m. The waste-water

output from clarifying treatment will be mixed with the waste-water output from one-stage treatment in phase project I and then sent to homogenization tank. For the condition of additional waste-water flow, the capacity of aeration tank need be increased by about 200kw. The secondary settling tank following aeration tank needs to be expanded. The diameter of additional secondary settling tank is 60m. Simultaneously, the capacity of three-stage chemical flocculation treatment process also needs to be increased. An additional floatation clarifying tank with diameter of 12.5m will be constructed to meet the handling requirement for additional waste-water.

(b) Feasibility analysis on waste-water treatment up to standard in phase project II

Additional discharged waste-water in phase project II is 17678m<sup>3</sup>/d. The quality of input waste-water in waste-water treatment station contains 560mg/L COD<sub>Cr</sub>, 237.6mg/L BOD<sub>5</sub> and 721.2 mg/L SS, which improves a lot compared with quality of the input waste-water of phase I project, 1410mg/L COD<sub>Cr</sub> and 477mg/L BOD<sub>5</sub>. The biochemical characteristic of additional waste-water in phase project II is better than that of pulping waste-water in phase project I. The dilution and synergetic degradation of paper-making waste-water can be utilized for the treatment of pulping waste-water which is difficult to be treated, for increasing the effectiveness of waste-water treatment.

The treatment of pulping and paper-making waste-water is the common method applied to in the world. The pulping waste-water and paper-making waste-water in Indonesia PRW Pulping and Paper-making Plant of APP Indah Kiat Pulp & Paper Corporation is also treated by mixed. The two-stage biochemical treatment process is applied in waste-water treatment station, i.e. primary settling tank + biological aeration tank process. The conditions of waste-water in whole plant are shown in table 15.2-11.

**Table 15.2-11 Operating data of waste-water treatment station in Indonesia PRW Pulping and Paper-making Plant**

|       | Concentration of pollutants (mg/l) |                       |                      |                       |                      |                       | Removing<br>rate<br>of<br>COD (%) |
|-------|------------------------------------|-----------------------|----------------------|-----------------------|----------------------|-----------------------|-----------------------------------|
| Month | SS                                 |                       | COD <sub>cr</sub>    |                       | BOD5                 |                       |                                   |
|       | Input<br>waste-water               | Output<br>waste-water | Input<br>waste-water | Output<br>waste-water | Input<br>waste-water | Output<br>waste-water |                                   |
| 1     | 181.29                             | 60.65                 | 1042.45              | 152.99                | 314.46               | 7.24                  | 85.32                             |
| 2     | 198.93                             | 60.36                 | 1006.31              | 160.26                | 296.95               | 5.42                  | 84.08                             |
| 3     | 184.73                             | 59.68                 | 864.89               | 145.68                | 285.82               | 5.42                  | 83.16                             |
| 4     | 173.56                             | 63.00                 | 995.78               | 130.48                | 304.52               | 3.71                  | 86.90                             |
| 5     | 191.29                             | 61.94                 | 965.65               | 140.01                | 292.85               | 2.61                  | 85.37                             |
| 6     | 209.57                             | 62.38                 | 976.53               | 141.35                | 293.53               | 3.98                  | 85.52                             |
| 7     | 209.57                             | 67.45                 | 938.14               | 153.68                | 303.34               | 5.41                  | 83.62                             |
| 8     | 187.96                             | 72.52                 | 904.05               | 131.11                | 299.13               | 7.22                  | 85.50                             |
| 9     | 191.11                             | 77.11                 | 880.53               | 148.57                | 341.27               | 7.32                  | 83.13                             |
| 10    | 187.66                             | 66.88                 | 919.19               | 161.71                | 327.74               | 6.32                  | 82.41                             |
| 11    | 178.79                             | 66.47                 | 852.80               | 170.59                | 276.08               | 8.89                  | 80.00                             |
| 12    | 194.31                             | 64.67                 | 867.93               | 136.53                | 275.67               | 8.48                  | 84.27                             |

Note: the above data are the monthly average values.



Compared with the operation data of the waste water treatment station of Yongjie Indonesian PRW Pulp & Paper Factory of Jinguang Group, calculated based on the minimum removal rate 80%, after Phase II project of this project is completed, the quality of the effluent from the two-stage biochemical treatment unit will be  $\text{COD}_{\text{Cr}} < 250\text{mg/l}$  and after three-stage physical-chemical treatment, the removal efficiency can be 64%, which is able to meet the discharge requirement of  $\text{COD}_{\text{Cr}} 90\text{mg/l}$ . According to the report of the researches conducted abroad, three-stage physical-chemical treatment is very effective in suspended solid removal so after two-stage biochemical treatment and three-stage physical-chemical treatment, it is feasible for SS to meet the discharge requirement of  $30\text{mg/l}$ .

After Phase II project is completed, the other indexes concerning the effluent from waste water treatment station: pH, color, ammonia-nitrogen, total nitrogen and total phosphorus, etc. can still comply with the discharge limit values of Phase I project: pH 6-9, color 50, ammonia-nitrogen  $6\text{mg/L}$ , total nitrogen  $8\text{mg/L}$  and total phosphorus  $0.8\text{mg/L}$ .

To sum up, it is feasible for the effluent from the waste water treatment station after the Phase II project of the project to construct is completed to meet the requirements of GB3544-2008, the *Discharge Standard of Water Pollutants for Pulp and Paper Industry* (release version): pH 6-9, color 50,  $\text{COD}_{\text{Cr}} 90\text{mg/L}$ ,  $\text{BOD}_5 20\text{mg/L}$ , SS  $30\text{mg/L}$ , ammonia-nitrogen  $8\text{mg/L}$ , total nitrogen  $12\text{mg/L}$  and total phosphorus  $0.8\text{mg/L}$ .

### (3) Feasibility analysis on waste-water treatment up to standard in phase project III

In phase project III, a production line with annual capacity of 450,000t high-grade culture paper with its supporting facilities will be added. Additional waste-water sources with quality and flow of waste-water are shown in table 15.2-3. All the waste-water will also be sent to waste-water treatment station in phase project II for treatment and then discharged to the deep sea after having been treated up to standard.

While phase project III is constructed, the waste-water treatment station in phase project II will be expanded to increase its design handling capacity to  $145000\text{m}^3/\text{d}$ . The expansion conditions of waste-water treatment station are shown in Fig. 15.2-4, with the expansion part represented in shadow in the figure. Additional buildings and equipments in phase project III are shown in table 15.2-12 and Table 15.2-13 respectively.

Table 15.2-12 Overview of additional main buildings of waste-water treatment station in phase project III

| No. | Name                  | Specification | Note |
|-----|-----------------------|---------------|------|
| 1   | Coagulating tank      | ---           | ---  |
|     | Primary settling tank | ---           | ---  |

Table 15.2-13 Overview of additional main equipments of waste-water treatment station in phase III project

| No. | Name of equipment | Quantity | Unit | Note |
|-----|-------------------|----------|------|------|
| 1   | Cooling tower     | 1        | ---  | ---  |
| 2   | Aeration system   | 1        | ---  | ---  |



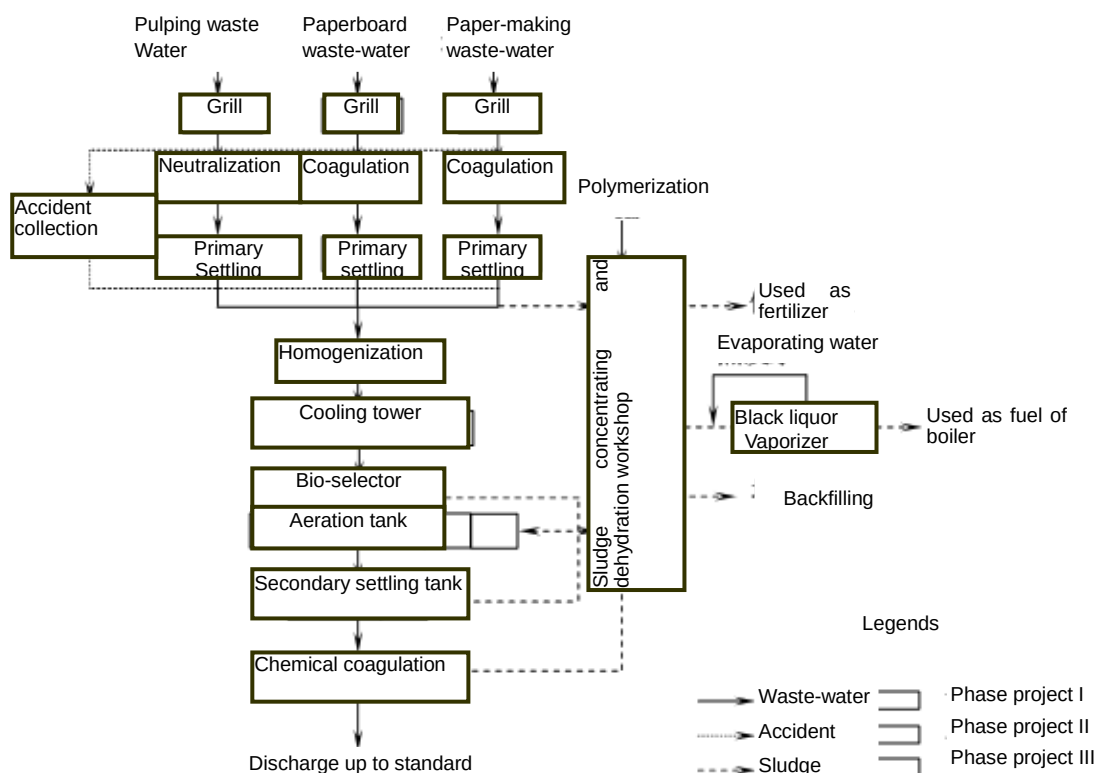


**Fig. 15.2-4 Process flowchart of waste-water treatment station in phase project III**

### ①Expansion of waste-water treatment station in phase project III

In phase project III, the waste-water treatment station will be expanded on the basis of phase project II. For Additional process waste-water of paper-making workshop in phase project III, a new set of one-stage treatment process will be added. The clarifying flocculation process will be applied to treat the process waste-water coming from paper-making workshop with auxiliary supporting equipments. The treated waste-water will be mixed with the waste-water output from one-stage treatment in phase project III and then sent to homogenization tank. In phase project III, a new cooling tower will be constructed after homogenization tank to cool down the waste-water entering into biochemical treatment workshop. For the condition of additional waste-water flow, the aeration heads will be added in active sludge aeration tank to meet the requirement for treating additional waste-water in phase project III. And Additional 150kW installed power is required. The secondary settling tank following aeration tank can meet the treatment requirement in phase project III.

### ②Feasibility analysis on waste-water treatment up to standard in phase project III

Phase III project will increase the volume of waste water by 15200m<sup>3</sup>/d and the quality of the water at the inlet of the waste water treatment station is as follows: COD<sub>Cr</sub> 433.6 mg/L, BOD<sub>5</sub>190.5 mg/L and SS 594 mg/L. Compared with the quality of the water at the inlet of phase II project COD<sub>Cr</sub> 1250 mg/L, the quality has been improved very much. The biochemical property of the newly increased waste water of phase III project is better than that of the pulping waste water of phase II project so the dilution function and the coordinated degradation function can be utilized for treating waste water of Phase II

project in order to improve waste water treatment effect.

In comparison with the pulping and paper-making enterprises in the class, such as Indonesia PRW Pulping and Paper-making Plant of APP Indah Kiat Pulp & Paper Corporation, according to operating data, if the minimum removing rate in two-stage biochemical treatment is defined 80% for calculation, the quality of output waste-water at two-stage biochemical treatment unit can contain COD<sub>Cr</sub> <228mg/l after phase project III of the proposed project is completed. After three-stage physical-chemical treatment, the removal rate can be 60%, which is able to meet the discharge requirement of COD<sub>Cr</sub> 90mg/l. According to the report of the researches conducted abroad, three-stage physical-chemical treatment is very effective in suspended solid removal so after two-stage biochemical treatment and three-stage physical-chemical treatment, it is feasible for SS to meet the discharge requirement of 30mg/l.

After Phase III project is completed, the other indexes concerning the effluent from waste water treatment station: pH, color, ammonia-nitrogen, total nitrogen and total phosphorus, etc. can still comply with the discharge limit values of Phase II project: pH 6-9, color 50, ammonia-nitrogen 6mg/L, total nitrogen 8mg/L and total phosphorus 0.8mg/L.

To sum up, it is feasible for the effluent from the waste water treatment station after the Phase III project of the project to construct is completed to meet the requirements of GB3544-2008, the *Discharge Standard of Water Pollutants for Pulp and Paper Industry* (release version): pH 6-9, color 50, COD<sub>Cr</sub> 90mg/L, BOD<sub>5</sub> 20mg/L, SS 30mg/L, ammonia-nitrogen 8mg/L, total nitrogen 12mg/L and total phosphorus 0.8mg/L.

#### 15.2.2.3 Feasibility of deep sea discharge of production waste-water

The demonstration result of the selection and planning of discharge outlet shows that the production waste-water in the project needs to be discharged to deep sea (B<sub>3</sub> pollution discharge area) after having been treated, and a discharge pipeline with a total length of about 9km (where land (including marine replacement land) pipeline is about 6km and sea pipeline is about 3km) should be built. Additional environmental protection investment for discharge pipes and devices is about 80,000,000 RMB whose detailed engineering scheme will be determined in the design of the project. The evaluation requires that during the design and construction of discharge pipes and devices, coordinate with related departments don't affect the shoreline utilization, sea-related project and port channel in the sea area.

#### 15.2.2.4 Recommendations and countermeasures in abnormal cases

In the normal case, waste-water treatment station can meet the discharge up to standard. In the abnormal case, the treatment effectiveness will be sharply decreased or even broken down. The effective measures should be taken to avoid or reduce the occurrences of abnormal cases. The detailed analysis is as follow:

(1) The abnormal cases in waste-water treatment station mainly include the following ones:

① The biological treatment is impacted by harmful substances, such as acid and alkali and

insufficient oxygen supply in biological reaction tank, which will restrict the growth of microbe and lead to the significant reduction in the efficiency of biological treatment or even the breakdown of system;

②**The great changes in the quality** and flow of waste-water will also lead to the reduction in the treatment efficiency.

## (2) Prevention and treatment countermeasures

①**Ensure the stable flow and quality of discharged water in individual workshops as far as possible;**

②Utilize the waste water emergency basin to adjust the flow and quality of waste-water to avoid the impacts on the system. After the operation become normal, the waste-water should be added into waste-water treatment system in a small flow gradually;

③Set online pH meter and adjustment system in adjustment tank to avoid the acid and alkali impact in aeration tank;

④Set online conductivity meter at the inlet of adjustment tank. Once a great amount of black liquor is leaked, the meter should be switched to allow black liquor to enter into accident tank at first;

⑤**In the design, accident tank** should have sufficient capacity;

⑥**In pulping section, evaporating station and causticizing section, the spillage water** channel should be set to collect the leaked and spilt waste-water and waste-liquor and sent to the sections for recovery, reducing the treatment load of waste-water treatment station;

⑦**During the waste-water** treatment, add nutrient substances such as N, P and etc. into aeration tank if they are insufficient. The dose of N and P required by microbe should be strictly controlled to prevent a great amount of unabsorbed N and P from being consequently discharged into the sea and causing the eutrophication and even red currents in the water area.

## 15.2.2 Countermeasures and measures for exhaust gas pollution prevention and treatment

### 15.2.2.1 Countermeasures and measures for fume pollution prevention and treatment

#### (1) Analysis on fume pollution source

Most of fume emission sources generated in the proposed project include alkali recovery boiler, lime kiln and circulating fluidized bed coal-fired boiler, for which, corresponding treatment measures have been taken.

The fume produced in alkali recovery boiler and lime kiln will be treated for dust removal by three-electric-field static dust cleaner and then discharged. The dust removing reaches above 99%. For SO<sub>2</sub>, most of sulphur in alkali recovery boiler is reduced by alkali substances in the boiler. Therefore, amount of discharged sulphur is very low. The calcinated white sludge in lime kiln will generate the limestone and react with SO<sub>2</sub> at high temperature, whose removing rate can reach above 70%. The fume discharge of alkali recovery boiler meets the standard requirement in 3rd Time-interval (boiler with

comprehensive resource utilization) in the Emission Standard of Air Pollutants for Thermal Power Plants, GB13223-2003, i.e. 200mg/m<sup>3</sup> fume and 800 mg/m<sup>3</sup> SO<sub>2</sub>; the fume discharge of lime kiln meets the Class II standard in the Emission Standard of Air Pollutants for Industrial Kiln and Furnace, GB9078-1996, i.e. 200mg/m<sup>3</sup> fume and 850 mg/m<sup>3</sup> SO<sub>2</sub>.

The fume from circulating fluidized bed coal-fired boiler is controlled by four-electric-field static dust cleaner with the dust removing 99.7%. The limestone is added into the boiler for desulfurization, with the desulfurization efficiency above 82%. The fume is discharged in a high altitude via the 120mHxΦ2.7m chimney. The fume of circulating fluidized bed coal-fired boiler meets the 3rd Time-interval (boiler with comprehensive resource utilization) in the Emission Standard of Air Pollutants for Thermal Power Plants, GB13223-2003, i.e. the standard requirement for 50mg/m<sup>3</sup> fume, 400mg/m<sup>3</sup> SO<sub>2</sub> and 450 mg/m<sup>3</sup> NO<sub>x</sub>.

Main fume emission sources and treatment measures of the proposed project are shown in table 15.2-14.

Table 15.2-14 Main fume emission sources and treatment measures of the proposed project

| Fume emission source                                                                      | Dust removal measures                                  | Desulfurization measures                   | Notes                                                                    |
|-------------------------------------------------------------------------------------------|--------------------------------------------------------|--------------------------------------------|--------------------------------------------------------------------------|
| 3 sets of 220t/h circulating fluidized bed boilers (two for operation and one for backup) | Four-electric-field static dust cleaner                | Limestone powder is added into the boiler. | The dust removing is above 99.7%; the desulfurization efficiency is 82%. |
| 1 set of 4000tD.S/d alkali recovery boiler                                                | Three-electric-field static dust cleaner               |                                            | Low odor boiler is applied, with dust removing of above 99%.             |
| <del>700t</del> 750t/d lime kiln                                                          | Three-electric-field static dust cleaner               |                                            | The dust removing is above 99%.                                          |
| Coal preparation system, lime breaking and delivery system                                | The produced dust is removed by bag-type dust cleaner. |                                            |                                                                          |

## (2) Feasibility analysis on fume treatment up to standard

### 1) Feasibility analysis on fume up to standard of alkali recovery boiler and lime kiln

Compare with the fume emission sources and their disposal measures with effects in present domestic enterprises, the details are shown in table 15.2-15.

It is shown in table 15.2-15 that the alkali recovery boiler of the proposed project has the three-electric-field static dust cleaner and the discharged fume meets the standard requirement in 3rd Time-interval (boiler with comprehensive resource utilization) in the Emission Standard of Air Pollutants for Thermal Power Plants, GB13223-2003, i.e. 200mg/m<sup>3</sup> fume and 800 mg/m<sup>3</sup> SO<sub>2</sub>; the lime kiln has the three-electric-field static dust cleaner and the discharged fume meets the Class II standard in the Emission Standard of Air Pollutants for Industrial Kiln and Furnace, GB9078-1996, i.e. 200mg/m<sup>3</sup> fume and 850 mg/m<sup>3</sup> SO<sub>2</sub>. These measures are feasible.

### 2) Feasibility analysis on fume up to standard of circulating fluidized bed boiler.

#### a. Feasibility analysis on smoke and dust control measures

According to the compiling statement of *Atmosphere Pollutant Emission Standard for Thermal Plant*, the smoke emission limit value is 50mg/Nm<sup>3</sup>. Please refer to Table 15.2-16 for technical approaches.

Table 15.2-15 Treatment measures and effects for main fume emission sources in present domestic enterprises [removed]

Table 15.2-16 Technical approaches for limiting fume and dust discharge under 50 mg/Nm<sup>3</sup>

| Technical approach                                    | Applicable conditions                                                           | Degree of maturity of technology                                                                                                                                                                            |
|-------------------------------------------------------|---------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Fiber bag precipitation                               | Applicable to thermal power plants burning all fuels                            | Commonly used in Australia and sometimes used in the U. S., Japan and Europe. In China there is already large scale thermal power plants using it. The technology is mature.                                |
| Electrostatic precipitation + wet desulfurization     | Applicable to fly dust not easily precipitated with electrostatic precipitators | Widely used overseas. The technology is mature.                                                                                                                                                             |
| electrostatic precipitation + fiber bag precipitation | Applicable to thermal power plants burning all fuels                            | Mostly applicable to transformation of old plants. The first-state bag precipitation is added to the electrostatic precipitator, called COMPACT structure, which is used in some of the U. S. power plants. |

As a highly efficient and stable smoke processing equipment, electrostatic precipitator is extensively used in various industries, especially in thermal power plant at present and enterprises have accumulated many operation experiences.

The operation principle of fiber bag precipitator is that filter bag is used for filtration and separate fly dust. When operation begins, there is no dust in the new filter bag, and after several minutes' operation, a very thin dust film will be formed on the surface of filter bag. As filter bag is usually made of fibers, before the dust film is formed, under the effect of diffusion, etc. bridge of dust will be gradually formed between fibers. After the bridging is completed, a dust layer with a thickness of 0.3-0.5mm will be formed on filter bag, which is called dust film or primary dust layer and the dust layer heaped up once again on the primary dust layer is called secondary dust layer to play a function of dust particle collecting. The formation of primary dust layer and secondary dust layer makes the dust collection efficiency greatly improved, which can be about 99.9%.

Control measure of three electric fields electrostatic precipitation + bag precipitation system is adopted for this project and according to the conservative calculation that the precipitation efficiency is 99.75%, the smoke emission concentration in the exhaust gas from circulating fluid bed boiler can meet the standard requirement of 50mg/Nm<sup>3</sup> so it is feasible to adopt the precipitation measure.

In order to ensure the normal operation of fiber bag precipitator, when design is conducted, following points should be taken into consideration:

1) Standby box should be provided for every set of fiber bag precipitator to prevent the bag from exhaust gas "short-circuit" caused by local damage, an on-line pressure measuring instrument should be installed at the gas inlet of the box, when "short-circuit" occurs, the exhaust gas should be switched into the standby box.

2) Bags with high strength and very good abrasive resistance should be adopted.

Feasibility analysis on desulfurization measures

Utilizing desulfurization agent for high-efficiency and cheap desulfurization in the boiler is the outstanding advantage of circulating fluidized bed boiler. The common desulfurization agent is the limestone powder. The bed temperature of circulating fluidized bed boiler is usually kept in 800~900°C. During operation, the limestone powder is directly added into the bed. The desulfurization efficiency can reach 80%-90%, if the mol ratio of calcium to sulphur and the grain size of limestone are proper.

The current project of UPM (Changshu) Paper Co., Ltd. has two 241t/h circulating fluid bed coal fired boilers and desulfurization is conducted via adding limestone powder into the furnace while sludge from waste water treatment station is incinerated. According to the acceptance and monitoring report of the current project conducted in May 2005 by China Environment Monitoring Station and the operation monitoring data provided by local environmental protection authority, the overall waste gas emission of the current project is obtained. Please refer to Table 15.2-17 for details.

Table 15.2-17 Fume Emission of the Furnace of the Circulating Fluidized Bed Boiler of UPM (Changshu)'s Current Project

| Major pollutant | Emission                                    |               | Treatment mode                 | Complying with standard |
|-----------------|---------------------------------------------|---------------|--------------------------------|-------------------------|
| SO <sub>2</sub> | Emission amount (t/h)                       | 0.0622~0.1428 | In-furnace dry desulfurization | Complying with standard |
|                 | Emission concentration (mg/m <sup>3</sup> ) | 154.7~276     |                                |                         |
| NO <sub>x</sub> | Emission amount (t/h)                       | 0.0234~0.09   | Low temperature combustion     | Complying with standard |
|                 | Emission concentration (mg/m <sup>3</sup> ) | 58.2~174      |                                |                         |

It can be seen from the table that the sulfur dioxide in exhaust gas from circulating fluid-bed coal-fired boiler is usually 154.7--276mg/Nm<sup>3</sup>.

Low sulfur coal (sulfur content 0.8%) is adopted for the project to construct, desulfurization is conducted via adding limestone powder into the furnace, the calcium-sulfur mole ratio is 2.2:1, the desulfurization efficiency is conservatively calculated as 82.3%; therefore, it is feasible for the sulfur dioxide emission concentration to meet the requirement of emission standard, less than 400mg/Nm<sup>3</sup>.

After the project is completed and put into production, it is recommended that the construction company should take the following measures, to ensure the desulfurization effectiveness of circulating fluidized bed boiler:

- Ensure the matching ratio of limestone in hybrid fuel. If the pureness or usage of limestone is insufficient, then the coal quality should be adjusted to reduce the usage of high-sulphur coals;
- Strengthen the commissioning of boiler and ensure the combustion temperature. The desulfurization effectiveness is best when the bed temperature is 840~900°C or so;
- Proper reduction in the grain size of limestone will be useful to increase the desulfurization efficiency (proper grain size of limestone is ≤50μm);



d. Strengthening the management is the important measure to ensure desulfurization efficiency; in addition, the desulfurization effectiveness in the boiler should also be periodically

### 3) Feasibility analysis on control of nitrogen oxide

The feature of circulating fluidized bed is the low-temperature combustion. The inert heat materials in the bed account for more than 95% of all solid materials in the bed. The carbon content in the bed is only 1.95%-2.18%. Therefore, the combustion temperature can be controlled at 800-900°C. The generation of NO<sub>x</sub> has a direct relation with the combustion temperature and excessive air. The NO<sub>x</sub> is generated due to the combustion in circulating fluidized bed boiler is far less than that of coal-powder boiler, whose NO<sub>x</sub> output is only 1/3-1/4 of coal powder combustion. The discharge concentration of NO<sub>x</sub> in the fume of circulating fluidized bed boiler in the proposed project is less than 450mg/Nm<sup>3</sup> required in the standard.

The monitoring data of the two 241t/h circulating fluid-bed coal-fired boilers of the current project of UPM (Changshu) Paper Co., Ltd., Table 15.2-17, are compared. It is feasible for the concentration of NO<sub>x</sub> in exhaust gas from the circulating fluid-bed coal-fired boilers of the current project to meet the requirement of standard, less than 450mg/Nm<sup>3</sup>.

To sum up, the emitted exhaust gas from the two 241t/h circulating fluid-bed coal-fired boilers of the current project meets the requirements of the standard in Chapter 3 of GB13223-2003 *Atmosphere Pollutant Emission Standard for Thermal Plants*, which includes smoke 50mg/m<sup>3</sup>, SO<sub>2</sub>400 mg/m<sup>3</sup> and NO<sub>x</sub>450 mg/m<sup>3</sup>, therefore, the measure is feasible.

For the dust treatment measures for coal preparation system, lime breaking and delivery system, the bag-type dust removal will be applied.

### (3) Treatment scheme for abnormal fume emissions of boiler

#### 1) Emergency treatment method for dust emission exceeding the standard

##### a. Identification of dust emission exceeding the standard:

CEMS online detection data  $> 50 \text{ mg/Nm}^3$ ;

The obvious dust is found at the discharge outlet of chimney by visual inspection;

##### b. Reasons causing dust emission exceeding the standard:

Partially tripping of static dust cleaner; the load of boiler exceeds the handling capacity of operation sections;

Fully tripping of static dust cleaner;

##### c. Treatment method:

If the dust emission exceeding the standard is caused due to the partially tripping of static dust cleaner and the load of boiler exceeding the handling capacity of operation sections, then the load of boiler should be reduced immediately until the dust emission is up to standard;

If the dust emission still exceed the standard after the load of Item 3.1 boiler is reduced to the minimum coal-burning load, then the starting burner should be put into operation and

the coal consumption reduced until the dust emission is up to standard;

If the dust emission exceeding the standard is caused due to the fully tripping of static dust cleaner, then the starting burner should be immediately put into operation and the coal burning should be stopped;

The causes of the failures of static dust cleaner should be immediately investigated. If the operation can be resumed in a short term, then the combustion with oil or coal and oil should be maintained while eliminating the failures;

If the failure of static dust cleaner can't be eliminated in a short term, then it should be decided to maintain the combustion with oil or to stop the boiler according to the stipulations in related procedures.

## 2) Emergency treatment method for SO<sub>2</sub> emission exceeding the standard

### a. Identification of SO<sub>2</sub> emission exceeding the standard:

CEMS online detection data  $>400 \text{ mg/Nm}^3$ ;

Manual detection data  $>400 \text{ mg/Nm}^3$ ;

### b. Reasons causing SO<sub>2</sub> emission exceeding the standard:

Partial failure of desulfurization agent filling equipment; the load of boiler exceeds the handling capacity of operation sections;

Total failure of desulfurization agent filling equipment;

Abnormally high sulphur content of incoming coal or insufficient purity of desulfurization agent; the maximum filling dose of desulfurization agent still fails for complete treatment;

### c. Treatment method:

If the SO<sub>2</sub> emission exceeding the standard is caused due to the partial failure of desulfurization agent filling equipment and the load of boiler exceeding the handling capacity of operation sections, then the load of boiler should be reduced immediately until the SO<sub>2</sub> emission is up to standard;

If the SO<sub>2</sub> emission exceeding the standard is caused due to the total failure of desulfurization agent filling equipment, then the starting burner should be immediately put into operation and the coal burning should be stopped;

If the SO<sub>2</sub> emission exceeding the standard is caused due to relatively high sulphur content of incoming coal or insufficient purity of desulfurization agent and maximum filling dose of desulfurization agent still failing for complete treatment, then the load of boiler should be reduced immediately until the SO<sub>2</sub> emission is up to standard;

The faulty equipments should be immediately investigated. If the operation can be resumed in a short term, then the operation with reduced load or the combustion with oil should be maintained while eliminating the failures;

If the failures can't be eliminated in a short term or the SO<sub>2</sub> emission still exceeds the standard after the above measures are taken, then it should be decided to maintain the operation with oil or to stop the boiler according to the stipulations in related procedures.

## 3) Measures to reduce the occurrences of abnormal fume emission to a maximum extent:

- a. The static dust cleaner is designed with sufficient redundancy;
- b. The ash hopper of static dust cleaner is equipped with high level alarm device, vibration or other efficient anti-clogging equipments;
- c. The desulfurization agent filling equipment is designed according to the number of boilers plus one set for standby and a certain of redundancy should be present, ensuring the normal filling of desulfurization agent;
- d. Control the quality of coals entering into the boiler. The sulphur content should be controlled within 0.8-1.2%;
- e. The operation management persons and operators should be strictly trained. The efficient calibration and maintenance should be provided for online detection instruments to ensure the exact display of data.

#### 15.2.2.2 Feasibility analysis on odor treatment measures

##### (1) Feasibility analysis on odor treatment in pulping process in the project

The major production process generated the odor in pulping process in the project include alkali recovery boiler, lime kiln, fusant dissolving tank, evaporating station, diluted black liquor tank and waste condensate tank.

The treatment of odor is divided into collection process and treating process. At first, the emissions of TRS (total reduced sulphur) and other odor to the environment are reduced by strengthening the tightness of production line. Secondly, the odors generated in individual sections should be collected. Wherein, the high-concentration odors include: the odors generated in steaming system, evaporating station and steam stripping non-condensable gases. The high-concentration odors will be collected and subsequently sent to alkali boiler for burning disposal; the low-concentration odors include: the odors generated in dissolving tank, diluted black liquor tank, waste condensate tank and etc. The exhaust gas of dissolving tank will enter into alkali boiler as a part of secondary air, used for heat recovery and controlling the total alkali and total reduced sulphur discharged into atmosphere; the odors generated in diluted black liquor tank and waste condensate tank will be collected and dehumidified and then sent to alkali recovery boiler for burning without emissions.

The odor substances in alkali recovery boiler and lime kiln are burned to be  $\text{SO}_2$  and then most of them are absorbed by alkali substances. The discharge of  $\text{H}_2\text{S}$  is less than the discharge limit given in table 2 in Emission Standard for Odor Pollutants, GB14554-93.

The combustion conditions should be controlled for the odor input into alkali boiler and the proper air-fuel ratio should be adjusted, avoiding the generation of reducing atmosphere in the boiler and increasing the content of solids in black liquor as far as possible.

At the same time, the backup scheme should be prepared for the odor treatment in pulping process. That is to say that a backup burner should be installed in the circulating fluidized bed coal-fired boiler. If the alkali recovery boiler has malfunction, the odors will enter into power boiler for burning. If both two burners stop the operation, then the odors will be sent to the oil-fired torch for burning out.

The fumes of alkali boiler and lime kiln are discharged via individual 120m exhaust stacks respectively. The online fume continuous detecting device is set in the flues to detect the

total reduced sulphur, sulphur dioxide, dust, nitrogen oxide and oxygen content, etc. The advanced design and operation control level of alkali boiler and lime kiln can ensure that the ground odor concentration in the fume can meet the standard requirement.

Decentralized odors: the decentralized odors mostly come from the discharge ditches, waste-water treatment, sludge and solid wastes treatment areas. In the view of technology, these odors are relatively difficult to be collected and collectively treated. The control of decentralized odors in the project mostly is realized by proper technological design and strong environmental protection management and monitoring system.

The odor treatment measures for the pulping process in the proposed project are feasible by the above solutions.

## (2) Treatment measures for odors in waste-water treatment station

When waste-water treatment station usually operates, a certain amount of foul odors such as  $\text{NH}_3$ ,  $\text{H}_2\text{S}$  and methyl mercaptan will be generated, as the organic substances in the water will be decomposed while the reproduction occurs in the waste-water in the biochemical process, especially for the anaerobic decomposition. The buildings producing these substances include aeration tank, cooling tower, sludge tank, sludge filter press room and etc.

As the delayed aeration is applied in waste-water treatment station in the proposed project, the output of sludge is low and tends to be aerobic and stable. Therefore the output of odors generated by active sludge is very low. The sludge dewatering process generates relatively more odors. In the proposed project, the management will be strengthened and the sludge will be treated in time, avoiding that the anaerobic reaction is activated and odors are generated due to the piling of sludge in a long term. In addition, a good ventilation condition will be kept in sludge dewatering machine room, avoiding the generation of odors by anaerobic reaction of sludge in a maximum. At the same time, the space in the plant area will be sufficiently utilized for planting to decrease the odor effects on the environment.

### 15.2.2.3 Control measures for unorganized flying dust

The pneumatic dust removal method will be applied for the flying dust in thermal power plant. The silo pump will lift and transfer the fine dust with compressed air into the dust silo. Then the fine dust will be sent out of the plant by tanker truck for comprehensive utilization. The whole system is enclosed. The flying dust is controlled by spraying water in the coal piling site. It is additionally suggested that wind break and dust control net should be adopted as the dust-proof measure for coal storage yard. The dust generated by coal preparation and delivery system will be removed by bag-type dust cleaner whose dust removing reaches 98%. The coal transport belt machine is placed in the enclosed trestle. The water spraying is applied to suppress the dust for the coal unloading at docks or the operation causing flying dust.

### 15.2.3 Noise control measures

The high noise sources included in phase project I, phase project II and phase project III are: wood chip screen, chipper, fan, air compressor, pulp kneader, pulping machine, alkali boiler, thermal power plant, vacuum pump and coal grinding machine, etc. The enclosed

construction is applied for pulping workshop and paper-making workshop for a good noise isolation effect (between 25 and 40 dB); it is proposed to take the vibration reduction measures for equipments with large vibration, to reduce the effects on the environment by the noises of equipments. The noise sources in alkali boiler and thermal power plant include the steam discharge of boiler, induced fan, steam turbine and water pump. Wherein, the noise intensity by steam discharge of boiler is 90-110dB(A), which is the place with the occurrence of most severe noise in the plant. The steam discharge noise of boiler can be reduced by silencer. And the basic vibration reduction measures and muffling measures (such as installing silencer and sound isolation hood) should be taken against the noises of other equipments.

The basic rule for noise control is that the equipments causing the noises more than 95dB(A) should be installed in the special noise isolation area. The equipments with sound pressure level between 85 and 95 dB(A) can be equipped with individual muffling devices to decrease the noises to below 85dB(A). After the project is completed, the noises at plant boundary can meet the requirements in Class III standard in the Standard of Noise at Boundary of Industrial Enterprises, GB12348-90.

#### 15.2.4 Treatment/disposal measures for solid wastes

The generation and disposal conditions of solid wastes in the proposed project are shown in table 15.2-18.

Table 15.2-18 Generation and disposal conditions of solid wastes after the proposed project is constructed and put into operation

| No. | Emission source           | Output in the proposed project (t/a) | Main components                                       | Disposal method                                                                                                                                                                       | Classification     |
|-----|---------------------------|--------------------------------------|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| 1   | Wooden wastes             | 73900 (water content: 45%)           | Fibers, lignin                                        | Before phase project II is put into production, they will be comprehensively utilized. After it is put into production, they will be sent to coal-fired boiler for burning.           | General pollutants |
| 2   | Pulp residues             | 14790 (water content: 70%)           | Foreign substances such as fibers, lignin, sand grain | To be sold to small paper-making plant                                                                                                                                                |                    |
| 3   | Green sludge, lime sludge | 37000 (water content: 50%)           | Solid unsolved substances such as $\text{CaCO}_3$     | Backfilling                                                                                                                                                                           |                    |
| 4   | Class I sludge            | 93770 (water content: 65%)           | Fibers, microbes, humus colloform, sands and etc.     | Before phase project II is put into production, they will be sent to forest land as fertilizers. After it is put into production, they will be sent to coal-fired boiler for burning. |                    |
| 5   | Class II sludge           | 30327 (water content: 80%)           |                                                       | To be burned in alkali boiler                                                                                                                                                         |                    |

| No. | Emission source                                        | Output in the proposed project (t/a)                                        | Main components | Disposal method                                            | Classification |
|-----|--------------------------------------------------------|-----------------------------------------------------------------------------|-----------------|------------------------------------------------------------|----------------|
| 6   | Class III sludge                                       | 41402 (water content: 80%)                                                  |                 | Backfilling                                                |                |
| 7   | Fine coal ash                                          | Amount of ashes and slag: 172000;<br>Wherein: ashes: 120000;<br>Slag: 52000 |                 | Comprehensive utilization (producing cement, paving roads) |                |
| 8   | Others (including living garbage, construction wastes) | 21240 (water content: 60%)                                                  |                 | Backfilling                                                |                |

#### 15.2.4.1 Sludge of waste-water treatment station

It is expected that the proposed project will produce 165499t sludge annually. The most sludge come from the individual settling tanks in waste-water treatment station. Main components are fine fibers, microbes, humus, sands and etc. They will be sent to the boiler for burning or to be backfilled for disposal.

#### 15.2.4.2 Green liquor dregs and lime sludge

The green liquor dregs come from the sediments of green liquor in causticizing section. Its main components are organics such as lime carbonate, calcium metasilicate, etc. and a small amount of alkali. China Environment Monitoring Station has conducted concrete analysis on the green sludge in solid waste and the monitoring result indicates that the pH value of the diffusion juice of the green sludge of solid waste is 10.54 – 10.74 and according to the assessment standard of GB5085.1-2007 *Dangerous Waste Discrimination standard Corrosiveness Discrimination* the green sludge is not corrosive. No mercury and the compound are detected, lead <0.2mg/L and according to assessment standard GB5085.3-2007 “Dangerous waste discrimination standard leaching-out toxicity discrimination”, the mercury and lead of the waste do not possess leaching-out toxicity. And the green sludge corrosiveness comparison and monitoring results of Guangxi Heda Paper Co., Ltd. (please refer to Table 11. 2-2 for details) indicate that pH values are 10.28 and 10.52. It can be seen that the green sludge is not a dangerous waste.

The main component of lime slag is also calcium carbonate. Filling and burying in solid waste filling and burying field out of the factory is adopted.

#### 15.2.4.3 Pulp residues and wood chips

Main components of pulp residues are fibers. They can be sold to the local small paper-making plant to produce the low-grade paper and egg tray.

Main components of wooden wastes such as wood chips are fibers and lignin with a very high heat value. If they are sent to the multi-fuel fluidized bed boiler for burning, a certain amount heat can be provided to reduce the coal consumption.

#### 15.2.4.4 Ashes and slag

The ashes and slag come from the coal ashes collected by dust removal equipments and boiler slag discharged from the boiler bottom.

As circulating fluid-bed boiler belongs to low temperature combustion, the combustion temperature is lower than 1000 °C and in combustion process, a great amount of desulfurizer limestone powders is added; therefore there is a great difference between the fine coal ash property and common fine coal ash. The SO<sub>3</sub> content of the discharged fine coal ash from CFB boiler is 6% - 11%, which is unable to meet the requirement of national standard that the mass fraction of SO<sub>3</sub> of fine coal ash used as building material must be less than 3%. Meanwhile, there is no requirement concerning SO<sub>3</sub> content in the technical indexes of sintered brick and there are only two indexes, break strength and compression strength. It is discovered in the experiment to use fine coal ash in sintered brick production that fine coal ash sintered brick can meet the performance requirements of common sintered brick and there is certain index margin.

In addition, when producing cement, in order to improve the performance of cement and regulate cement number, certain active mixture material must be added. Slag can be used as cement mixing material. The quantity of addition and the utilization benefit depend on the ash activity index of the slag. Ash activity of slag refers to the capability of the slag to generate hydrated calcium metasilicate and hydrated calcium aluminate. The researches conducted by the units such as Wuhan University, Zhejiang University and Hunan Coal Science Research Institute indicate that the activity of the slag after 850 °C ~ 1000 °C combustion is the best; meanwhile CFB boiler is just combusting at such a temperature. It is indicated in experiment that using CFB slag to replace lime slag originally used and when the addition is 14%, the performance index of the cement is still ensured and there is some allowance. Sufficient utilization of CFB boiler slag can not only reduce the consumption of cement clinker but reduce the cement production cost as well.

To sum up, the overall utilization of circulating fluid-bed boiler slag is feasible, fine coal ash can be used in sintered brick production and the slag can be used as cement mixing material. According to the letter of intent, Zhangzhou City Yicai Fine Coal Ash Development Co., Ltd. is responsible for accepting the slag generated from the project to construct (please see Appendix 25 for details).

#### 15.2.4.5 Environmental protection measures in coal storage site

The enclosed pneumatic lifting facility is used for the ash discharge in thermal power plant and all ashes are directly sent to the ash tanker which has the bag-type dust cleaner to remove the dust and prevent the flying dust; the flying dust is controlled in coal storage site by spraying water; the dust produced by coal preparation and delivery system will be removed by bag-type dust cleaner with dust removing up to 98%; the coal transport belt machine is placed in enclosed trestle and the water spraying is applied to suppress the dust for the coal unloading at docks or the operation causing flying dust.

#### 15.2.4.6 Environmental protection measures in solid wastes piling site

The solid wastes landfill site will be constructed out of the plant address in the proposed

project, which will be used for backfilling green sludge and lime sludge and utilized as the backup piling site of ashes and slag from boilers. The floor area of solid wastes landfill site is 300 mu. The proposed piling height is 4m on the ground. The total backfilling capacity is 400,000m<sup>3</sup> and effective piling capacity is 720,000t solid wastes (if the density is 0.9 for calculation). As the total output of green sludge and lime sludge is 37000t/a in the proposed project, this piling site can store the solid wastes in nearly 20 years.

Main environmental protection measures applied in solid wastes piling site are as follow:

(1) The earth-retaining walls are set in the surrounding of piling site. The solid wastes will be piled in the open area. When solid wastes are piled, the mechanical leveling will be applied for compacting, preventing the slag particles from drifting with the wind resulting in secondary pollution to a maximum extent. The surface will be covered with temporary waterproof canvas and water spraying facility will be installed. When the wind occurs, the water spraying facility will be started to suppress the dust. If the preset height of piling is contained, the earth covering will be made.

(2) The disposal ditches are set in the surroundings of each section. The water will be drained into blind ditches, collected into collection tank and pumped back to waste-water treatment station in pulping plant 500m away from solid wastes landfill site for treatment.

(3) Due to the 0.31~1.31m embedded depth of ground water level in the site which don't conform to the requirement in Standards for Pollution Control on the Storage and Disposal Site for General Industrial Solid Wastes, GB18599-2001, it is necessary make up the level in the site with clay to allow that the distance between ground surface of natural foundation layer and ground water level is not lower than 1.5m, in order to prevent penetrating fluid from entering into ground water. And then lay the impermeable film under the site. The detailed steps are: level the site at first, fill up with clay layer by layer and compact it to meet the requirement of bearing capacity to pile solid wastes, lay the impermeable film at 50cm (or impermeable film + non-woven fabrics, covering the surroundings of spoil site) and join the impermeable films by fusion; and then backfill the remaining 50cm thick clay and compact it; the water vapor permeability coefficient of impermeable film is  $\leq 1.0 \times 10^{-13}$  cm/s; and meet the requirement in Standards for Pollution Control on the Storage and Disposal Site for General Industrial Solid Wastes, GB18599-2001.

(4) One sampling well should be set at the four edges of site respectively to detect whether the penetrating fluid enters into ground water and causes the pollution to ground water. Before the site is put into operation, the water sample should be taken in advance for analysis and record it as the background value of water sample. After the solid wastes landfill site is put into operation, the ground water should be detected once a month.

(5) The environmental protection graphs and signs will be set in the surrounding of site.

The above measures conform to the requirement in Standards for Pollution Control on the Storage and Disposal Site for General Industrial Solid Wastes, GB18599-2001 and the disposal scheme is feasible.

### 15.2.5 Marine environmental protection

The marine environmental protection is a systematic project and many issues are involved. In addition to the efforts of related functional departments of the government, the



understanding and supports of people in the coastal areas are also required. At the same time, the pollution discharge enterprises should realize its internal potential, save the energy and reduce the emissions, reducing the pollution to the sea and practically protecting the marine ecological environment.

For the party to implement the project, Main measures are:

- (1) Strictly manage and ensure the normal operation of equipments, preventing the occurrence of pollution events;
- (2) Establish the emergency leading team and emergency accident disposal and prevention scheme;
- (3) Strengthen the online monitoring; install the online monitoring equipments at the discharge outlet of main pollutants; realize the pre-discovering and pre-disposal for the pollution events;
- (4) Positively conduct the energy saving and emission reduction and clean production inside the enterprise; continuously develop new process and new technology; reduce the discharge of pollutants;
- (5) Strengthen the daily monitoring in evaluated sea area. The party to implement the project should commission the environment monitoring unit to periodically monitor the sensitive protection areas in evaluated sea area, especially periodically monitoring the ecological system and water environment at the discharge outlets, Shankou mangrove sanctuary, dugong sanctuary and proposed Yingpan pearl-oyster protection area

### **15.3 Investment for environmental protection**

The proposed project has the complete environmental protection facilities, including wastewater treatment, exhaust gas treatment, solid wastes treatment/disposal and noise control measures and facilities, etc. The detailed investment is shown in table 15.3-1. The investment for environmental protection is 2,340,000,000 RMB, accounting for 11.5% total investment of 20,300,000,000 RMB.

Table 15.3-1 Investment for main environmental protections in the proposed project

| Period              |    | Environmental protection equipments and measures                                                           | Amount of investment (RMB) |
|---------------------|----|------------------------------------------------------------------------------------------------------------|----------------------------|
| During construction | 1  | ---                                                                                                        | ---                        |
|                     | 2  | Oil smoke cleaning processor                                                                               | ---                        |
|                     | 3  | Waste-water treatment facilities                                                                           | ---                        |
|                     | 4  | Sound isolation protection                                                                                 | ---                        |
|                     | 5  | Personal protections for workers, such as helmet, ear hood and ear plug                                    | ---                        |
|                     | 6  | Treatment of construction wastes and living garbage                                                        | ---                        |
|                     | 7  | Water protection measures                                                                                  | ---                        |
| During operation    | 1  | Evaporating station                                                                                        | ---                        |
|                     | 2  | Alkali recovery boiler and static dust cleaner                                                             | ---                        |
|                     | 3  | Causticizing equipment                                                                                     | ---                        |
|                     | 4  | Lime kiln and static dust cleaner                                                                          | ---                        |
|                     | 5  | Circulating fluidized bed boiler (including desulfurization and dust removal)                              | ---                        |
|                     | 6  | Bleaching exhaust gas absorbing tower                                                                      | ---                        |
|                     | 7  | Waste-water treatment station                                                                              | ---                        |
|                     | 8  | Equipment for discharging waste-water into the sea                                                         | ---                        |
|                     | 9  | Waste condensate stripping equipment                                                                       | ---                        |
|                     | 10 | Waste-water ditches and facilities in whole plant                                                          | ---                        |
|                     | 11 | NCG recovery system                                                                                        | ---                        |
|                     | 12 | Solid wastes landfill site (permeability reducing, water discharge, dust prevention, rainwater collection) | ---                        |
|                     | 13 | Investment for tree planting and greening                                                                  | ---                        |
|                     | 14 | Investment for monitoring instruments                                                                      | ---                        |
| Total               |    |                                                                                                            |                            |

## 16 Water and Soil Conservation Scheme

### 16.1 Current conditions of soil and water loss

#### 16.1.1 Zoning of regional prevention and treatment of soil and water loss

According to the requirements in the 'Notice on the Zoning of the Critical Sub-zones for Prevention and Treatment of Soil and Water Loss by Autonomous Regional People's Government', No. [2000]40 of Gui Government Issuance by Guangxi Zhuang Autonomous Region and related stipulation in the Standard for Classification and Gradation of Soil Erosion (SL 190-96), this area is within the critical monitoring zone for water and soil conservation in Guangxi. The maximum allowable soil loss tolerance is  $500\text{t}/\text{km}^2\cdot\text{a}$ .

#### 16.1.2 Current conditions of soil and water loss in the area

The area where the project is located has a gentle surface relief. In the evaluation range, the dry land is dominated and partial forest land is present. The percentage of plant coverage is high (above 90%) and meanwhile the water permeability of topsoil which is sandy soil is good. Therefore, the washing of surface runoff on the soil layer is greatly reduced and the soil and water loss is efficiently prevented. The current level of soil and water loss in the area where the project is located is low. In the area, the water erosion is dominated in the soil and water loss. According to the documents provided by Beihai Water Conservancy Bureau, the soil erosion modulus in the area is  $500\sim 700\text{ t}/\text{km}^2\cdot\text{a}$ . The soil and water loss is slight.

### 16.2 Prediction on soil and water loss

#### 16.2.1 Division of prediction period

According to the stipulations in the Regulation on Water and Soil Conservation Plan of Development and Construction Projects, the soil and water loss prediction shall be divided into two periods (including basic construction i.e. construction phase, and production and operation period) for implementation.

As the ashes and slag are comprehensively utilized in the project, therefore the prediction is only applicable to the construction phase.

#### 16.2.2 Soil and water loss prediction

According to the floor area of construction area in the project and the soil and geological conditions, the corresponding soil erosion module ( $m_1$ ,  $m_2$ ) of original surface feature and damaged one will be determined. And then the soil erosion modulus method will be applied to calculate the additional soil and water loss. The applied formula is:

Wherein:  $Q$  - additional soil and water loss,  $\text{t}$ ;  
 $m_2$  - soil erosion modulus of original surface feature,  $\text{t}/\text{km}^2\cdot\text{a}$ ;  
 $m_1$  - soil erosion modulus of disturbed surface feature,  $\text{t}/\text{km}^2\cdot\text{a}$ ;  
 $A$  - soil and water loss area caused after the project area is damaged,  $\text{km}^2$ ;  
 $a$  - years of influence,  $\text{a}$ .

The parameters are identified as follow:

a. Soil erosion modulus of original surface feature,  $m_2$

It is identified that the soil erosion module is  $500\sim 700\text{t}/\text{km}^2\cdot\text{a}$  when the original surface feature, soil and plant cover are damaged.

b. Soil erosion modulus of disturbed surface feature,  $m_1$ , shown in table 16.2-1

Table 16.2-1 Soil erosion modulus of disturbed surface feature

| No. | Item                                                      | Soil erosion modulus of disturbed surface feature t/km <sup>2</sup> .a |
|-----|-----------------------------------------------------------|------------------------------------------------------------------------|
| 1   | Construction area in plant area (site leveling phase)     | 10930                                                                  |
|     | Construction area in plant area (main construction phase) | 2520                                                                   |
| 2   | Living area for construction and production               | 7830                                                                   |
| 3   | Road area in the plant                                    | 8570                                                                   |
| 4   | Pipeline area outside the plant                           | 9490                                                                   |
| 5   | Temporary soil piling area                                | 25370                                                                  |

The prediction result shows that the total soil and water loss is 46734t and additional soil and water loss is 39618 t.

### 16.2.3 Earth cutting and spoil sites

The amount of excavation is 4,808,200 natural cubic meters of earth; the amount of fill is 4,074,700 actual cubic meters of earth. The conversion factor between natural cubic meters of earth and actual cubic meters of earth is assumed to be 1.18. That is to say that the 4,074,700 actual cubic meters of earth can be converted to be 4,808,200 natural cubic meters of earth. Therefore, the elevation planning is that “quantity of fill is 4,808,200m<sup>3</sup> and quantity of excavation is 4,808,200m<sup>3</sup>”.

The amounts of excavation and fill are balanced in the project. The setting of earth cutting and spoil sites are not required.

The balance of earthwork in the project is shown in table 16.2-2.

Table 16.2-2 Balance table of earthwork [m3, denominator 10,000 missing in table, see text for figures]

| Item                                     |                                        |         | Excavation           |                    | Fill           |                    |
|------------------------------------------|----------------------------------------|---------|----------------------|--------------------|----------------|--------------------|
|                                          |                                        |         | Amount of excavation | Surface humus soil | Amount of fill | Surface humus soil |
| Plant area                               | Site leveling                          | ①       | 8.61                 | 0.62               | 8.46           | 0.62               |
|                                          |                                        | ②       | 28.26                | 1.85               | 27.66          | 1.85               |
|                                          |                                        | ③       | 19.52                | 1.44               | 19.04          | 1.44               |
|                                          |                                        | ④       | 1.48                 | 0.79               | 19.05          | 0.79               |
|                                          |                                        | ⑤       | 55.91                | 7.01               | 147.09         | 7.01               |
|                                          |                                        | ⑥       | 230.95               | 8.46               | 143.24         | 8.46               |
|                                          |                                        | ⑦       | 20.23                | 1.79               | 5.17           | 1.79               |
|                                          |                                        | ⑧       | 69.91                | 3.81               | 68.67          | 3.81               |
|                                          |                                        | ⑨       | 4.15                 | 0.63               | 3.91           | 0.63               |
|                                          | Basic earthwork of building foundation |         | 14.57                | 0.00               | 11.30          |                    |
| Drainage pipeline area outside the plant |                                        | 0.700   | 0.125                | 0.700              | 0.13           |                    |
| Total                                    |                                        | 454.290 | 26.525               | 454.290            | 26.525         |                    |

## 16.3 Prevention and treatment scheme of soil and water loss

### 16.3.1 Prevention and treatment objectives of soil and water loss

The prevention and treatment objectives of soil and water loss soil and water loss are shown in table 16.3-1.

Table 16.3-1 Table of prevention and treatment objectives

| No. | Item                                        | Restoration ratio of disturbed farmland (%) | Control ratio of soil and water loss (%) | Control ratio of soil erosion | Retaining ratio of discarded earth and stone (%) | Restoration ratio of destroyed vegetation (%) | Coverage degree of forestry and grass (%) |
|-----|---------------------------------------------|---------------------------------------------|------------------------------------------|-------------------------------|--------------------------------------------------|-----------------------------------------------|-------------------------------------------|
| 1   | Construction area in plant area             | 96                                          | 89                                       | 1.0                           | 96                                               | 95                                            | 15                                        |
| 2   | Living area for construction and production | 93                                          | 85                                       | 1.0                           | 96                                               | /                                             | /                                         |
| 3   | Road area in the plant                      | 93                                          | 85                                       | 1.0                           | 96                                               | /                                             | /                                         |
| 4   | Drainage pipeline area outside the plant    | 97                                          | 96                                       | 1.0                           | 96                                               | 99                                            | 40                                        |
| 5   | Temporary soil piling area                  | 96                                          | 90                                       | 1.0                           | 96                                               | /                                             | /                                         |
|     | Total                                       | 95                                          | 87                                       | 1.0                           | 96                                               | 95                                            | 15                                        |

### 16.3.2 Scope of responsibility for prevention and treatment of soil and water loss

The Scope of responsibility for prevention and treatment of soil and water loss soil and water loss is shown in table 16.3-2. The included direct influence area and indirect influence area are 213.56 hm<sup>2</sup> totally.

The direct influence area includes construction area in plant area, living area for construction, roads in the plant and drainage pipelines outside the plant and is 198.9 hm<sup>2</sup> totally. The indirect influence area includes emplacement area for clearance, modification area for special facilities, surrounding area in the plant and the surrounding of drainage pipeline, and is 14.66 hm<sup>2</sup> totally.

Table 16.3-2 Scope of responsibility for water and soil conservation Unit: hm<sup>2</sup>

| Sub-zone                         | No.       | Item                                        | Administrative region             | Total  | Paddy field | Upland field | Forest land | Water pool | Construction land | Wild grass ground | Naked land |
|----------------------------------|-----------|---------------------------------------------|-----------------------------------|--------|-------------|--------------|-------------|------------|-------------------|-------------------|------------|
| Construction area in the project | 1         | Construction area in plant area             | Tieshan Port<br>Tieshan Port area | 150.56 | 8.32        | 18.97        | 19.88       | 47.69      | 29.66             | 24.83             | 1.21       |
|                                  | 2         | Living area for construction and production |                                   | 13.44  | 2.37        | 5.41         | 5.66        |            |                   |                   |            |
|                                  | 3         | Road area in the plant                      |                                   | 27.00  | 4.77        | 10.86        | 11.37       |            |                   |                   |            |
|                                  | 4         | Drainage pipeline area outside the plant    |                                   | 0.90   |             |              |             |            |                   | 0.90              |            |
|                                  | 5         | Temporary soil piling area                  |                                   | 7.00   | 1.24        | 2.82         | 2.94        |            |                   |                   |            |
|                                  | Total     |                                             |                                   | 198.90 | 16.70       | 38.06        | 39.85       | 47.69      | 29.66             | 25.73             | 1.21       |
| Direct influence area            | 1         | Emplacement area for clearance              |                                   | 6.88   |             | 6.88         |             |            |                   |                   |            |
|                                  | 2         | Modification area for special facilities    |                                   | 5.16   |             | 5.16         |             |            |                   |                   |            |
|                                  | 3         | Surrounding area in the plant               |                                   | 1.42   |             | 0.85         |             |            |                   | 0.57              |            |
|                                  | 4         | Surrounding of drainage pipeline            |                                   | 1.2    |             |              |             |            |                   | 1.2               |            |
|                                  | Sub-total |                                             |                                   | 14.66  |             | 6.01         |             |            |                   | 1.77              |            |
| Total                            |           |                                             |                                   | 213.56 | 16.70       | 44.07        | 39.85       | 47.69      | 29.66             | 27.50             | 1.21       |

## 16.4 Additional measures for water and soil conservation

### 16.4.1 Design of engineering measures

#### 16.4.1.1 Plant area

During construction, the temporary protection measures of the fencing with color steel plates and the covering with fine mesh nets will be taken in the process of earth filling.

#### 16.4.1.2 Living area for construction and production

The temporary drainage facilities will be installed in the living area for construction and production. The drainage ditches will be excavated in its surroundings and the PE film will be laid for leakage prevention. The sand basin will be set at the end of drainage ditches.

#### 16.4.1.3 Road areas in the plant

At both sides of temporary roads, the temporary drainage facilities will be added, the drainage ditches will be excavated and PE film will be laid for leakage prevention.

#### 16.4.1.4 Drainage pipeline area outside the plant

The temporary retaining wall will be constructed with the gunny bags filled with earth, for the temporary retaining of the excavated earth for pipeline.

#### 16.4.1.5 Temporary soil piling site

The temporary retaining wall will be constructed with the gunny bags filled with earth, for the temporary retaining of the piled earth. The temporary drainage ditches shall be constructed to drain the collected water in Temporary soil piling site. The covering with fine mesh nets shall be applied to protect the slope face of temporarily piled filling earth.

### 16.4.2 Design of plant measures

#### 16.4.2.1 Plant area

- (1) In the surrounding of open coal site and dry coal shed, the windbreak forest shall be planted to prevent the loss of coal ashes and powders.
- (2) In the plant, the grass seeds shall be broadcasted in the naked sites of phase II and III, to prevent the soil and water loss in naked lands.
- (3) The creepers shall be planted on the earth-retaining walls in the plant area, to beautify the environment.

#### 16.4.2.2 Drainage pipeline area outside the plant

The grass seeds shall be broadcasted in the naked backfilling sites for the drainage pipeline outside the plant for plant protection.

#### 16.4.2.3 Temporary soil piling site

The grass seeds shall be broadcasted in the temporary soil piling site where the surface humus soil is piled, for plant protection.

## 16.5 Quantity and investment of water and soil conservation

### 16.5.1 Quantity of water and soil conservation

According to the variations in the project, the different measures for water and soil conservation are taken respectively. The quantity of water and soil conservation is shown

in table 16.5-1.

Table 16.5-1 Quantity of additional measures for water and soil conservation

| No. | Name of item                                                | Unit                  | Quantity |
|-----|-------------------------------------------------------------|-----------------------|----------|
| A   | Part I Engineering measures                                 |                       |          |
| (A) | Plant area                                                  |                       |          |
| 1   | Site leveling                                               | hm <sup>2</sup>       | 41.6     |
| 2   | Backfilling the humus soil                                  | 10,000 m <sup>3</sup> | 12.48    |
| (B) | Drainage pipeline area outside the plant                    |                       |          |
| 1   | Site leveling                                               | hm <sup>2</sup>       | 0.45     |
| 2   | Backfilling the humus soil                                  | 10,000 m <sup>3</sup> | 0.13     |
| B   | Part II Plant measures                                      |                       |          |
| (A) | Plant area                                                  |                       |          |
| 1   | Broussonetia papyrifera                                     | Piece                 | 190      |
| 2   | Dogbane                                                     | Piece                 | 480      |
| 3   | Local Chinese ilex                                          | Piece                 | 950      |
| 4   | Broadcasting grass seeds (Bradley Bermudagrass)             | hm <sup>2</sup>       | 41.6     |
| 5   | Creepers                                                    | 10,000 bundles        | 1.24     |
| (B) | Drainage pipeline area outside the plant                    |                       |          |
| 1   | Broadcasting grass seeds (Zoysia matrella)                  | hm <sup>2</sup>       | 0.45     |
| (C) | Temporary soil piling site                                  |                       |          |
| 1   | Broadcasting grass seeds (Crotalaria pallida Ait.)          | hm <sup>2</sup>       | 6        |
| C   | Part III Temporary measures                                 |                       |          |
| (A) | Plant area                                                  |                       |          |
| 1   | Color steel plates                                          | 10,000 m <sup>2</sup> | 0.4      |
| 2   | Fine mesh nets                                              | 10,000 m <sup>2</sup> | 5.1      |
| (B) | Living area for construction and production                 |                       |          |
| 1   | Earth excavation                                            | 10,000 m <sup>3</sup> | 0.39     |
| 2   | PE impermeable film                                         | 10,000 m <sup>2</sup> | 2.77     |
| (C) | Road areas in the plant                                     |                       |          |
| 1   | Earth excavation                                            | 10,000 m <sup>3</sup> | 0.08     |
| 2   | Earth backfilling                                           | 10,000 m <sup>2</sup> | 0.09     |
| 3   | PE impermeable film                                         | 10,000 m <sup>3</sup> | 0.6      |
| (D) | Drainage pipeline area outside the plant                    |                       |          |
| 1   | Temporary retaining walls with gunny bags filled with earth | 10,000 m <sup>3</sup> | 0.05     |
| (E) | Temporary soil piling site                                  |                       |          |
| 1   | Temporary retaining walls with gunny bags filled with earth | 10,000 m <sup>3</sup> | 0.48     |
| 2   | Earth excavation                                            | 10,000 m <sup>3</sup> | 0.08     |
| 3   | Fine mesh nets                                              | 10,000 m <sup>2</sup> | 1.8      |



### 16.5.2 Investment of water and soil conservation

The investment of water and soil conservation in the proposed project is shown in table 16.6-1. The total investment of water and soil conservation in the project is 21,275,700 RMB. Wherein, the listed investment of main works is 12,077,800 RMB and the additional investment is 9,197.900 RMB.

Table 16.5-2 Estimation of investment of water and soil conservation Unit: 10,000 RMB

| No. | Name of item or costs                                            | Additional measure costs                        |                     |                            |                 |                   | Listed investment of main works | Total investment of water and soil conservation |
|-----|------------------------------------------------------------------|-------------------------------------------------|---------------------|----------------------------|-----------------|-------------------|---------------------------------|-------------------------------------------------|
|     |                                                                  | Construction and installation engineering costs | Plant measure costs |                            | Equipment costs | Independent costs | Subtotal investment             |                                                 |
|     |                                                                  |                                                 | Planting costs      | Costs of seedling and seed |                 |                   |                                 |                                                 |
| A   | Part I Engineering measures                                      | ---                                             |                     |                            |                 |                   | ---                             | ---                                             |
| B   | Part II Plant measures                                           |                                                 | ---                 | ---                        |                 |                   | ---                             | ---                                             |
| C   | Part III Temporary construction items                            | ---                                             |                     |                            |                 |                   | ---                             | ---                                             |
| D   | Part IV Independent costs                                        |                                                 |                     |                            |                 | ---               | ---                             | ---                                             |
| E   | Total of Part I-IV                                               | ---                                             | ---                 | ---                        |                 | ---               | ---                             | ---                                             |
| F   | Basic preparation costs (Part I-IV) x6%                          |                                                 |                     |                            |                 |                   | ---                             | ---                                             |
| G   | Compensation costs for facilities of water and soil conservation |                                                 |                     |                            |                 |                   | ---                             | ---                                             |
| H   | Static total investment of water and soil conservation           |                                                 |                     |                            |                 |                   | ---                             | ---                                             |

## 17 Total Emission Control Indices and Regional Reduction Plan of Pollutants

### 17.1 Recommendations on the total emission control indices of pollutants in the project

#### 17.1.1 Recommendations on the total emission control indices of SO<sub>2</sub> atmospheric pollutant

According to the analysis result of the project, the SO<sub>2</sub> emission in the proposed project is 3070t/a; wherein, the part from coal-fired boiler (1597t/a) is classified into the emission index of heat power industry. The rest (1473 t/a) is classified into the non- heat power industry.

#### 17.1.2 Recommendations on the total emission control indices of COD pollutant

According to the analysis result of the project, the COD emission in the project is 3476t/a; the details are shown in table 17.1-1.

Table 17.1-1 Report table of COD emissions in waste-water pollutants

| Phase                 | Output of waste-water | Total emission of COD (t/a) |
|-----------------------|-----------------------|-----------------------------|
| Phase I (2007~2009)   | 76260                 | 2427.8                      |
| Phase II (2009~2010)  | 17678                 | 564                         |
| Phase III (2011~2012) | 15220                 | 484.2                       |
| Total                 | 109158                | 3476                        |

### 17.2 Total emission control indices during 11th Five-year in Beihai

According to the Responsibilities for Total Emission Reduction Targets of Water Pollutants during '11<sup>th</sup> Five-year' and the Responsibilities for Total Emission Reduction Targets of Sulphur Dioxide during '11<sup>th</sup> Five-year' signed by the Autonomous Regional People's Government' and the Beihai People's Government, the total emission target of COD<sub>Cr</sub> is controlled to be 38,000t/a and that of SO<sub>2</sub> is controlled to be 35,100 t/a (wherein, the emission of sulphur dioxide in heat power industry doesn't exceed 7,300t) in Beihai during '11<sup>th</sup> Five-year'.

The total emission control indices of main pollutants issued to Beihai by Guangxi Environmental Protection Bureau are shown in table 17.1-2; wherein, the total emission index of sulphur dioxide issued to Beihai heat power industry is 7,300t, which is specified to be the total emission index for Beihai Power Plant of Beihai Guotou Beibuwan Power Generation Co., Ltd.

The sulphur dioxide emission of power generation boiler in the forest-pulp-paper project is within the index for heat power industry, and the rest is the index for non- heat power industry. According to the project schedule, when phase project I is completed in 2009, the required emission index of sulphur dioxide (non- heat power) is 1473t.

2427.8t COD<sub>Cr</sub> emission index is required till 2009 and 3476t COD<sub>Cr</sub> emission index is required till 2012.

The total emissions approved by the Autonomous Regional People's Government have been distributed. During this period, there are other new projects to be constructed in Beihai. Therefore, the total emission indices for the project shall be obtained by the regional reduction in Beihai city.

Table 17.1-2 Total emission control indices of main pollutants and the distribution in Beihai during '11<sup>th</sup> Five-year' Unit: 10,000t/a

| Factor in total emission control | Total emission control index during '11 <sup>th</sup> Five-year' | Distributed index |
|----------------------------------|------------------------------------------------------------------|-------------------|
| SO <sub>2</sub>                  | 3.51                                                             | 3.51              |
| COD                              | 3.8                                                              | 3.8               |

### 17.3 Solution for total emission indices of pollutants in the project

#### 17.3.1 Solution for total emission index of COD in the project

During the eleventh “five-year-plan” period, in order to ensure the total COD index required by the forest, pulp and paper project, Beihai City has worked out a corresponding emission reduction project and the emission reduction project is the total volume control project during the eleventh “five-year-plan” period and the emission reduction index is effective. Please refer to Table 17.3-1 COD total volume supporting project for Beihai forest, pulp and paper project. It can be seen from the table that the volume of COD emission reduction is 4575t/a, where 3476t/a is allocated for Stora Enso Forest, Pulp and Paper project and it can completely meet the requirement of phase I project of the forest, pulp and paper project 2427.8t/a (during eleventh “five-year-plan” period) and the total requirement of the project 3476t/a (including COD 1048.2t that will be required after the phase II and phase III projects are completed during in twelfth “five-year-plan” period).

Table 17.3-1 Overview of Supporting Projects (Emission Reductions) for Total Emission of COD in the Forest-pulp-paper Project in Beihai

| Name of emission reduction project                     | Control level of the enterprise | Production scale                                                     | Emission reduction project        | 2006 environment statistics COD emission volume (t) | COD emission reduction target (t/a) | COD emission reduction volume (t/a) | COD (t) emission reduction should be completed before the forest, pulp and paper project construction starts | Construction contents of emission reduction project                                                                                                                            | Adopted fuel          | Actual COD emission volume (t/a) after emission reduction | Date of control project completion          | Date of closing         | Remark                                                                                                                                                                           |
|--------------------------------------------------------|---------------------------------|----------------------------------------------------------------------|-----------------------------------|-----------------------------------------------------|-------------------------------------|-------------------------------------|--------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------------------------------------------------|---------------------------------------------|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Beihai Sugar branch of Guangxi Huajing Group Co., Ltd. | State controlled                | Sugarcane squeezed per day 5000t and alcohol produced per year 6000t | Sugar waste water control project | 1821                                                | 126                                 | 1695                                | 1695                                                                                                         | No wash filter cloth vacuum filtration, cooling water circulation for use, clean and hazy split-flow pipe network, bio-chemical treatment of waste water from sugar production | Fuel coal and bagasse | 103                                                       | It was put into operation in November 2006. |                         | The sugar waste water control project successfully passed the acceptance inspection conducted by the Environmental Protection Bureau of Guangxi Autonomous Region in March 2007. |
|                                                        |                                 |                                                                      | Closing alcohol production line   | 2880                                                | 0                                   | 2880                                | 2880                                                                                                         | Closing                                                                                                                                                                        | Fuel coal and bagasse | 0                                                         |                                             | Closed in November 2006 | Circular of Beihai City People's Government on closing the alcohol production line of Beihai Sugar Branch of Guangxi Hauling Group co., Ltd. (BZH [2006] No. 142                 |
| Total                                                  |                                 |                                                                      |                                   | 4702                                                | 126                                 | 4575                                | 4575                                                                                                         |                                                                                                                                                                                |                       |                                                           |                                             |                         |                                                                                                                                                                                  |

### 17.3.2 Solution for total emission index of sulphur dioxide in the project

The Environmental Protection Bureau of Guangxi Zhuang Autonomous Region has worked out a total SO<sub>2</sub> volume supporting emission reduction plan for the total SO<sub>2</sub> volume index required for the forest, pulp and paper project. The emission reduction project is a total volume control project during the eleventh “five-year-plan” period and the emission reduction index is effective. Please refer to Table 17.3-2 and Table 17.3-3 Beihai City forest, pulp and paper project total SO<sub>2</sub> volume supporting project (total volume index adjustment project). It can be seen from the tables that the thermal power unit of Don shun Thermal Power Plant of Baise Power Co., Ltd. will be closed, the thermal power unit of Hezhou Babu Water Conservancy Electric Power co., Ltd. is closed and 1732.5t/a thermal power index can be transferred for other uses. 1597t/a of that will be allocated to Stora Enso forest, pulp and paper project to meet the requirement of total SO<sub>2</sub> thermal power industry index. 1700t/a SO<sub>2</sub> emission will be reduced via bagasse replacing fuel coal as the fuel for Xincheng Sugar Mill of Laibing City Xincheng Sugar Co., Ltd. and 1472t/a of that will be allocated to Stora Enso forest, pulp and paper project to meet the requirement of total SO<sub>2</sub> thermal power industry index. It can be seen that the total SO<sub>2</sub> index from the supporting emission reduction projects can completely meet the requirement of thermal power index and non-thermal-power index required for sulfur dioxide emission of the forest, pulp and paper project.

Table 17.3-2 Total SO<sub>2</sub> volume supporting projects of Stora Enso forest, pulp and paper project (thermal power part)

| Name of project                                                                                               | Contents to close |                              | Basis for closing                                                                                                                                                                                                                                  | Date of closing              | If it has been listed in the list of the Development & Reform Commission | Emission amount of environmental statistics  |       | If it is taken into environmental statistics data |
|---------------------------------------------------------------------------------------------------------------|-------------------|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|--------------------------------------------------------------------------|----------------------------------------------|-------|---------------------------------------------------|
|                                                                                                               | Unit number       | Installed capacity (10000kw) |                                                                                                                                                                                                                                                    |                              |                                                                          | 2005                                         | 2006  |                                                   |
| The thermal power unit of the Dongshun Thermal Power Plant of Baise Electric Power Co., Ltd. has been closed. | 1 #               | 1.2                          | “The letter of the people's government of Guangxi Zhuang autonomous Region about the implementation solution of building large thermal power project rather than small ones in Guangxi for energy saving and emission reduction” GZH [2007] No. 54 | It is closed in Jan. 2007.   | Yes                                                                      | 4126                                         | 3435  | Yes                                               |
| Hezhou Babu Water Conservancy Electric Power Co., Ltd.                                                        | 1 #               | 2.5                          | “The letter of the people's government of Guangxi Zhuang autonomous Region about the implementation solution of building large thermal power project rather than small ones in Guangxi for energy saving and emission reduction” GZH [2007] No. 54 | It is closed in April. 2007. | Yes                                                                      | 1963                                         | 347.8 | Yes                                               |
| Unit operation situation in 2006                                                                              |                   |                              |                                                                                                                                                                                                                                                    |                              |                                                                          | Sulfur dioxide reduction after closing (t/a) |       | Accomplishment value                              |
| Generated energy (100 million kwh)                                                                            |                   | Generated sulfur dioxide (t) | Quantity of fuel coal (10000t/a)                                                                                                                                                                                                                   |                              | Sulfur content of fuel coal (%)                                          |                                              |       |                                                   |
| 0.71                                                                                                          |                   | 3435                         | 11.3                                                                                                                                                                                                                                               |                              | 1.9                                                                      | 3435                                         |       | 495                                               |
| 0.27                                                                                                          |                   | 174.5                        | 2.85                                                                                                                                                                                                                                               |                              | 0.93                                                                     | 174.5                                        |       | 1237.5                                            |
| 合计                                                                                                            |                   |                              |                                                                                                                                                                                                                                                    |                              |                                                                          |                                              |       | 1732.5                                            |

Table 17.3-3 Total SO<sub>2</sub> volume supporting projects of Stora Enso forest, pulp and paper project (non-thermal-power part)

| Name of project                                                                                                 | Production scale of enterprise                                             | Contents and progress of the project                                                                                                                                                                                                             | Emission amount of environmental statistics          |      |
|-----------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|------|
|                                                                                                                 |                                                                            |                                                                                                                                                                                                                                                  | 2005                                                 | 2006 |
| Bagasse replacing fuel coal as the fuel for Xincheng Sugar Mill of Laibing City Xincheng Nanhua Sugar Co., Ltd. | Squeezing sugarcane 3000t per day (Bagasse produced per day is about 730t) | Bagasse is used for replacing fuel coal originally used by the three boilers (totally 90t/h) of the electric power workshop. The project was completed and accepted at the end of 2006 and the 3 boilers combust about 525t bagasse per day now. | 1600                                                 | 1700 |
| Operation situation of the unit in 2006                                                                         |                                                                            |                                                                                                                                                                                                                                                  | Reduced sulfur dioxide emission of the project (t/a) |      |
| Quantity of fuel coal (10000 t/a)                                                                               | 量 Sulfur content of fuel coal (%)                                          | Generated sulfur dioxide (t)                                                                                                                                                                                                                     |                                                      |      |
| 2.99                                                                                                            | 3                                                                          | 1700                                                                                                                                                                                                                                             | 1700                                                 |      |

## 17.4 Summary

The non-thermal-power index 1473t/a and the thermal power index 1597t/a required by Stora Enso Project are resolved by the Autonomous Region via emission reduction projects. Please see Appendix 5 for details.

The COD<sub>Cr</sub> emission index 3476t/a required by the project is resolved by Beihai City via allocating the emission reduction of current projects. Please see appendix 6 for details.

## **18 Analysis on the Rationalization of Planning and Layout, Plant Site Selection and General Plan Layout**

### **18.1 Analysis on the consistency with related planning**

The evaluation will analyze the consistency of the project with related planning in two levels of regional development and general urban planning.

#### **18.1.1 Analysis on the consistency with regional development planning**

Since 1999, the national government started to implement the strategy of the development of the western regions. Guangxi is one of the western provinces and faces the new challenges for development. The People's Government of Guangxi Zhuang Autonomous Region makes the strategic arrangement to develop the coastal industries, for promoting the industrialization progress in Guangxi.

The Beihai city, Qinzhou city and Fangchenggang city are specified to be the coastal industrial cities in the Development Planning of Guangxi Industrialization and the Outline of General Development Planning of Guangxi South-North Qin-Fang Economic Zone issued and implemented in 2000, and it is selected to locate the large coastal industrial base of Guangxi in the coastal area in Tieshan Port area.

The Guangxi Government proposes the concept of regional economic co-operation pattern of China-ASEAN 'One-pole and Two-wing'. The so-called 'One-pole and Two-wing' consists of two areas of Pan-Beibuwan Economic Co-operation Zone and Great Mekong River Sub-region and one pole of Nanning-Singapore Economic Corridor in the layout. They form an 'M'-shape pattern of 'One-pole and Two-wing'. There are marine economic co-operation, mainland economic co-operation and Mekong sub-region co-operation in its contents.

Guangxi is the only region connecting China and ASEAN in both land and sea. And meanwhile, it is adjacent to the economically advanced Pearl River Delta Area and Hong Kong and Macao area. It is an important integral part in the development of the western regions. With the faster construction progress of China and ASEAN Free Trade Area, especially after Nanning, capital of Guangxi Region, became the permanent host place of China-East Expo, Guangxi is becoming an important intersecting point for multi-regional co-operation.

"The development planning for the North Bay Economic Zone in Guangxi" approved by the State Council in 2008 for implementation has planned that Tieshan Port Industrial Zone is mainly to develop energy industry, chemical industry, forest, pulp and paper industry, container manufacture, port machinery and marine industry as well as other supporting or related industries.

In aspect of overall industry arrangement, "The development planning for the North Bay

Economic Zone in Guangxi” clarifies that North bay Economic Zone should critically develop coastal petrochemical project, coastal steel & iron base, coastal forest, pulp and paper base, Nanning aluminum processing base, Nanning fine chemical base, high-tech industrial bases such as Beihai and Nanning electronic and information, biological pharmacy, new material, software development, computer, and telecommunication, etc., coastal marine industry base, coastal and Nanning light industry and food industry base, Nanning heavy machinery and equipment manufacture project and major energy saving and emission reduction technology popularization projects.

The superiority of suitable for fast-growing plantation should be utilized to construct large forest, pulp and paper bases in Qingzhou and Tieshan Port for producing high and medium paper series product and developing integrated forest, pulp and paper industry and forming integrated coastal industrial group of forest, pulp and paper.

The North Bay Economic Zone is located at the top end of North Bay in China, with is the binding site of South China economic ring, Southwest China economic ring and ASEAN economic ring. The North Bay Economic Zone is the only coastal area of the West China development area in China with both marine channel to ASEAN countries and land contiguous to ASEAN countries. The location superiority is remarkable, the strategic position is critical, natural resources are abundant and development potential is huge. Beihai city is the forward area of North Bay Economic Zone and Beihai City Guangxi is selected as the site for the project. The overall arrangement complies with the development strategy of the country for West china development and the strategic planning of coastal industry development in “The development planning for the North Bay Economic Zone in Guangxi”.

### **18.1.2 Analysis on the consistency with general urban planning**

#### **18.1.2.1 General urban planning of Beihai city**

In the General Urban Planning of Beihai City, the whole city is divided into four economic zones.

Core economic zone: includes the urban area and Lianzhou Town. It takes the fast development of main city area, Tieshan Port area and Lianzhou city area as the core. The functions of center city will be developed in a priority. The relationship between the protection and development of individual towns will be coordinated.

The general layout of core city area consists of main city area and two auxiliary city areas of Tieshan Port and Lianzhou Town in the General Urban Planning of Beihai City.

The Tieshan Port area is the auxiliary city area in Beihai and is one of the sub-centers in center city area in Beihai. It is within the core economic zone of Beihai city. Its city feature is identified to take the port as the core, and develop the entrepot trade, coastal heavy chemical industry and energy industry, etc.

It is proposed in the General Urban Planning of Beihai City that the high-tech industry will be the guide in Tieshan Port area and it will be constructed to be the large coastal industrial base in Beihai city and the port base of marine channel in South-west China.

The project is located in Tieshan Port, and in the core part of general planning for urban



construction in Beihai city. In the Tieshan Port, the opportunity of introducing the Stora Enso (Guangxi) Pulp-and-Paper Co., Ltd. will be caught to focus on developing the large-scale coastal industry and sufficiently utilize the core effect of the construction of industrial base. It will have an important effect on the implementation of development strategy in Beihai city. Macroscopically speaking, it conforms to the strategy for the urban construction and development in Beihai.

#### **18.1.2.2 Zoning planning of Tieshan Port area in Beihai city**

The feature of Tieshan Port area is that it is one of the auxiliary city areas in Beihai city; it takes the port as the core, and develops the functional zones for coastal heavy chemical industry, energy industry, port trade and etc.

The planned zone is an integrated zone which has the dominated industrial production and storage with the administration, living and residence, commerce, port transportation and processing.

Layout of functional zones:

- (1) According to the current development conditions in the city and recent development rules in port area, the planned zone is divided into administration and living residence zone, Xinggang living service zone, industrial zone and dock zone.
- (2) The administration and living residence zone is the developing zone with the original port area administration center as its core to the north of Class I Beitie highroad.
- (3) Xinggang living service zone is located in the east-south corner of intersecting point between Class I Beitie highroad and planned railway line.
- (4) Industrial zone is the area in the south of Class I Beitie highroad and in the north of the railway in the east-west direction.
- (5) Dock zone is the coastal zone along the shore.

The project address is selected in the land of 'forest-pulp-paper integration' in the zoning planning of Tieshan Port area (see the General Plan of Beihai Tieshan Port Area Zoning). It conforms to the functional location of zoning in Tieshan Port and the layout requirement of functional area.

#### **18.1.3 Analysis on the consistency with '11<sup>th</sup> Five-year' Planning for Industry Development of Guangxi**

The project conforms to the following requirements in the '11<sup>th</sup> Five-year' Planning for Industry Development of Guangxi:

##### **(1) Critically developed industries**

The industries such as non-ferrous metal, automobile machinery, petrochemical, steel, iron and manganese industry, electric power industry, sugar and food industry, agricultural product processing and high-tech, etc. should be critically developed at present and in a period of time in near future and the industries such as forest, pulp and paper (integrated), cement and building material, modern Chinese medicine and biological mass, etc. should be cultivated with energetic support and marine industry should be positively developed. A group of pillar industries with outstanding superiority, comparatively large scale and strong market competitive strength should be successfully cultivated at the end of the eleventh "five-year-plan" period. Industrial colonies should be developed, deep processing should be promoted, industrial chain should be prolonged, industrial supporting capability should

be strengthened to form a group of superior industries and promote industrial vitalization.

## (2) Layout structure adjustment

The steps of “two retreats and three advances” in old urban areas of central cities should be sped up, the centralization of industries into industrial zones in cities should be promoted, major industrial projects arrangement and construction in coastal areas should be accelerated, the coastal heavy chemical industry layout should be perfected, superior resource development and deep processing projects should be arranged and constructed in resource enriched places to form scale production bases; characteristic and superior industries should be developed in major cities and towns along major lines of communication to quickly form economic belt; local superiorities should play their functions in multi-area cooperation to promote centralized industrial areas with characteristics in various places.

## (3) Optimizing development areas

The industrial layout, major project layout and the superiorities of various places should be organically combined according to location, traffic, market and industrial division and cooperation requirements. We will try hard to strengthen the industrial and economic belt with Nanning – Laibing – Liuzhou – Guilin and the central axis and **accelerate** building of an industrial zone with Beihai, Qinzhou, Fangchenggang, Nanning and Chongzuo as well as Hezhou, Wuzhou, Yulin, Guigang, Liuzhou, Hechi and Baise as the two corridors to form a new industrial development pattern of “one axis and two corridors”.

## (4) Development target of forest, pulp and paper integration

Guangxi will strengthen the joint investment and cooperation with large paper **corporations** in China and abroad, speed up the construction of fast-growing and high-yield raw material plantation base, build modern pulping and paper making enterprises, quickly expand the scale of paper making industry and optimize product structure. In 2010, the newly built fast-growing and high-yield raw material plantation (including bamboo) base will be 10 million mu, the output of pulp will be 4 million tons, where 2.50 million tons will be wood pulp, 700000t will be bamboo pulp and 800000t will be bagasse pulp. The output of paper and paper board will be 4.50 million tons, where high grade paper and the related products will be 2.80 million tons, bagasse paper will be 1 million tons and waste paper utilization and miscellaneous will be 700000t. The forest, pulp and paper industry will achieve an annual sales income of more than CNY 30 billion, the industrial added value will be more than CNY 12 billion and the increased directly employed will be 22000.

When layout is conducted, forest resources, water resources, environmental capacity, traffic and transportation and supporting conditions should be taken into consideration and planned as a whole.. The areas in Guangxi in which large pulp and paper projects are **suitable** to construct are mainly coastal areas such as Liuzhou, Wuzhou and Hezhou, etc. The 900000t/a pulp and 900000t/a paper and paper board project of Stora Enso (Guangxi) Forest, Pulp and Paper Co., Ltd. has been listed as a major project in “The eleventh ‘five-year-plan’ for critical industry development in Guangxi”.

Guangxi will be constructed into an important integrated forest, pulp and paper base in China in 2020.

### 18.1.4 Analysis on the consistency with industrial development planning

#### 18.1.4.1 Analysis on the consistency with the national forest-paper integration planning

The National Development and Reform Commission issued the Tenth-Five-Year and 2010 Special Plan of National Forest-Paper Integrated Engineering Construction, Document No.[2004]9 of Development and Reform Industry.

The Stora Enso (Guangxi) Pulp-and-Paper Co., Ltd. is jointly founded by the Stora Enso Pulp-and-Paper (Asia) Co., Ltd. and Guangxi Gaofeng Forest & Pulp-paper (Group) Co., Ltd. and is a joint venture. It conforms to the policy and measure for 'To sufficiently utilize the two domestic and foreign money markets and raise the funds in various ways, the national government encourages the domestic enterprises with various systems of ownership and foreign companies to invest in the construction of forest- paper integration projects.'

The Stora Enso (Guangxi) Pulp-and-Paper Co., Ltd. has a production capacity of 900,000t pulp and 900,000t paper and paperboards, conforming to the following requirements in the Tenth-Five-Year and 2010 Special Plan of National Forest-Paper Integrated Engineering Construction:

(1)The starting scale shall be outstood in new projects. The starting scale shall be: a single chemical wood pulp production line generally shall have the 500,000t and more annual capacity; a single chemical bamboo pulp production line generally shall have the 100,000t and more annual capacity; a single chemimechanical wood pulp production line generally shall have the 100,000t and more annual capacity; a single paper-making production line generally shall have the 100,000t and more annual capacity;

(2)The national construction layout of forest-paper integration projects focuses on the development in east-south coastal areas, mostly including Guangdong, Guangxi, Hainan and Fujian. While the construction of present medium- and large-scale forest-paper integration projects of leading enterprises is well handled, it is planned to construct 3-4 large-scale forest-paper integration chemical wood pulp projects with 500,000t and more annual capacity in Guangdong, Guangxi, Hainan and Fujian.

(3) In 2000 – 2010, it is planned to construct the 1,800,000 hm<sup>2</sup> forestation base (1,500,000 hm<sup>2</sup> wood base; 300,000 hm<sup>2</sup> bamboo base); wherein, during '10<sup>th</sup> Five-year', 720, 000 hm<sup>2</sup> forestation base will be constructed; during '11<sup>th</sup> Five-year', 1,080,000 hm<sup>2</sup> forestation base will be constructed. It is planned to establish the pulping production capacity of 3,310,000t; wherein, 2,600,000t for wood pulp; 710,000t for bamboo pulp.

(4) After 2010, when all bases come into rotation, more than 19,000,000m<sup>3</sup> woods and 6,750,000t bamboo can be produced annually. Depending on the raw materials supplied by the bases, more than 6,300,000t pulping production capacity can be established; wherein, the wood pulp production capacity is 4,300,000t and bamboo pulp production capacity is 2,000,000t. About 6,500,000t supporting paper-making production capacity can be constructed.

#### 18.1.4.2 Planning for forest-pulp-paper integration in Guangxi

The production capacity of the Stora Enso (Guangxi) Pulp-and-Paper Co., Ltd. is 900,000t pulp and 900,000t paper and paperboards, conforming to the following requirements in the Overall Plan for the Development of Forestry-pulp-paper Integration Industry of Guangxi from 2005 to 2015 issued by the Development and Reform Commission of Guangxi Zhuang Autonomous Region:

(1) Guangxi Zhuang Autonomous Region is the important region for the construction of forest-pulp-paper integration projects in China. The forest-pulp-paper integration industry is the industry with the advantages of resource and geographic location in Guangxi. The CPP Committee and Government of Guangxi Zhuang Autonomous Region decides to develop and strengthen the forest-pulp-paper integration industry to establish the new pillar industry in the Region.

(2) Objectives of pulping and paper-making: based on about 400,000t pulping production capacity established in the Region in 2005, it is planned to additionally establish 2,800,000t pulping capacity during '11th Five-year', achieving about 4,000,000t pulping capacity in the Region by the end of '11th Five-year'; wherein, 2,500,000t for wood pulp, 700,000t for bamboo pulp, and 800,000t for bagasse pulp; it is planned to achieve 6,000,000t pulping capacity in the Region in 2015; wherein, 4,000,000t for wood pulp and 1,000,000t for bamboo pulp.

(3) Objectives for paper-making: the output of paper and paperboards is about 1,200,000t in Guangxi in 2005. Based on it, it will be developed to 4,500,000t by the end of '11th Five-year'; wherein, 2,800,000t high-grade paper and its articles will be produced; it is planned to produce 6,000,000t paper and paperboards annually in 2015; wherein, 4,500,000t high-grade paper will be produced.

(4) Establish two coastal large-scale pulping projects in Qinzhou and Beihai as soon as possible. It shall be tried to establish the project of Guangxi Jingui Pulp & Paper Co., Ltd. (joint venture) for annual capacity of 300,000t pulping, 600,000t paper and 250,000t liquid package paper before 2008, to establish the joint venture (co-operation) project for 900,000t pulp and 900,000t paper annually in Beihai before 2010. If the conditions are proper, the phase project II can be constructed in Qinzhou and Beihai.

#### **18.1.5 Analysis on the consistency with '11<sup>th</sup> Five-year' planning for environmental protection in Beihai**

The general target of '11<sup>th</sup> Five-year' planning for environmental protection in Beihai requires that in 2000, the environmental pollution shall be basically controlled, the ecological damage shall be suppressed preliminarily, the environment quality shall be improved, the ecological function of ecological protection areas and natural protection areas shall be basically stable, and various functional zones shall meet the corresponding standards on environment quality. In the whole city, the water quality of centralized drinking water source shall meet the standard basically and the air quality shall meet environment standards classified in atmospheric environment functional zones in Beihai, paving a solid basis for continuous development of economy, positive circulation of ecological environment, and cleanliness and elegance of urban and country environments,

The construction of forest bases in the project is within the land planned for the forestry. It is constructed according to the classification of the land. It is not located in the same land with the protection areas and ecological functional areas classified by the environmental protection planning measures and it has a certain protection distance away from these sensitive areas. According to the prediction results, after the project is put into operation, the emissions of waste-water, waste gases and noises will have a insignificant effect on

the environment quality in evaluated area, and the corresponding requirements of environment quality will be basically met. Therefore, the project is basically consistent with the general target of '11<sup>th</sup> Five-year' planning for environmental protection in Beihai.

#### **18.1.6 Analysis on the consistency with the environment functional zoning**

##### **(1) Environment functional zoning in Beihai**

The Beihai Environmental Protection Bureau prepares the Atmospheric Environment Functional Zoning in Beihai, the Water Environment Functional Zoning in Beihai and the Noise Environment Functional Zoning in Beihai. Their scopes are only applicable to the main city areas of Beihai city, not including the Tieshan Port Industrial Zone.

At present, no environment functional zoning is made in Tieshan Port Industrial Zone. However, the Tieshan Port sub-region is planned to be the port and industry centralized zone. One of its locations is to construct large-scale wood pulp and paper-making industry. The project is located in the industrial zone and in the land planned for forest-pulp-paper integration. Therefore, the project won't cause the conflict with the local environment functional zoning.

##### **(2) Environment functional zoning in offshore sea area in Guangxi**

In the environment functional zoning in offshore sea area in Guangxi, Class I-IV functional zones are set in the environment functional zoning for Tieshan Port and the hybrid pollution discharge area is specially delimited.

The industrial waste-water in the project is discharged into deep sea. The discharge outlet is located in the Tieshan Port hybrid pollution discharge area, conforming to the requirement in the environment functional zoning in offshore sea area in Guangxi.

#### **18.1.7 Analysis on the consistency with the construction planning of ecological province in Guangxi**

The outline of construction planning of ecological province (area) shall specify the ecological and economic function location of individual areas according to the geographic location features, natural resources, environmental conditions and bearing capacity, economic and social development conditions and the development potential of individual areas. It shall specify the main directions of their protection and development according to the layout requirements of functions for optimized development, centralized development, limited development and prohibited development, to form the regional development pattern with the individual features and coordinated relationship among economy, society and population, resource and environment. In the basis of ecological functional zoning in the Region, the whole region is divided into eight ecological zones: East-north of Guangxi mountain and hill ecological zone, Middle Guangxi karst basin ecological zone, West Guangxi mountain ecological zone, East-south of Guangxi hill ecological zone, South Guangxi bench terrace ecological zone, South-west of Guangxi karst and mountain ecological zone, Middle-northern Guangxi karst mountain ecological zone and offshore marine ecological zone.

The raw material forest bases of the project to construct are mainly laid out in the ecosphere in Southeast Guangxi and basically no forest base is configured in karst

ecosphere; therefore, it is basically coordinated with the ecological construction planning. There are mainly hills in the ecosystem in Southeast Guangxi and the bases are laid out in planned forest lands so there is no conflict with the ecologically protected areas.

The superiority of coastal location of Tieshan Port Industrial Zone where the production base of the project to construct is located is remarkable, the coastline is long, the port conditions are very good, the bearing capability of the resource environment is strong, the economic and population collecting conditions are excellent and it has been listed as key development areas in "Ecological Guangxi construction planning outline (2006 – 2025)".

It is required in "Ecological Guangxi construction planning outline (2006 – 2025)" that the area should be critically developed under protection. While industrialization and urbanization are promoted and economic strength is enhanced, total amount of discharged pollutants must be strictly controlled to achieve that when production is increased, pollution is not increased. Modern heavy chemical industry should be developed utilizing coastal superiorities in terms of industrial development.

Therefore, the construction of this project complies with the ecological Guangxi construction planning outline.

## **18.2 Analysis on the rationalization of address selection of the project**

The address of the project is located in Tieshan Port area in Beihai. The evaluation will discuss the rationalization of address selection of the project in the two aspects: the plant construction conditions (including traffic and basic facilities) and environmental factors.

### **18.2.1 Analysis on the rationalization of traffic layout**

Advantage of port resource in Beihai: the Beihai Port includes the Beihai old port area, Shibuling port area, Tieshan Port area and Dafengjiang port area. All national coastal cities and South-east Asia countries can be directly reached; the port resource in Beihai is very adequate and a lot of port berths with different styles can be constructed. The recent construction is mostly located in Shibuling port area and Tieshan Port area. The Tieshan Port area where the project is located has two constructed 100,000t level berth at present. The port area has the deep water, gentle wave and long shoreline. It has a good condition for port construction. From the trench at bay-mouth into the bay, the water area with the natural depth of water above 5m is 217,000m<sup>2</sup>; wherein, the one with the natural depth of water above 10m is 9,000m<sup>2</sup>. A large-scale deepwater harbor can be constructed.

The conditions of highroad, aviation, railway transportation in Beihai are convenient. The plant address is 30km away from the Chongqing-Zhanjiang speedway. The Tieshan Port Hepu-Hechun railway section directly reaches the Tieshan Port area and is connected to Xiang-Qian Line, Xiang-Gui Line, Nan-Kun Line, Yue-Gui Line, forming the railway network going to the whole nation.

In a word, the marine, land and air traffic conditions in Beihai are convenient and the advantage of geographic location is very significant. It is suitable for the construction of large-scale coastal industry

### 18.2.2 Analysis on the rationalization of construction land of the project

In the plant area, most part is the surface feature with gentle hill. The level of landform is between 10m and 20m, and the area is open. The most part of ground surface is covered with the sandy clay or sand and gravel layer. It has no presence of poor geological signs such as landslide, collapse, solution cavity and etc., and has no passing of regional or active faults, meeting the requirement of construction land of the project.

The fixed assets investment of this project is CNY --- billion, the original planned occupied land is 250,33 hm<sup>2</sup>, the investment strength is CNY 71.768 million/ hm<sup>2</sup>, the volumetric ratio is 0.6 and the building coefficient is 35%. The area of the land required for administration, offices and living facilities is 15hm<sup>2</sup>, occupying 6% of the total land area. The land use index of this project meets the relevant requirement of "Land control index for industrial project construction (proposed)" (please see Table 18. 2-1). Compared with similar large integrated project, pulp and paper project, however, the occupied land of Stora Enso (Guangxi) forest, Pulp and Paper Co., Ltd. project is slightly too great and in view of treasuring and rationally utilizing land as well as protecting cultivated land, this environmental assessment suggests that the land be controlled within 200hm<sup>2</sup>.

**Table 18.2-1 Comparison of control indexes of land for construction**

| Index                                                  | Land control index for industrial project     | Actual index of this               |
|--------------------------------------------------------|-----------------------------------------------|------------------------------------|
| Investment strength                                    | No less than CNY 6.75 million/hm <sup>2</sup> | CNY 71.768 million/hm <sup>2</sup> |
| Volumetric ratio                                       | No less than 0.6                              | 0.6                                |
| Building coefficient                                   | No less than 30%                              | 35%                                |
| Land for administration, offices and living facilities | No less than 7%                               | 6%                                 |

According to the above recommendations of evaluating company, the Stora Enso (Guangxi) Pulp-and-Paper Co., Ltd. has re-adjusted the plan layout of plant area. The area of construction land is reduced to 198hm<sup>2</sup>, with a reduction in the land by 52 hm<sup>2</sup>.

### 18.2.3 Analysis on the rationalization of the infrastructure construction and utilities

According to Beihai City Tieshan Port division planning, the planning and construction situations of the environmental protection infrastructures are as follows:

There is no planned centralized heat supply in the industrial zone, the current fuel gas storage and distribution station of the Beihai Petrochemical Complex is the fuel gas supply in near future and natural gas will be used at a specified future date.

The planned city drainage system is a rain/sewage split-flow drainage system and the expected sewage discharge is 596000t/d. With the railway as a demarcation line, the sewage is divided into two drainage areas, the east and the west, where, the scale of the east area waste sewage treatment plant is 556000t/d, mainly for treating industrial waste water and after two-stage treatment in waste water treatment plant, the waste water is drained into the sea. The scale of the west area sewage treatment plant is 40000t/d, the sewage is lifted in a pump station and sewage treatment is taken into a unified

consideration of planning.

It is required in planning that overall utilization of various solid wastes and resource conservation should be enhanced, the solid wastes should be rationally handled and treated and special treatment facilities for industrial solid wastes should be constructed according to the requirement of industrial development. Non-coal energy should be achieved in living area, non-harmful treatment before the solid wastes are buried should be conducted to prevent and reduce the pollution caused by solid wastes. Within the planned period, the percentage of non-harmful treatment of domestic rubbish should be 100% and the industrial solid waste handling, treatment and overall utilization ratio should be 100%.

A special "industrial solid waste treatment plant" has been planned for Tieshan Port Industrial Zone and according to the principle of centralized treatment, the solid wastes of the project to construct should be sent to the industrial solid waste (common solid waste of class II) treatment plant, which is built according to relevant national standards. As the industrial solid waste treatment plant project of Tieshan Port Industrial Zone has not started yet, it is suggested that the construction be sped up. Before the industrial solid waste treatment plant of Tieshan Port Industrial Zone is put into operation, a bury field for solid waste (common solid waste of class II) should be built according to relevant national standard for handling the solid wastes of the project to construct.

The self-owned thermal power stations of phase I, phase II and phase III projects to construct all comply with the stipulation in JJC [2000] No. 1268 "Stipulations on thermoelectric joint production" issued by the National Development & Planning commission, the National Economic & Trading Commission, the Ministry of Construction and the State Environmental Protection Bureau "for thermoelectric units with an unit capacity below 50 megawatts – 200 megawatts, the annual average thermoelectric ratio should be greater than 50%, the average total heat efficiency of the whole year should be greater than 45%" and "when a single unit capacity of heat supply boiler is 20t/h and above, the heat load annual utilization should be greater than 4000h and when remarkable economic benefit is proved via technical and economic demonstration, it should be transformed into thermoelectric joint production". The production days of the project to construct per year are 354 days, the demand for supplied heat is huge and in case that the centralized heat supply facilities in Tieshan Port area are not perfect, it is difficult to depend on continuous and smooth power supply and heat supply from outside; therefore, the construction of self-owned thermoelectric power stations complies with the stipulation of the National Development & Reform Commission and the Ministry of Construction in FGNY [2007] No. 141 "Interim stipulations on the construction and management of thermoelectric joint production and overall coal gangue utilization power generation project" "that no self-owned thermoelectric power plant of enterprise should be repeatedly planned and constructed within the heat supply scope of existing thermoelectric power plants in principle. It is restricted as the construction of thermoelectric joint production project servicing a single enterprise except large petrochemical, chemical, steel & iron and paper-making enterprises, etc". Therefore, the construction of the thermoelectric units of phase II and phase III projects is absolutely necessary.

As the only coastal urban area with sea, land and air stereoscopic channels and planned construction of large port and port related industries in Guangxi, the infrastructures of



Tieshan Port area are continuously being perfected. The government of Guangxi Autonomous Region has paid close attention to the construction of infrastructures. In the great coastal infrastructure construction battle in Guangxi in 2004, the 8 projects of Tieshan Port area, such as channel dredging project, operation area start project, water supply project for industrial zone and railway branch project of Tieshan Port, etc. were listed in the plan of the autonomous region. As the construction of these projects is going on, the infrastructures of Tieshan Port area will be further improved to provide a very good foundation for the construction of this project. Please see "Overview of society" of this report for concrete contents.

#### **18.2.4 Analysis on the total emission control indices of pollutants**

According to the conclusion of Chapter 17 of this report "Total pollutant volume control indexes and regional reduction plan", Beihai City has no SO<sub>2</sub> emission index during the eleventh "five-year-plan" period; therefore, the non-thermal power index 1473t/a and thermal power index 1597t/a required for the project should be resolved by the autonomous Region via unified allocation and the total volume indexes required for the project have already been resolved. The COD emission index 3476t/a required for the project has been resolved by Beihai City via allocating the emission and discharge reduction of current projects.

#### **18.2.5 Analysis on regional environmental bearing capacity**

##### **18.2.5.1 Environment capacity**

According to the conclusion of Tieshan Port Industrial Zone planning and environmental assessment, the actual allowable regional discharges of sulfur dioxide, nitrogen oxide and chemical oxygen demand are respectively: 34500t/a, 34600t/a and 13500t/a. the regional discharges of sulfur dioxide, nitrogen oxide and chemical oxygen demand are respectively: 3070t/a, 1325t/a and 3476t/a, occupying 8.90%, 3.83% and 26.63% of the actual allowable regional discharges; please see Table 18.2-2. It can be seen from the comparison and analysis of above described economic indexes and pollutant discharges that the shares of actual allowable discharges occupied by sulfur dioxide and nitrogen oxide are comparatively small and are reasonable and although the actual allowable discharge shares occupied by chemical oxygen demand is slightly greater, it is far smaller than the actual regional allowable discharge so the regional environment capacity is able to meet the pollutant discharge requirement of the project to construct.

Table 18.2-2 Analysis on the shares of environment capacity occupied by the discharge of the project to construct (万 10,000 denominator)

| Pollutant                                                                            | Sulfur dioxide | Nitrogen oxide | Chemical oxygen demand |
|--------------------------------------------------------------------------------------|----------------|----------------|------------------------|
| Actual regional allowable discharge                                                  | 3.45 万 t/a     | 3.46 万 t/a     | 1.35 万 t/a             |
| Discharge of the project to construct                                                | 3070t/a        | 1325 t/a       | 3476t/a                |
| Shares of environment capacity occupied by the discharge of the project to construct | 8.90%          | 3.83%          | 26.63%                 |

According to the planning, Tieshan Port Industrial Zone will import a group of major industrial projects by stages in near future, future and forward future, such as forest, pulp and paper, Beihai power plant, --- heavy oil chemical, Tieshan Port polypropylene of --- Company, --- Beihai Refinery new site transformation, etc. Please refer to Table 18.2-3.

Table 18.2-3 Planned industrial projects of Tieshan Port Beihai City in near future, future and forward future

| No. | Name of project                                               | Construction scale                                                                                                                                                                       | Total investment (CNY 100 million) | Planned construction period of time |
|-----|---------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|-------------------------------------|
| 1   | Forest, pulp and paper project                                | Annual out put of 900000t pulp and 900000t paper and paper board                                                                                                                         | ---                                | 2008-2012                           |
| 2   | Beihai Power Plant                                            | Total installed capacity of Phase I and Phase II 1.80 million kw and the 600000 kw unit of Phase I has already been put into operation.                                                  | ---                                | 2008-2010                           |
| 3   | Tieshan Port oil & gas storage project                        | Phase I and Phase II, construction of 726000 m <sup>3</sup> storage tanks and construction of one attached 50000t oil & gas wharf and one 100000t oil & gas wharf respectively.          | ---                                | 2008-2010                           |
| 4   | Beihai Refinery new site petrochemical transformation project | First stage, 200000t/a polypropylene, 3 million t/a crude oil commercial reserve storage and Weizhou island crude oil wharf and pipeline project and later stage, 8 million t/a refinery | ---                                | 2008-2015                           |
| 5   | --- urea made from coal                                       | Annual output of 1.6 million tons urea and 1.5 million tons new building materials                                                                                                       | ---                                | 2008-2012                           |
| 6   | Beihai Tieshan Port equipment manufacture project             | Manufacture of marine engineering equipments, tanked transportation equipment, engineering machinery equipments and container, etc.                                                      | ---                                | 209-2015                            |
| 7   | Tieshan Port heavy oil chemical project                       | 12 million t/a heavy oil chemical                                                                                                                                                        | ---                                |                                     |
| 8   | Beihai Tieshan Port ship repair and ship building             | Construction of repair and building facilities such as 20000-30000t shipyard, etc.                                                                                                       | ---                                | 2008-2010                           |

| No. | Name of project                             | Construction scale                                                                        | Total investment (CNY 100 million) | Planned construction period of time |
|-----|---------------------------------------------|-------------------------------------------------------------------------------------------|------------------------------------|-------------------------------------|
|     | project                                     |                                                                                           |                                    |                                     |
| 9   | Beihai Tieshan Port oceangoing ship project | Construction of <b>repair</b> and building facilities such as 20000-50000t shipyard, etc. | ---                                | 2008-2010                           |
| 10  | Beihai Tieshan Port public wharf            | Annually handling capacity 12 million tons                                                | ---                                | 2007-2010                           |

Please refer to Table 18.2-4 for pollutant discharges of Beihai Power Plant, --- heavy oil chemical and the project to construction (forest, pulp and paper). Please refer to Table 18.2-1 for pollutant allowable discharges in Tieshan Port area given in “Beihai city Tieshan Port large port and industrial base area environment effect report”. It can be seen from the two groups of data that compared with pollutant allowable discharges in Tieshan Port planned area, in the pollutant discharges of some planned industrial projects, sulfur dioxide occupies 44.9% and chemical oxygen occupied 47.4%. Compared with pollutant allowable discharges in Tieshan Port planned area, in the pollutant discharges of the project to construct (forest, pulp and paper), sulfur dioxide occupies 8.9% and chemical oxygen occupied 28.6%. After deducting the checked and ratified pollutant discharges of **industrial projects**, the surplus regional environment capacity can meet the requirement of pollutant discharges of the project to construct (forest, pulp and paper).

Table 18.2-4 Pollutant discharges of some planned industrial projects

| Name of project                               | Sulfur dioxide (t/a) | <b>Chemical</b> oxygen demand (t/a) | Remark               |
|-----------------------------------------------|----------------------|-------------------------------------|----------------------|
| Beihai Power Plant                            | 12000                | 2500                                | Checked and ratified |
| --- heavy oil chemical                        | 426.5                | 41.3                                | Checked and ratified |
| Project to construct (forest, pulp and paper) | 3070                 | 3476                                | Expected             |
| Total                                         | 15496.5              | 6017.3                              |                      |

#### 18.2.5.2 Current situation of environmental quality

According to the current environmental situation investigation and the analysis on historical data, the environmental quality of the assessed region is very good. Please refer to Table 18.2-4 for concrete indexes.

**Table 18.2-4 Current environmental quality situation of assessed region**

| Essential environmental   | The standard grade or index requirement to comply with                                                                                                                                                                                                                            |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Environmental air         | GB3095-1996 "Environmental air quality standard" Grade II standard                                                                                                                                                                                                                |
| Water quality of sea area | GB3097-1997 "Sea water quality standard" corresponding water quality standard                                                                                                                                                                                                     |
| Environmental noise       | GB3096-1993 "Urban area environmental noise standard" Class 3 standard                                                                                                                                                                                                            |
| Underground water         | GB/T14848-93 "Underground water quality standard" Class III standard                                                                                                                                                                                                              |
| Marine organisms          | The sea area chlorophyll a content and water body nutrient salt concentration are far lower than eutrophication level, and the initial productivity is comparatively stable. The species in the assessed sea area are comparatively rich and the diversity is comparatively high. |
| Sea area deposit          | GB18668-2002 "Quality standard for sea deposit" corresponding functional area standard limit value                                                                                                                                                                                |
| Land vegetation           | The structure is simple, artificial vegetation occupies a dominant position, the species diversity is poor, the quantity of resources is not great, the quality is                                                                                                                |
| Land animal               | No <b>wild</b> animal critically protected by the state is discovered within the assessed region.                                                                                                                                                                                 |

#### 18.2.5.1 Environmental quality changing tendency

According to environmental effect prediction result, after the project to construct is put into operation, in normal situation, the environmental quality of the assessed region can maintain the current level. Please refer to Table 18.2-5 for concrete indexes.

**Table 18.2-5 Analysis on the environmental quality changing tendency of the assessed region**

| Essential environmental factor | Changing tendency after the project to construct is put into operation                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Environmental air              | The effect on the air quality at various sensitive points is not great, will not cause down-grading of the air quality of the region. Grade II standard level of GB3095-1996 "Environmental air quality standard" can be maintained.                                                                                                                                                                                                                                                                                |
| Sea area water quality         | The effect of pollutant discharge on sea area water environment is local and no direct effect will be generated on Rugen projected area, Red Forest protected area and Yingpan sea water culture area. Corresponding water quality standard of GB3097-1997 "Sea water quality standard" can be maintained.                                                                                                                                                                                                          |
| Environmental noise            | Class 3 standard of GB3096-1993 "Urban area environmental noise standard" can be maintained.                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Marine ecological situation    | The waste water discharge of the project only affects, to some extent, the species distribution of the phytoplankton and benthos in local sea area near the pollution discharge area, there is no great effect on marine organisms within the assessed sea area and the effect on major environmental protection targets (protected <b>area</b> and culture area) is slight. The stability of the ecological system of the assessed sea area will not be damaged so the project can be accepted by the environment. |
| Land organisms                 | The caused chronic effect on vegetation is not remarkable. The reduction of plant species diversity of the area will not be caused.                                                                                                                                                                                                                                                                                                                                                                                 |

To sum up, the current environmental situation of the assessed area is very good and there is some environmental capacity. After taking strict pollution control measures, the waste water and waste gas discharges of the project to construct are all within the allowable scope of the regional environmental capacity, the effect on environmental quality of the assessed area is comparatively small and the regional environmental quality can be maintained at current level; therefore, the project to construct is within the scope accepted by the regional environmental bearing capacity.

#### **18.2.6 Analysis on the reasonableness of pollution discharge exit**

According to the “Technical report of Tieshan Port industrial base pollution discharge exit layout solution demonstration” (please refer to Appendix 10 for the official and written reply) compiled by Tianjin Hydraulic Transportation Engineering and Science Research Institute under the Ministry of Communications and the Environmental Protection Science Research Institute of Guangxi Zhuang autonomous Region, the pollution discharge exit of the project to construct is configured at B<sub>3</sub> pollution discharge exit. The pollution discharge exit meets following several basic requirements:

- 1) The discharge outlet is set in the planned pollution discharge area in Tieshan Port area, conforming to the requirements in the Marine Functional Zoning in Guangxi and the Environment Functional Zoning of Offshore Sea Area in Guangxi (2007 revised version).
- 2) The hydrodynamic force condition in the surrounding of discharge outlet is favorable for transferring and diffusing the pollutants to the open sea. As shown in the prediction result of effects on water environment and the calculation result of material displacement path, the diffusing of waste-water at the discharge outlet has a very slight effect on the water quality in the adjacent water area.
- 3) As shown in the calculation result, the characteristic of reversing current at the river mouth where the discharge outlet is located is significant. Whichever the rising tide or falling tide is, the material displacement path is in the right side of river mouth, having no effect on the mangrove sanctuary and dugong sanctuary.
- 4) It avoids the present channel and is more than 200m away from the centerline of channel, having no effect on the normal navigation in the channel.

In a word, the address selection of discharge outlet is proper.

#### **18.2.7 Analysis on the bearing capacity of resources**

##### **18.3.7.1 In the aspect of water resource**

At present, the ground water is mostly applied in Tieshan Port area. With the higher development speed and rapid growth of various industries, the population is growing faster. The fresh water resource in the Tieshan Port area is insufficient to meet the requirement for economic development of large-scale port and industrial base in Tieshan Port.

It has been planned recently to utilize the water resource in Hepu reservoir group as the water source for Tieshan Port industrial base. In the long-term plan, the water will be supplied by both Hepu reservoir group and Nanlijiang River, and the shortage of water resource in Tieshan Port will be solved.

It is confirmed according to “The water resource demonstration report of Beihai City Tieshan Port area water supply project” compiled by Guangxi water conservation and

electric power Survey and Design Research institute and GSSZ [2007] No. 40 “Review opinions on the water resource demonstration report of Beihai City Tieshan Port area water supply project of Guangxi coastal industrial zone water supply engineering project” (please refer to Appendix 17):

It is expected that in 2020, the total river bridge floodgate irrigation water consumption downstream of the Nanlijiang River will be 97.84 million  $\text{m}^3/\text{a}$ , the water consumption of human beings and livestock in countryside will be 3.64 million  $\text{m}^3/\text{a}$ , industrial water consumption will be 7.24 million  $\text{m}^3/\text{a}$  and the total irrigation water consumption will be 108.72 million  $\text{m}^3/\text{a}$ . The multi-year average incoming water of Hepu reservoir water source is 1.535 billion  $\text{m}^3$  and the water that can be supplied is 698 million  $\text{m}^3$ . Besides meeting the requirement of agricultural and human beings as well as livestock water consumptions within the irrigation region, it can also meet the requirement of Tieshan Port area Phase I water supply engineering scale 230000 $\text{m}^3/\text{d}$ , annual intake 64.58 million  $\text{m}^3$  and a water consumption guarantee rate of 97%.

The multi-year average incoming water at the cross-section of the upstream dam of Nanliu River is 3.85 billion  $\text{m}^3$ , the incoming water in 95% low-water-level year is 1.97 billion  $\text{m}^3$  and when joint water supply is conducted with Nanliu River and Hepu reservoir, it can meet the requirements of maximum daily water demand of 447000  $\text{m}^3/\text{d}$  of Tieshan Port water supply project in 2020 and the water consumption guarantee rate 97%.

The maximum intake of Nanliu River is 6  $\text{m}^3/\text{s}$ , the average intake is 1.25 $\text{m}^3/\text{s}$ , the multi-year average flow-rate of Nanliu River is 211 $\text{m}^3/\text{s}$ , the intake base flow of Nanliu River is 90%, the average flow-rate in the lowest-water-level month is 13.7  $\text{m}^3/\text{s}$  and when it is less than 13.7  $\text{m}^3/\text{s}$ , no water will be pumped to ensure the ecological water consumption of Nanliu River basin.

#### 18.2.7.2 Forest resource bearing capacity

It is concluded according to “Report on the special subject of ecological environment effect of Stora Enso (Guangxi) Forest, Pulp and Paper Co., Ltd. 900000 $\text{t}/\text{a}$  pulp, 900000 $\text{t}/\text{a}$  paper and paper board project and 160000 $\text{hm}^2$  raw material forest project” compiled by China Environmental Science Research Institute that:

The scale of the designed pulp raw material forest base of the project is 160000  $\text{hm}^2$ , it is planned to be laid out in 8 state-owned forestry centers under Guangxi Gaofeng Group and 15 counties of 4 cities such as Beihai, Fangchenggang, Yulin and Chongzuo, etc. Forest land subcompartment statistics indicate that the current forest land area complying with environmental protection requirements and looked after by the workers is 135800  $\text{hm}^2$ , occupying 84.9% of the planned forestry base area.

The kinds of trees selected for this project are eucalyptus and jequirity tree, the planned afforestation will be 123056.0 $\text{hm}^2$ , and tending 36944.0 $\text{hm}^2$  current eucalyptus. The designed regulatory rotation age is 6-7 years, the designed annually average yield is 3.1184 million  $\text{m}^3$  and the project is able to meet the demand for wood of the pulping factory.

This project meets the layout requirement in “The tenth ‘five-year-plan’ and special plan for 2010 on national forest-paper integration project construction”. The forest land construction area and the tree kinds of selection meet the requirements in “Overall planning of key area fast-growing and high-yield forest base construction project”. The currently fixed yield of

selected forest land can meet the production requirement of the pulp factory with economic scale and the requirements of forest-paper integration project construction.

The scope of selected land of this project complies with the land selection range determined in "Several opinions of the People's Government of Guangxi Zhuang Autonomous Region about accelerating the construction of forest, pulp and paper raw material forest base in coastal areas" and there is no problem of competing for land with other forest-paper project.

The construction of the project will increase 12.9 million  $\text{hm}^2$  artificial eucalyptus forest areas, which will increase the eucalyptus planting proportion in the project area by 8.8% and may make the distribution of species in the project area unified.

Unfavorable environmental effects such as reduced organism diversity, soil fertility declination and soil erosion, etc. caused by raw material forest base construction can be avoided via scientific eucalyptus planting and scientific forest culture and management measures.

#### 18.2.7.3 Bearing capacity of land resource

The implementation of the forest-pulp-paper project will occupy 132.7540 $\text{hm}^2$  agriculture lands in Xinggang Town (wherein, the area of dry land is 72.3814 $\text{hm}^2$ , and the area of paddy field is 60.3726 $\text{hm}^2$ ). The area of return construction land for the removal of involved population is 5.1600 $\text{hm}^2$  dry land. It will cause the cultivated land in Xinggang Town to be reduced by total 137.9140 $\text{hm}^2$ . By adjusting the reserved construction land, 3 pieces of cultivated lands (B, C, and D) at Nankang Town have a total area of 69.7802 $\text{hm}^2$ . To ensure the unchanged annual recoverable deposits of cultivated lands in the planned objectives in Tieshan Port area, it is identified that the piece of land E at Sanhekou Village, Fucheng Town, Yinhai District, Beihai is relatively suitable for the compensation and will be classified into cultivated land with area of 73.0857  $\text{hm}^2$ , based on the analysis and study on the potential of land utilization in Land Development, Arrangement and Planning (2001-2010) in Beihai Guangxi Zhuang Autonomous Region and the field review. In original planning, that piece of land was wild grass ground. Since the implementation of the planning, that piece of land has been reclaimed to be dry land by the farmers by themselves in several years. It is used for planting the sugar-cane and cassava and the crops are in good condition. It is suitable to compensate the cultivated land. The aim can be realized that the recoverable deposits and the quality of cultivated lands in the range of Beihai won't be reduced.

In the range of the land for the project, there are 58.0113  $\text{hm}^2$  which are within the protection scope of basic farm field in Xinggang Town, Tieshan Port area, Beihai. Wherein, the area of paddy field is 57.0766  $\text{hm}^2$  and the area of dry land is 0.9347  $\text{hm}^2$ .

To ensure the unchanged area of protected basic farm field, it is proposed to take the 43.1025  $\text{hm}^2$  area (34.0332  $\text{hm}^2$  for paddy land and 9.0693  $\text{hm}^2$  for dry land) in the piece of land F in Santang Village, Nankang Town to compensate and be set into the protection scope of basic farm field in Santang Village, Nankang Town for increasing the area of basic farm field from original 47.74  $\text{hm}^2$  to 90.8425  $\text{hm}^2$ ; to take the 14.9088  $\text{hm}^2$  area (9.4410  $\text{hm}^2$  for paddy land and 5.4678  $\text{hm}^2$  for dry land) in the piece of land G in Santang Village, Nankang Town to compensate and be set into the protection scope of basic farm field in Santang Village, Nankang Town for increasing the area of basic farm field from

original 138.7333 hm<sup>2</sup> to 153.6421 hm<sup>2</sup>. The total 58.0113 hm<sup>2</sup> (43.4742 hm<sup>2</sup> for paddy land and 14.5371 hm<sup>2</sup> for dry land) area of land F and G is applied to compensate and be set into the protection scope of basic farm field in Nankang Town. After the compensation, the recoverable deposits of cultivated lands in Nankang Town are increased by 58.0113 hm<sup>2</sup> and the recoverable deposits of cultivated lands in Xinggang Town are reduced by 58.0113 hm<sup>2</sup>. It is basically ensured that the recoverable deposits and the quality of cultivated lands in the range of Beihai won't be reduced.

The targets that the cultivated land and basic agricultural land possessed will not decrease and the quality will not be reduced after the project is constructed and the scale of the land occupied by this project will be maintained within the regional land resource bearing capacity scope can be achieved within the scope of Beihai City via above described measures.

### 18.2.8 Analysis on environmental and resource restricting factors of the project

The existing environmental and resource restricting factors in terms of site selection of the project to construct are mainly that the local fresh water resource of Tieshan Port area is in rather short supply, the ecological effect of raw material forest base and the issue of cultivated land occupied for construction, etc. Please refer to Table 18.2-6 for solutions and results.

Table 18.2-6 Environmental and resource restricting factors and the solutions

| Restricting factor | Solution                                                                                                                                                                                                                                                                                                                        | Effect                                                                                                                                                                   |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Water resource     | In near future, the water resources of Hepu Reservoir is planned to be used as the water source for Tieshan Port industrial base and in forward future, joint water supply by Hepu Reservoir and Nanliu River has been planned.                                                                                                 | The problem of insufficient water resource of Tieshan Port can be resolved.                                                                                              |
| Forestry resource  | The kinds of trees selected for this project are eucalyptus and jequirity tree, the planned afforestation will be 123056.0hm <sup>2</sup> , and tending 36944.0hm <sup>2</sup> current eucalyptus. The designed regulatory rotation age is 6-7 years and the designed annually average yield is 3.1184 million m <sup>3</sup> . | The forest base scale basically matches the scale of pulp and paper factory and is able to meet the requirement of wood raw material for 900000t pulp and paper factory. |
|                    | The scope of selected land of raw material forest base project complies with the land selection range determined in "Several opinions of the People's Government of Guangxi Zhuang Autonomous Region about accelerating the construction of forest, pulp and paper raw material forest base in coastal areas"                   | The problem of competing with other forest/paper projects for land can be avoided.                                                                                       |



| Restricting factor | Solution                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Effect                                                                                                                                                                                 |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Organism diversity | (1) The forest lands that may affect ecologically sensitive targets can be rejected via forest land selecting; (2) Protecting under-vegetation, protecting the original vegetation of a whole piece of land, protecting forest edge vegetation and the natural broad leaf trees and various shrubs; (3) At least 1km isolation belt should be reserved as the border between selected forest land and natural protected area; (4) When selecting forest land, the subcompartment area should be no greater than 20hm <sup>2</sup> and in terms of tree kind selection, multi-clonal group interactive configuration forestation should be adopted. | Unfavorable environmental effects such as reduced organism diversity, soil fertility declination and soil erosion, etc. caused by raw material forest base construction can be avoided |
| Land resource      | Three land blocks (cultivated land) B, C and D in Nankang Town reserved for construction are allocated, land block E of Sanhekou Village Fucheng Town Yinhai district Beihai city will be reclaimed and two land blocks F and G of Santang village Nankang Town will be additionally incorporated into the basic agricultural land protection scope of Nankang Town.                                                                                                                                                                                                                                                                               | The targets that the cultivated land and basic agricultural land possessed will not decrease and the quality will not be reduced can be achieved within the scope of Beihai City       |
| Protected area     | Pollutant discharge and pollutant discharge exit optimization can be controlled via engineering measures.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | No direct effect will be generated on Rugen Protected Area, Red Woods Protected Area and Yingpan Sea Water Culture Area                                                                |

### 18.2.9 Conclusion of site selection reasonableness

The selected site of the project is located in Tieshan Port area in Beihai city, which complies with the requirements of relevant planning and possesses superior location superiority and traffic conditions. The infrastructure conditions are very good, environmental quality is good and the raw material and water resources can meet the requirement of project construction. The pollution diffusing capability of atmosphere and sea water is comparatively strong. According to the analysis on environmental capacity and total pollutant discharge index, the discharge of chemical oxygen demand of the project does not exceed the total quantity control index of Beihai's 11<sup>th</sup> Five Year. There is still environmental capacity in the area where the project locates. To sum up, the site selection of the project is evaluated as reasonable.

## 18.3 General plan layout

### 18.3.1 General plan layout

As the project is a new modern pulp-paper integration industry project and is constructed based on the rules for high starting point, high level and high efficiency, the factors such as internal sequence of process, efficiency, energy consumption, safety, fire protection and sanitation are considered in the general plan layout and a large space is created in the plant for the unblocked production and traffic, convenient power supply and proper management and operation.

The main factors to be considered for the general plan layout are as follow:

- (1) Meet the requirement of process flow and the proper transition between utilities and production facilities;
- (2) Shorten the traffic line and power supply pipeline as far as possible to achieve the objectives for saving the land, energy and costs;
- (3) The traffic organization and function zoning shall match the landscape arrangement for the convenient and safe transportation and proper utilization of land;
- (4) Meet the clearance requirement on industrial fire protection, explosion protection, sunlight and etc;
- (5) The orientation of main buildings shall avoid the dominated wind direction in the winter by utilizing the winter sunlight, utilize the natural ventilation in the summer and adapt to the local climate features;
- (6) Various piling sites with relatively poor sanitation condition shall be located in the lee side of dominated wind direction.

### 18.3.2 Zoning of Main functions

If it is considered that the perennial dominated wind direction in the place where the plant address is located is the north wind and the dominated wind direction in the summer is the east-south wind. To avoid the adverse effect caused due to the conflicts between the perennial dominated wind direction and summer dominated wind direction, it is proposed to properly adjust the orientation of buildings to the east by south by  $40^{\circ}$  and place the front plant area in the east-south end of plant area in the general plan layout.

The general plan layout is arranged by centralizing the core area. The production area is the core of the project. Its main contents are the 900,000t pulping production, alkali recovery, heat power plant and 450,000t high-grade packaging cardboards project and 450,000 high-grade culture paper project. The single units in its buildings mostly include pulping workshop, pulp board drying workshop, evaporating workshop, causticizing workshop, combustion workshop, chemical pulp finished pulp board warehouse as well as the single units including main heat power workshop, chemical water workshop and main control buildings. The pulping and alkali recovery workshop are far away from the plant boundary in the distance, reducing the pollution on atmospheric environment in the residential areas outside the plant area.

The pulping and paper-making production area is located in the center of the land for the phase of the project. The flow of production process roughly runs from north to south.

The finished product warehouse is connected to main workshop to reduce the secondary handling of finished product.

The 450,000t high-grade packaging cardboards project and the 450,000t high-grade culture paper project are located in the land in the south side of the area. The components

of these parts are as follow: paper-making workshop, crushing section, intermediate warehouse, finishing workshop, finished product warehouse, coated paper processing workshop.

The raw materials supply area is located in the east-north and east side of the pulping core area. This part consists of the following single units: raw material site, wood chip piling site, stock preparation workshop. The supply of raw materials to the production shall be convenient and in a good order. The transportation of raw materials into the plant area shall be completed in two flow lines of highroad and dock for consideration. Wherein, the dock transportation will be applied in the emergency event.

The risk levels of fire protection in the production of various sections in planned chemicals preparation workshop are classified into Class A, B and C respectively, which therefore are all located in the north and has a fire protection clearance more than 40m away from the adjacent log piling site for ensuring the safety.

The power zone is placed in the north side of pulping and paper-making production area for sending the barks and wood chips into near boilers for burning.

The maintenance warehouse zone is placed near the pulping and paper-making production area.

Based on the consideration for the local drainage condition and water frequency characteristics, the container piling site and waste-water treatment station are located in the most south side of plant area for the discharge into the deep-water sea area of Tieshan Port bay in the east-south side of plant address.

According to the consideration and planning of related departments, it is considered to located the solid wastes piling site for coal ash slag and etc. in low lying land near Beimu salt field in the east-south side of plant address,

The general plan layout of plant area is shown in attached drawing 10.

### **18.3.3 Vertical layout**

Due to the slight relief in the site and relatively large volume of main buildings, the self balance between excavation and filling is focused for consideration in the vertical layout, in addition to the considerations for the vertical relationship between the buildings and roads in the plant area and the roads outside the plant, according to the 1:15000 geographical map provided by Tieshan Port Planning Bureau. High-volume and high-load buildings shall avoid the excavation and filling area as far as possible to reduce the investment for foundation; the high-volume water tank shall be located in the place with relatively low natural relief as far as possible.

Based on the considerations that the surface features are gentle slopes and hills in the proposed site and the absolute elevation is about 20-30m or so, therefore the vertical layout combining the level type and step type is applied to save the quantity of earthwork.

### **18.3.4 Traffic organization of highroad, railway and shipping**

The plant is connected to the city roads in the surroundings. 5 entrance and exit points are set in the plant area. The entrance and exit point adjacent to No. 7 Road in the north side is used for transporting raw materials into plant. The entrance and exit point opposite to it

in the south side of plant is the one for finished products, which is close to the dock for the easy transportation of high-volume goods; 2 entrance and exit points are set in the west side of plant area. The one near heat power station is used for the transportation of coal slag and etc. The one near the production area mostly is used for the transportation of packaging materials and commercial wood pulp; the entrance and exit point for persons is located in the east-south side. The distances between all points and main roads of the city are not less than 70m.

The high-volume material flow in the project covers the log raw material, coal and finished products. The closed ring flow lines are formed for the three items in the individual function areas respectively. There are no cross points or conflicts among them. The centralized hard paved road is set in the goods transport center in the plant area, meeting the requirement for goods turnover of each production unit.

According to the features of local tidal water level, the coal dock and mixing loading dock which the project depends on are planned to be located in the east-north and the north of the plant area. The connection between the entrance and exit point in the north side of plant area and shipping dock will be unblocked and convenient.

### **18.3.5 Greening layout**

The front area and planting area are located along the roads outside the plant. By utilizing the features of sufficient modeling of civil buildings such as office building, food dining buildings and etc., a good street-side landscape will be formed to establish a good impression of the modern enterprise, meeting the requirement of urban planning.

The planting will be focused on the front plant area in the proposed project. The centralized planting areas will be set in the empty lands in the surroundings of individual main workshops and in the both sides of the roads to ensure a good ecological environment in plant area. The planting coverage rate in production area will reach 20%.

### **18.3.6 Analysis on the rationalization of general layout plan**

The advantages of the scheme are that: the general layout plan is compact; the process flow is relatively unblocked; the zoning is clear and proper; the front plant area is independent from the production area for easy management; the reservation land is located in the west side of Phase I production line for easy expansion and no restriction of the variations in production capacity. The distance of automobile transportation is short and convenient.

The disadvantages of the scheme are that: the heat power plant is located in the north side of plant area and the coal storage site is located in the west-north side of plant area, which are within the upwind side of the perennial dominated wind (north wind). It will easily cause the perennial effects of smoke (powder) and dust on the plant area. The liquefied gas station is located in the west side of finished product warehouse with a great risk of fires. It is recommended to set the proper fire protection clearance between the both to ensure the safety.

In a word, based on the analysis in the environmental protection, process flow, material transportation, landscape of plant area and etc., it is identified in the evaluation that the scheme is generally proper and proper adjustment shall be considered in local parts.

## 19 Analysis on Economic Profit & Loss of Environmental Impact

### 19.1 Project Economic and Social Benefits

#### 19.1.1 Economic Benefits

The total project investment is 20,395,623,900 yuan ---. After the project come up to the designed production capacity (in 3~18 years), it shall yield a total sales revenue of --- yuan with a total cost of --- yuan. Therefore, the total profit shall be --- yuan and after-tax profit --- yuan. The annual sales revenue for the years of normal full production capacity (in 8-18 years) shall be --- yuan; average annual profit shall be ---

The profit margins on project investment and the rate of profit and tax on investment are --- and --- respectively. The after-tax static investment payback period is --- years (including the construction period). The financial internal rate of return on total investment is --- With a loan repayment period of --- years (including the construction period), this project is featured with high discharge ability and low breakeven point, enabling high risk resistance and excellent economic benefits.

See Table 19.1-1 for the financial and economic indices of the project.

Table 19.1-1

Table of Financial and Economic Indices

| SN | Name of index                           | Unit | Amount         | Notes                                                |
|----|-----------------------------------------|------|----------------|------------------------------------------------------|
| 1  | Total investment                        | yuan | 20,395,623,900 | ---                                                  |
| 2  | Total sales revenue                     | yuan | ---            |                                                      |
| 3  | Value-added tax                         | yuan | ---            |                                                      |
| 4  | Total cost                              | yuan | ---            |                                                      |
| 5  | Total profit                            | yuan | ---            |                                                      |
| 6  | Income tax                              | yuan | ---            |                                                      |
| 7  | Profit after tax                        | yuan | ---            |                                                      |
| 8  | Profit margin on investment             | %    | ---            |                                                      |
| 9  | Rate of profit and tax on investment    | %    | ---            |                                                      |
| 10 | Total investment pre-tax indices:       |      |                |                                                      |
|    | Static investment payback period        | year | ---            | Construction period                                  |
|    | Financial internal rate of return       | %    | ---            |                                                      |
|    | Financial net present value             | yuan | ---            |                                                      |
| 11 | Total investment after-tax indices:     |      |                |                                                      |
|    | Static investment payback period        | year | ---            | Including 2 years of construction                    |
|    | Financial internal rate of return       | %    | ---            | After tax                                            |
|    | Financial net present value             | yuan | ---            |                                                      |
| 12 | Project break even:                     |      |                |                                                      |
|    | Utilization rate of production capacity | %    | ---            | The 1 <sup>st</sup> year of full production capacity |
|    | Break even point                        | %    | ---            | The 1 <sup>st</sup> year after loans payoff          |

### 19.1.2 Social Benefits

Stora Enso (Guangxi) Pulp & Paper Co., Ltd. is to develop the forest-and-paper integration project in scale, which complies with the strategic requirement of China's grand western development program and is one of the key projects in this program. It is of great significance to the enhancement of equipment standard of pulp and paper making industry in Guangxi as well as the grade improvement of the paper and cardboard products.

The taxes turned over each year after the project is put into production may help increase the national and local financial revenue, enhance the economic strength of Beihai City and promote the development of local public welfare undertakings effectively.

After the project is put into production, it may produce over 1400 working opportunities, which may not only relieve the social burden and employment pressure, but also improve people's living standards, thus creating good social benefits.

The project construction shall further drive the development of other relevant industries, such as the forestry, traffic and transportation, energy, mechanical processing and maintenance, catering, etc. It may also indirectly create more work positions and facilitate the development of local economy.

## 19.2 Environmental Protection Investment and Environmental Benefits Analysis

The total environmental protection investment of the project amounts up to --- yuan, among which: --- yuan covers the construction period, while --- yuan covers the operation period. The total environmental protection investment takes up --- of the total project investment (---).

As the project construction may deliver complex impact on the environment, it may lead to various environmental losses, some of which can be calculated directly, while others are hard to be monetized. As the major environmental pollution of this project shall occur in the operation period, a brief analysis shall be carried out on the environmental profit and loss only for the operation period.

### 19.2.1 Environmental Protection Investment during Project Operation Period

Guided by the principles of high starting point, adaptability and reliability, the proposed project adopts advanced production process together with sophisticated environmental protection measures for its environmental control. The investment on environmental

protection measures during the project operation period is estimated to reach --- yuan, including --- yuan used directly for “three wastes” treatment and --- yuan for other indirect environmental protection. The environmental protection investment for the project operation period covers --- of the total project investment.

See Table 19.2-1 for the estimation of environmental protection investment for the project operation period (see more details in Chapter 15).

**Table 19.2-1 Estimation Table of Environmental Protection Investment during Project Operation Period** [investment cost information removed]

| SN                                           | Item                                      | Content                                                                                                                                                                                    | Investment (yuan) |
|----------------------------------------------|-------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| Direct environmental protection investment   | Alkali recovery system                    | Evaporation station                                                                                                                                                                        | ---               |
|                                              |                                           | Alkali recovery boiler and electrostatic                                                                                                                                                   | ---               |
|                                              |                                           | Causticizer                                                                                                                                                                                | ---               |
|                                              | Waste gas treatment                       | Limekiln and electrostatic precipitator                                                                                                                                                    | ---               |
|                                              |                                           | Bleaching tail gas absorption tower                                                                                                                                                        | ---               |
|                                              |                                           | Circulating fluidized bed boiler (including desulfurization, dedusting, damping and noise reduction, fly dust collection, slag collection, chimney, coal shed, soft water treatment, etc.) | ---               |
|                                              | Wastewater treatment                      | Sewage treatment station                                                                                                                                                                   | ---               |
|                                              |                                           | Equipment for seaward sewage discharge                                                                                                                                                     | ---               |
|                                              |                                           | Condensed sewage stripping equipment                                                                                                                                                       | ---               |
|                                              |                                           | Underground sewage ditch facilities of the whole plant                                                                                                                                     | ---               |
|                                              |                                           | NCG recovery system                                                                                                                                                                        | ---               |
|                                              | Solid waste disposal                      | Solid waste landfill site (seeping-proof, drainage, dust-proof and rainwater collection)                                                                                                   | ---               |
|                                              | Subtotal                                  |                                                                                                                                                                                            | ---               |
| Indirect environmental protection investment | Other environmental protection investment | Tree planting                                                                                                                                                                              | ---               |
|                                              |                                           | Environmental protection monitoring                                                                                                                                                        | ---               |
|                                              | Subtotal                                  |                                                                                                                                                                                            | ---               |
| Total                                        |                                           |                                                                                                                                                                                            | ---               |

### 19.2.2 Environmental Protection Investment Cost on Pollution Prevention and Control

The environmental protection investment cost on pollution prevention and control refers to the investment used directly in the pollution prevention and control, including that for environmental protection facilities, maintenance and operation expenses of environmental protection facilities, expenses for “three wastes” treatment as well as the salary of environmental protection personnel.

#### 1. Annual Investment on Environmental Protection Facilities

The direct investment on “three wastes” treatment facilities amounts to --- yuan with the service life of 12 years as indicated in the Project Application Report and thus the annual investment on environmental protection facilities is --- yuan.

#### 2. Maintenance of Environmental Protection Facilities

The maintenance expenses take up --- of the total investment on environmental protection facilities and the annual maintenance expense is about --- yuan.

#### 3. Operation Expenses of Environmental Protection Facilities & Treatment Cost of “Three Wastes”

(1) The operation costs of waste gas treatment equipment and other relevant equipment are estimated to be 5,000,000 yuan/year.

(2) The sewage treatment system of the project is mainly adopted to treat the wastewater in the sewage treatment station with a total treatment amount of 109,158 m<sup>3</sup>/d, annual treatment amount of 38,641,900 m<sup>3</sup>/a. It is estimated that the average cost of sewage treatment shall be about 8 yuan/m<sup>3</sup> and the annual operation expense of the sewage treatment system shall be about 30, 9135,000 yuan.

Subtotal: 314,135,000 yuan/a.

#### 4. Salary of Environmental Protection Personnel

The designated labor of the project is 1392 people, among which the environmental protection personnel amount for 3%, being about 42 people (including the lab environmental monitoring personnel, the management of sewage treatment station, etc). Assume the annual salary of each person is 15,000.0 yuan as per the *Project Feasibility Research Report*, the total amount of salary for environmental protection personnel shall be 630,000 yuan/a.



To sum up, the total investment costs covered by the abovementioned item 1~4 are 699,790,700 yuan/a. For more details, see Table 19.2-2.

**Table 19.2-2 Investment Costs of Environmental Protection concerning Project Pollution**

| SN    | Item                                                        | Expenses (yuan/a) |
|-------|-------------------------------------------------------------|-------------------|
| 1     | Direct investment on environmental protection facilities    | ---               |
| 2     | Maintenance expenses on environmental protection facilities | ---               |
| 3     | "Three wastes" treatment and operation costs                | 314,135,000       |
| 4     | Salary of environmental protection personnel                | 630,000           |
| Total |                                                             | ---               |

### 19.2.3 Environmental Protection Investment Benefits

The operation of environmental protection facilities reduces the amount of pollutant discharged to the air and water. The environment economic benefits of the proposed project can be demonstrated by the economic losses saved through the operation of environmental protection facilities.

#### 1. Alkali Recovery

The annual consumption of sodium hydroxide in the project shall be 35810t with the alkali recovery rate over 98%. Therefore, about 35093.8t of alkali shall be recovered each year. Suppose the recovery benefit is 200 yuan/t, the environmental protection investment benefits shall be up to 7,019,000 yuan/a with the deduction of cost.

#### 2. Wastewater Treatment

Upon completion of Phase III Project, the total volume of sewage drainage shall reach 109,158 m<sup>3</sup>/d, with annual discharge volume of 3,864.19m<sup>3</sup>/a. In the sewage: 43,896t/a of COD shall be generated, among which 3,476t/a shall be discharged after treatment. Thus, the annual discharge volume can be reduced by 40,420t; 15,399t/a of BOD<sub>5</sub> shall be generated, among which 771.7t/a shall be discharged after treatment. Thus, the annual discharge volume can be reduced by 14627.3t; 21307t/a of SS shall be generated, among which 1161.1t/a shall be discharged after treatment. Thus, the annual discharge volume can be reduced by 20,145.9t. 333t/a of AOX shall be generated, among which 35t/a shall be discharged after treatment. Thus, the annual discharge volume can be reduced by 298t.

In accordance with the *Measures for the Administration of the Charging Rates for Pollutant Discharge Fees* promulgated by the State Administration of Environmental Protection on

Feb. 28<sup>th</sup>, 2003, the pollutant discharge fees shall be collected according to the pollution equivalent value of various pollutants for each discharge outlet and no more than three pollutants with the highest pollution equivalent value shall be charged. For the COD and BOD<sub>5</sub> in the same discharge outlet, only the one with higher pollution equivalent value shall be charged.

In the project, the pollution equivalent value of BOD<sub>5</sub> ranks the first. Each pollution equivalent shall be charged 0.7 yuan and the pollutant discharge fees saved annually on BOD<sub>5</sub>, SS and AOX after being treated with the sewage treatment facilities shall be 17,772,000 yuan, 3,052,000 yuan and 834,000 yuan respectively. The total amount of pollutant discharge fees saved annually from the sewage treatment adopted by the project shall be up to 21,658,000 yuan.

### 3. Waste Gas Treatment

Upon the completion of Phase III Project, the total volume of waste gas generated shall be  $1.18 \times 10^6 10^{10} \text{ Nm}^3/\text{a}$  and the total volume of waste gas discharged shall be  $1.18 \times 10^6 10^{10} \text{ Nm}^3/\text{a}$ , where:

6607.2t/a of smoke and dust shall be generated, among which 567.3t/a shall be discharged after treatment. Thus, the discharge volume can be reduced by 6064.1t/a.

9647t/a of SO<sub>2</sub> shall be generated, among which 3,070t/a shall be discharged after treatment. Thus, the discharge volume can be reduced by 6577t/a.

1,325t/a of NO<sub>x</sub> shall be generated, among which 1,325t/a shall be discharged after treatment. Thus, the discharge volume can be reduced by 0t/a.

Calculated in accordance with the *Measures for the Administration of the Charging Rates for Pollutant Discharge Fees* promulgated by the State Administration of Environmental Protection on Feb. 28<sup>th</sup>, 2003, the annual pollutant discharge fees on smoke & dust and SO<sub>2</sub> can be reduced by 16,690,000 yuan and 41,539,000 yuan respectively. The total amount of pollutant discharge fees saved annually from the waste gas treatment adopted by the project shall be up to 58,009,000 yuan.

### 4. Comprehensive Utilization of Waste Residue

(1) The project production shall generate annually: 172,000t of fly ash residue, to be comprehensively utilized by truck transportation (for cement production or road paving and pit filling); 73,900t of wooden waste (with water content of 45%), to be comprehensively utilized by selling out before the Phase II is put into production and burnt in the coal boiler after the project is put into production; 14,790t of pulp residue, to be sold out as low grade paper material. Certain income can be gained each year, but the amount is to be confirmed. Therefore, its profit shall not be calculated temporarily.

(2) 65,499t of sludge shall be generated. It can be used as boiler fuel or burnt in the alkali

boiler, which may reduce the environmental pollution as well as creating more resources.

## 5. Energy-efficiency Benefit

All steam required in Phrase I of the project are provided by the alkali recovery boiler. About  $97.5 \times 10^4 \text{t}$  of steam can be recycled in Phrase I. Suppose 6.9t of steam equals to 1t of standard coal and the price of standard coal is 400 yuan/t, the steam provided by alkali recovery boiler can help to save  $14.1 \times 10^4 \text{t}$  of coal consumption every year, saving 56,400,000 yuan totally.

To calculate based on the abovementioned item 1~5, the economic benefit achieved from the environmental protection investment may reach 143,086,000 yuan/a.

### 19.2.4 Analysis on Environmental Economic Profit & Loss of the Project

The ratio method shall be adopted in analysis of the profit & loss of the environmental protection investment.

#### (1) Cost-benefit Ratio

$$Z = S_i / H_f$$

Wherein: Z —cost-benefit ratio;

$S_i$ —economic benefit returned from environmental protection investment;

$H_f$ —annual expenses of pollution prevention and control

Concluded from the analysis above,  $S_i$ , the annual economic benefit from environmental protection investment, amounts to 143,086,000 yuan, while  $H_f$ , the environmental protection investment directly used on pollution prevention and control, amounts to 699,790,700 yuan.

Therefore, the cost-benefit ratio is 0.20, i.e. when 1 yuan is invested on environmental protection, 0.20 yuan of economic benefit may be obtained. Furthermore, it is hard to calculate the economic value concerning health (disease) issues which receive lighter pollution impact due to the investment on environmental protection. And it is also difficult to account in the form of money the productivity loss in industrial and agriculture industries caused by the damage of ecology.

#### (2) Profit-loss Ratio

The environmental economic profit and loss are indicated with the environmental economic profit-loss ratio:

$$R = R_1 / R_2$$

Wherein: R —profit-loss ratio;

$R_1$ —economic income, accounted as the total profit after tax in 3-18 years when full production capacity is realized;

$R_2$ —the annual environmental protection investment, accounted as the one-off investment on environmental protection.

$R > 1$ , the project construction is reasonable;

$R = 1$ , the project construction is of little significance;

$R < 1$ , the project construction is unreasonable.

After putting into production, the project may obtain --- yuan of economic income (profit after tax). The environmental protection investment during the project operation period amounts to --- yuan with the profit-loss ratio of ---, indicating that the economic income of the project go beyond the investment on environmental protection.

## 20 Public Participation

### 20.1 Objective

The public participation investigation aims to find out the opinions and suggestions on the environmental impacts may caused during and after the project construction as well as relevant environmental protection measures to be adopted from residents, enterprises, institutions and other relevant public in the area where the proposed project locates. The environmental impact evaluation shall then be made more democratic and publicized, serving as a reference to the environmental protection decisions, design and management of the project.

### 20.2 Working Procedures

The work group has carried out a large number of public participation investigations concerning the environmental sensitive points and problems after the geographic location, land area and project structure was determined. The forms of interview, announcement, questionnaire and expert consultation are adopted. The first investigation has been carried out on June 12<sup>th</sup>, 2007, targeting at Environmental Protection Bureau of Beihai City, Beihai Construction Bureau, relevant government institutions of Tieshan Port District and the members in Stora Enso's Houses Demolishment and Land Requisition Team; the second investigation took place on June 29<sup>th</sup>, 2007, targeting at the sensitive points within the plant site and the surrounding area; the third investigation was carried out on July 19<sup>th</sup>, 2007, targeting at Chijiang Primary School, which is close to Chijiang slag stockpile in the comparison and selection; the fourth investigation took place on Oct. 31<sup>st</sup>~Nov. 2<sup>nd</sup>, 2007. Relevant institutions of Beihai Municipal Government and Tieshan Port District government, as well as representative villagers from the houses demolishment and land requisition area have been organized to attend the discussion session. The spot investigation has also been conducted on resettlement residents for environmental protection. The fifth investigation was carried from July 22<sup>nd</sup> to August 1<sup>st</sup>, 2008, which was mainly to issue the third public participation announcement on the website of People's Government of Guangxi Zhuang Autonomous Region, thus to collect opinions and suggestions of the public for this project from the higher and more extensive level.

The series of investigations have help to collect fully and in depth the opinions and suggestions on the proposed project from the public. The sorted opinions and suggestions are listed in §19.5. See Picture 20.2-1 for the photos of spot investigation.

### 20.3 Identification of Core Public Group

In consideration of the land cover, construction content and scale and the distribution of environmental sensitive points around the plant location, the core public group for this Public participation shall include:

- a. Residential area within the plant site (to resettle for land requisition): Xinwupo Villager Group, Pokoutang Villager Group, Nanle Villager Group, Beimu No.1 Villager Group, Beimu No.2 Villager Group, Tianliao Villager Group, Tianliao No.1 Villager Group and Tianliao No.3 Villager Group.
- b. Residential area nearby the plant site (1~2 residential areas within 1km to the east, west, south and north respectively, mainly the resettlement residents due to environmental protection): Dengwu Village, Shanxin Village, Nageatang, Haishan Dam and Xinhai Village;
- c. Major sensitive points nearby the selected slag stockpile (within 1km): Chijiang Village and Chijiang Middle School;
- d. Local government institutions: Beihai Municipal People's Congress, Beihai Municipal Political Consultative Conference, Beihai Municipal Development and Reform Commission, Beihai Construction Bureau, Land and Resources Bureau, Planning Bureau, Environmental Protection Bureau, Agriculture Bureau, Oceanic Bureau, Fishery & Animal Husbandry Bureau, Forestry Bureau, Transportation Bureau of Beihai; Tieshan Port District People's Government, Environmental Protection Bureau, Planning Bureau, Land and Resources Bureau of Tieshan Port District; the Township Governments of Nangkang Town, Yingpan Town and Xinggang Town.
- e. Environmental protection experts of Guangxi Region: Experts and senior technicians from the Environmental Protection Bureau of Guangxi, Guangxi Ecological Environmental Protection Association, Guangxi Phoenix Pulp & Paper Co. Ltd, and other relevant environmental protection institutions and enterprises.



**Picture 20.2-1 Photos from Survey of Public Participation**

## 20.4 Time and Major Forms

The public participation investigation has been conducted in accordance with the relevant requirements of *Temporary Measures of the Public Participation in Environmental Impact Assessment* during the period from early September, 2006 to early November, 2007 in the forms of announcement, interview, investigation questionnaire and discussion sessions.

## 20.5 Investigation Results

### 20.5.1 Feedback Opinions of Announcement

The first public participation announcement was published in Beihai Daily on Sept. 5<sup>th</sup>, 2006. which was mainly to announce the Project Profile, sewage conditions and main control measures as well as the procedures and steps of this environment evaluation. By the end of public opinion collection period, one letter and one fax from Beihai citizens have been received, namely, the letter from Mr. Liu of Chengdong School of Beihai, the fax from Mr. Gao of Yinwu Garden, Shanghai Toad, Beihai City. Their opinions on the proposed project are quite the opposite: Mr. Liu thinks that the largest fortune and advantage of Beihai are the blue sky and ocean. However powerful the company is, it shall make damages to the environment of Beihai. Therefore, he holds a negative attitude towards this project; while Mr. Gao believes that with the advanced pulp & paper making technology and extensive experience on “three wastes” treatment in Finland, this project may not cause much environmental pollution. In case our party raises strict requirements on environmental protection and the enterprise’s funds on environmental protection is in place, the negative impact on environment of the proposed project can be effectively controlled.

The second announcement was released on the website of Guangxi Environmental Protection Bureau on Oct. 29<sup>th</sup>, 2007, which was mainly to announce preliminary conclusion of the environment evaluation report. By the end of public opinion collection period, no telephone, mail, e-mail or any other forms of feedback has been received from the public.

The third announcement was released on the website of People's Government of Guangxi Zhuang Autonomous Region from July 22nd to August 1st, 2008, which was mainly to announce the environment evaluation conclusion in the revised environment evaluation report which had been examined and appraised. By the end of public opinion collection period, only an opinion has been received, namely, an opinion from a member of old Guangxi Association of Science & Technology, who thought that the project is beneficial for development of local economic development, but large areas of eucalyptus



planting will have negative influence on Guangxi's ecological environment as well as the diversity of trees and crops. He also thought that the development of the local economy should set forth from the consideration for the long-term interests, and hoped that the Government could consider more about the interests of future generations.

See Appendix 27 for the detailed contents of the announcements.

### 20.5.2 Opinion Collection from the Public Discussion Session

The public discussion session about the project took place in the People's Government of Tieshan Port District on Oct. 31<sup>st</sup>, 2007, with participants including leaders and representatives from relevant government institutions of Beihai and Tieshan Port District, villager representatives from Villager Group of land requisition and resettlement, enterprise representatives of Stora Enso and the representatives from environment evaluation working group. The session was hosted by this environment evaluation working group.

See Table 20.5-1 for the composition of participants and Table 20.5-5 for the opinions and suggestions collected from various institutions and villagers.

**Table 20.5-1 Composition of Participants**

| Content Category                            | Name                                               | Number of participants |
|---------------------------------------------|----------------------------------------------------|------------------------|
| Representative from government institutions | Beihai Municipal People's Congress                 | 1                      |
|                                             | Beihai Municipal Political Consultative Conference | 1                      |
|                                             | Beihai Municipal Development and Reform Commission | 1                      |
|                                             | Beihai Municipal Economic Commission               | 1                      |
|                                             | Beihai Municipal Construction Commission           | 1                      |
|                                             | Beihai Municipal Land & Resource Bureau            | 1                      |
|                                             | Beihai Municipal Environmental Protection Bureau   | 1                      |
|                                             | Beihai Municipal Oceanic Bureau                    | 1                      |
|                                             | Beihai Municipal Maritime Bureau                   | 1                      |
|                                             | Beihai Municipal Fishery & Animal Husbandry Bureau | 1                      |
|                                             | Tieshan Port District Government                   | 1                      |
|                                             | Tieshan Port District Planning Bureau              | 1                      |
|                                             | Tieshan Port District Land & Resource Bureau       | 1                      |

| Content Category                     | Name                                                  | Number of participants |
|--------------------------------------|-------------------------------------------------------|------------------------|
|                                      | Tieshan Port District Environmental Protection Bureau | 1                      |
| Villager representatives             | Xinwupo Villager Group                                | 2                      |
|                                      | Pokoutang Villager Group                              | 2                      |
|                                      | Nanle Villager Group                                  | 2                      |
|                                      | Beimu No.1 Villager Group                             | 2                      |
|                                      | Beimu No.2 Villager Group                             | 2                      |
|                                      | Tianliao Villager Group                               | 2                      |
|                                      | Tianliao No.1 Villager Group                          | 2                      |
|                                      | Tianliao No.3 Villager Group                          | 2                      |
| Stora Enso Guangxi Branch            | /                                                     | 1                      |
| Environment evaluation working group | /                                                     | 3                      |
| Total                                |                                                       | 34                     |

### 20.5.3 Statistic Results and Feedback Opinions Collected from the Investigation Questionnaire

#### 20.5.3.1 Composition of Questionnaire Participants

Public participation investigation questionnaires have been extended in the process of spot interview, discussion session and expert consultation, etc. The age, educational background and profession of the participants are listed in Table 20.5-2.

**Table 20.5-2 Basic Information of the Interviewees**

| Item                    | Content                                            | Number (person) | Proportion to the whole |
|-------------------------|----------------------------------------------------|-----------------|-------------------------|
| Gender                  | Male                                               | 174             | 78%                     |
|                         | Female                                             | 48              | 22%                     |
| Age                     | Below 20                                           | 20              | 9%                      |
|                         | 21-30                                              | 40              | 18%                     |
|                         | 31-40                                              | 62              | 28%                     |
|                         | 41-50                                              | 65              | 29%                     |
|                         | Above 50                                           | 35              | 16%                     |
| Educational background  | Primary school                                     | 16              | 7%                      |
|                         | Junior middle school                               | 70              | 32%                     |
|                         | Senior middle school                               | 17              | 8%                      |
|                         | Technical secondary school                         | 10              | 5%                      |
|                         | Junior college                                     | 49              | 22%                     |
|                         | Bachelor                                           | 59              | 27%                     |
|                         | Master                                             | 1               | 0.4%                    |
| Village                 | Nanle Village                                      | 23              | 10%                     |
|                         | Tianliao Village                                   | 25              | 11%                     |
|                         | Beimu Salt Works                                   | 10              | 5%                      |
|                         | Pokoutang                                          | 6               | 3%                      |
|                         | Chuanjiang Village                                 | 10              | 5%                      |
|                         | Tanshan Village                                    | 7               | 3%                      |
|                         | Haishankan                                         | 11              | 5%                      |
|                         | Pitou Village                                      | 5               | 2%                      |
|                         | Xiejia Village                                     | 4               | 2%                      |
|                         | Chijiang Primary School                            | 19              | 9%                      |
| Government institutions | Beihai Municipal Government                        | 3               | 1%                      |
|                         | Beihai Municipal People's Congress                 | 1               | 0.4%                    |
|                         | Beihai Municipal Development and Reform Commission | 1               | 0.4%                    |
|                         | Beihai Municipal Economic Commission               | 1               | 0.4%                    |
|                         | Beihai Municipal Planning Bureau                   | 1               | 0.4%                    |
|                         | Beihai Municipal Construction Commission           | 1               | 0.4%                    |
|                         | Beihai Municipal Land & Resource Bureau            | 1               | 0.4%                    |
|                         | Beihai Municipal Environmental Protection Bureau   | 3               | 1%                      |
|                         | Beihai Municipal Oceanic Bureau                    | 1               | 0.4%                    |
|                         | Beihai Municipal Maritime Bureau                   | 1               | 0.4%                    |
|                         | Beihai Municipal Fishery & Animal Husbandry Bureau | 1               | 0.4%                    |
|                         | Beihai Municipal Monitor Central Station           | 1               | 0.4%                    |

| Item | Content                                    | Number (person) | Proportion to the whole |
|------|--------------------------------------------|-----------------|-------------------------|
|      | Tieshan Port District People's             | 1               | 0.4%                    |
|      | People's Congress of Tieshan Port District | 3               | 1%                      |
|      | Tieshan Port District Planning Bureau      | 1               | 0.4%                    |

**Table 20.5-2 (continued) Basic Information of the Interviewees**

| Item                    | Content                                         | Number (person) | Proportion to the whole |
|-------------------------|-------------------------------------------------|-----------------|-------------------------|
| Government institutions | Land & Resource Bureau of Tieshan Port District | 1               | 0.4%                    |
|                         | Nankang town                                    | 10              | 5%                      |
|                         | Yingpan town                                    | 10              | 5%                      |
|                         | Xinggong Township Government                    | 13              | 6%                      |
|                         | Tieshan Port District People's Government       | 9               | 4%                      |
|                         | Beihai Municipal Construction Bureau            | 3               | 1%                      |
|                         | Environmental Protection Bureau                 | 5               | 2%                      |
|                         | Agriculture Bureau                              | 3               | 1%                      |
|                         | Hygiene Bureau                                  | 6               | 3%                      |
|                         | Fishery Bureau                                  | 3               | 1%                      |
|                         | Forestry Bureau                                 | 3               | 1%                      |
|                         | Broadcast and Television Bureau                 | 3               | 1%                      |
|                         | Guangxi Phoenix Pulp & Paper Co. Ltd            | 1               | 0.4%                    |
|                         | Water Resources Department of Guangxi           | 1               | 0.4%                    |
|                         | Hydroelectric Power Institution of Guangxi      | 1               | 0.4%                    |
|                         | Beihai Environmental Protection Association     | 1               | 0.4%                    |
|                         | Others                                          | 8               | 4%                      |
| Profession              | Peasant                                         | 76              | 34%                     |
|                         | Cadre                                           | 47              | 21%                     |
|                         | Civil servant                                   | 52              | 23%                     |
|                         | Student                                         | 20              | 9%                      |
|                         | Teacher                                         | 11              | 5%                      |
|                         | Others                                          | 16              | 7%                      |

### 20.5.3.2 Statistic Results of the Investigation Questionnaire

222 pieces of investigation questionnaires of public participation have been collected. See Table 20.5-3 for details and Table 20.5-4 for the result of statistic analysis.

**Table 20.5-3 Stora Enso (Guangxi) Pulp & Paper Co., Ltd  
Forest-pulp-and-paper Integration Project (with an annual productivity of 900,000 Ton Pulp and 900,000 Ton Paper and Cardboard)  
Questionnaire of Public Participation Investigation**

**Project introduction:** The Forest-pulp-and-paper Integration Project (with an annual productivity of 900,000 tons of pulp and 900,000 tons of paper and cardboard) of Stora Enso (Guangxi) Pulp & Paper Co., Ltd. is a new investment program in China initiated by Stora Enso (Guangxi) Pulp & Paper Co., Ltd., which shall be undertaken by Stora Enso (Guangxi) Pulp & Paper Co., Ltd. and Guangxi Gaofeng Forest-Pulp-and-Paper (Group) Co. Ltd. The proposed project is located in Tieshan Port Offshore Industrial Zone, Beihai City, Guangxi, covering the total area of 250 hm<sup>2</sup>, with Beihai Power Plant to the north, Beimu Salt Works to the southeast, Dapaoling Village to the west, and 41km away from Beihai downtown. The production process involves pulp making and alkali recovery, which shall inevitably causes some environmental pollution, such as waste gas from boiler, alkali furnace, sewage treatment station as well as odor from slag stockpile, flyash from material transportation area and noises. To better carry out the environmental protection work through the project and promote the environmental protection consciousness of the public, we have prepared the following questionnaire concerning the environmental protection issues of the project. Please give your answers to these questions and provide your valuable suggestions. Your active participation is a sound guarantee for the implementation of our task.

Name: \_\_\_\_\_ Gender: \_\_\_\_\_ Age: \_\_\_\_\_ Educational background: \_\_\_\_\_ Unit: \_\_\_\_\_ Profession: \_\_\_\_\_

### **I. Project Overview**

1. Do you know the project?  
A. know much      B. know a little      C. know nothing
2. Do you think the project adopts an appropriate production scale?  
A. yes      B. no      C. no idea
3. Do you think the selection of plant site is reasonable?  
A. yes      B. no      C. no idea

### **II. Current Situation of Local Environment Quality**

1. How do you think of the current situation of local environment quality?  
A. very good      B. good      C. just so so      D. terrible      E. no idea
2. How much do you think of the marine areas of Tieshan Port District has been polluted so far?  
A. very seriously      B. seriously      C. slightly      D. no pollution      E. no idea
3. How do you think of the current situation of local sound environment?  
A. good      B. just so so      C. terrible      D. no idea

### **III. Environment Impact of the Proposed Project**

1. Are you worried about the pollution on local air condition after the project is put into production?  
A. yes      B. a little      C. no      D. no idea
2. Are you worried about the pollution on marine areas of Tieshan Port District after the project is put into production?  
A. yes      B. a little      C. no      D. no idea
3. How much do you think the ecological environment of the ocean and coast shall be influenced after the implementation of the project?  
A. very seriously      B. seriously      C. slightly      D. no influence      E. no idea
4. Do you think the growth of marine aquatic livings shall be influenced after the implementation of the project?  
A. yes      B. no      C. no idea
5. Are you worried that serious solid waste pollution shall occur after the project is put into production?  
A. yes      B. a little      C. no      D. no idea
6. Do you think the site selection of slag stockpile is proper?  
A. yes      B. no      C. no idea
7. Are you worried that the odor shall impose negative influence on the surrounding environment?  
A. yes      B. a little      C. no      D. no idea
8. How far do you think the slag stockpile shall be located away from the residential area?  
A. 500m      B. 1km      C. 1.5km      D. above 2.0km (see reverse)

**IV. Social & Economic Impact of the Proposed Project**

1. Where does your income mainly come from so far?

- A. aquiculture      B. salt industry      C. fishery      D. forestry  
 E. crop plantation      F. work away from home      G. other means

2. How much shall the proposed project influence your income source?

- A. greatly influenced      B. certain influence      C. slightly influenced      D. no influence  
 E. no idea

3. If you are required for resettlement, do you agree to do this?

- A. yes with no conditions      B. yes but with conditions      C. no      D. no idea

4. Do you have any requirement on the resettlement conditions? (multiple choices)

- A. reasonable compensation      B. proper resettlement location      C. complete basic living facilities  
 D. transportation convenience      E. sufficient employment opportunity      F. others      G. no idea

**V. Miscellaneous**

1) Based on the above issues, will you support the construction of this project?

- A. yes      B. yes but with conditions      C. postpone the construction      D. no      E. no idea

**VI. Questions**

1. What kind of environmental problem will occur with the implementation of the project? Which environmental pollution will most influence you? Do you have any requirement and suggestions on the environmental protection measures taken during the project implementation?

2) What suggestion and requirement on resettlement issues would you like to propose?

Investigation unit: Guangxi Environmental Protection Scientific Research Institution

May, 2007

**Table 20.5-4 Public Opinions on the Project and Statistic Results of the Investigation**

| Investigation Content                                                                         | Answers        | Number of people | Proportion | Analysis                                                                                                                                                                                                                                                                                      |
|-----------------------------------------------------------------------------------------------|----------------|------------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| I. Project Overview                                                                           |                |                  |            |                                                                                                                                                                                                                                                                                               |
| 1. Do you know this project?                                                                  | Yes            | 88               | 40%        | About 89% of the public know or know a little about the project, indicating high public concern on the project. For some people, the project is closely related to their livings.                                                                                                             |
|                                                                                               | A little       | 109              | 49%        |                                                                                                                                                                                                                                                                                               |
|                                                                                               | No             | 25               | 11%        |                                                                                                                                                                                                                                                                                               |
| 2. Do you think the project adopts an appropriate production scale?                           | Yes            | 126              | 57%        | More than half of the public think the production scale of the project is proper; a small number of the public regard it improper in terms of resource, total quantity control and pollution treatment; most peasants with poor educational background express directly their ignorance of it |
|                                                                                               | No             | 16               | 7%         |                                                                                                                                                                                                                                                                                               |
|                                                                                               | No idea        | 80               | 36%        |                                                                                                                                                                                                                                                                                               |
| 3. Do you think the site selection of the plant is proper?                                    | Yes            | 130              | 59%        | More than half of the public think the plant location is proper; a small number of the public believe it is improper. Most of them are facing land requisition or resettlement. The other people express their ignorance                                                                      |
|                                                                                               | No             | 26               | 12%        |                                                                                                                                                                                                                                                                                               |
|                                                                                               | No idea        | 66               | 30%        |                                                                                                                                                                                                                                                                                               |
| II. Current Situation of Local Environment Quality                                            |                |                  |            |                                                                                                                                                                                                                                                                                               |
| 1. How do you think of the current situation of local air environment quality?                | Very good      | 139              | 63%        | 86% of the public think the current situation of local air quality is very good or good, which indicates the good current situation of local air environment.                                                                                                                                 |
|                                                                                               | Good           | 50               | 23%        |                                                                                                                                                                                                                                                                                               |
|                                                                                               | Just so so     | 23               | 10%        |                                                                                                                                                                                                                                                                                               |
|                                                                                               | Terrible       | 1                | 0%         |                                                                                                                                                                                                                                                                                               |
|                                                                                               | No idea        | 9                | 4%         |                                                                                                                                                                                                                                                                                               |
| 2. How much do you think the marine areas of Tieshan Port District have been polluted so far? | Very seriously | 5                | 2%         | Nearly 50% of the public think the waters of Tieshan Port District have not been polluted until now, while a few believe that marine areas have been polluted to a certain extent.                                                                                                            |
|                                                                                               | Seriously      | 10               | 5%         |                                                                                                                                                                                                                                                                                               |
|                                                                                               | slightly       | 78               | 35%        |                                                                                                                                                                                                                                                                                               |
|                                                                                               | No pollution   | 106              | 48%        |                                                                                                                                                                                                                                                                                               |
|                                                                                               | No idea        | 23               | 10%        |                                                                                                                                                                                                                                                                                               |
| 3. How do you think of the current situation of local sound environment?                      | Good           | 140              | 63%        | The majority think the current situation of local sound environment is good.                                                                                                                                                                                                                  |
|                                                                                               | Just so so     | 62               | 28%        |                                                                                                                                                                                                                                                                                               |
|                                                                                               | Terrible       | 5                | 2%         |                                                                                                                                                                                                                                                                                               |
|                                                                                               | No idea        | 15               | 7%         |                                                                                                                                                                                                                                                                                               |

**Table 20.5-4 (cont.) Public Opinions on the Project and Statistic Results of the Investigation**

| Investigation Content                                                                                                                   | Answers        | Number of people | Proportion | Analysis                                                                                                                                                                                                                                                                                                                                                                                               |
|-----------------------------------------------------------------------------------------------------------------------------------------|----------------|------------------|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>III. Environmental Impact of the Proposed Project</b>                                                                                |                |                  |            |                                                                                                                                                                                                                                                                                                                                                                                                        |
| 1. Are you worried about the pollution on local air condition after the project is put into production?                                 | Yes            | 88               | 40%        | 87% of the public worry or worry a little about the air environment, which indicates that this issue raises high public concern, and the enterprise shall take appropriate environmental protection measures.                                                                                                                                                                                          |
|                                                                                                                                         | A little       | 104              | 47%        |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                                                                                         | No             | 27               | 12%        |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                                                                                         | No idea        | 3                | 1%         |                                                                                                                                                                                                                                                                                                                                                                                                        |
| 2. Are you worried about the pollution on marine areas of Tieshan Port District after the project is put into production?               | Yes            | 100              | 45%        | 86% of the public worry or worry a little about the water environment, which, therefore, shall be regarded as an important pollution treatment task conducted by the enterprise.                                                                                                                                                                                                                       |
|                                                                                                                                         | A little       | 90               | 41%        |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                                                                                         | No             | 29               | 13%        |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                                                                                         | No idea        | 3                | 1%         |                                                                                                                                                                                                                                                                                                                                                                                                        |
| 3. How much do you think the ecological environment of the ocean and coast shall be influenced after the implementation of the project? | Very seriously | 45               | 20%        | 78% of the public think that the implementation of the project shall exert influence on the ocean and coast ecological environment to certain extent. Thus, the ecological protection shall be taken during the project construction and operation period. Effective measures shall be adopted to reduce the negative impact made on the oceanic ecological environment.                               |
|                                                                                                                                         | Seriously      | 48               | 22%        |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                                                                                         | Slightly       | 81               | 36%        |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                                                                                         | No influence   | 17               | 8%         |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                                                                                         | No idea        | 31               | 14%        |                                                                                                                                                                                                                                                                                                                                                                                                        |
| 4. Do you think the growth of marine aquatic livings shall be influenced after the implementation of the project?                       | Yes            | 100              | 45%        | Quite a number of people believe that the implementation of the project shall influence the growth of marine aquatic livings. Therefore, the enterprise shall guarantee the discharge of waste water meets the standard required, and try every possible means to improve the production process and apply the advanced equipment so as to reduce the density and volume of the pollutants discharged. |
|                                                                                                                                         | No             | 43               | 19%        |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                                                                                         | No idea        | 79               | 36%        |                                                                                                                                                                                                                                                                                                                                                                                                        |
| 5. Are you worried that serious solid waste pollution shall occur after the project is put into production?                             | Yes            | 74               | 33%        | 76% of the public worry or worry a little about the solid waste generated from the project. Therefore, the enterprise shall have the solid waste disposed effectively, utilized comprehensively or covered up properly in designated places. Besides, relevant measures shall be taken during the solid waste transportation in order to avoid second pollution.                                       |
|                                                                                                                                         | A little       | 95               | 43%        |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                                                                                         | No             | 30               | 14%        |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                                                                                         | No idea        | 23               | 10%        |                                                                                                                                                                                                                                                                                                                                                                                                        |
| 6. Do you think the location of slag stockpile is proper?                                                                               | Yes            | 64               | 29%        | 29% of the public think the location is proper, as it is near the plant area and may reduce the environment pollution during transportation. 17% of the public think the location is improper, as it is near the coast and in the windward direction of many villages; while most people haven't got a clear idea about the location of the waste disposal area.                                       |
|                                                                                                                                         | No             | 38               | 17%        |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                                                                                         | No idea        | 120              | 54%        |                                                                                                                                                                                                                                                                                                                                                                                                        |
| 7. Are you worried that the odor shall impose negative influence on the                                                                 | Yes            | 89               | 40%        | 84% of the public worry or worry a little about the odor generated in the slag stockpile. Therefore, its location shall be as far as                                                                                                                                                                                                                                                                   |
|                                                                                                                                         | A little       | 86               | 39%        |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                                                                                         | No             | 29               | 13%        |                                                                                                                                                                                                                                                                                                                                                                                                        |



| Investigation Content                                                                  | Answers     | Number of people | Proportion | Analysis                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------------------------------------------------------------------------------------|-------------|------------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| surrounding environment?                                                               | No idea     | 18               | 8%         | possible from the residential area and relevant measures shall be adopted to relieve the negative influence of odor on the public.                                                                                                                                                                                                                                                                                                                    |
| 8. How far do you think the slag stockpile shall be located from the residential area? | 500m        | 16               | 7%         | Though 64% of the public regard 2.0 km above as an appropriate distance between the slag stockpile and the residential area, according to GB 18599-2001 <i>Standards for Pollution Control on the Storage and Disposal Site for General Industrial Solid Wastes</i> , it shall meet the criteria as long as the area is located in the leeward of dominant wind of the residential area, and its border shall be 500m away from the residential area. |
|                                                                                        | 1km         | 40               | 18%        |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                                                                                        | 1.5km       | 23               | 10%        |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                                                                                        | Above 2.0km | 143              | 64%        |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

**Table 20.5-4 (cont.) Public Opinions on the Project and Statistic Results of the Investigation**

| Investigation Content                                                | Answers                 | Number of people | Proportion | Analysis                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------------------------------------------------------------------|-------------------------|------------------|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>IV. Social &amp; Economic Impact of the Proposed Project</b>      |                         |                  |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 1. Currently, your income mainly comes from?                         | Aquiculture             | 117              | 53%        | Among the interviewees, the incomes of peasants mainly come from shrimp farming, the plantation of cassava, peanut and other economic crops, as well as ocean fishery. Therefore, the land requisition of the project may exert certain influence on the income of peasants.                                                                                                                                                                                               |
|                                                                      | Salt industry           | 10               | 5%         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                                                                      | Fishery                 | 49               | 22%        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                                                                      | Forestry                | 5                | 2%         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                                                                      | Crop plantation         | 66               | 30%        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                                                                      | Work away from home     | 9                | 4%         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                                                                      | Other means             | 83               | 37%        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 2. How much shall the proposed project influence your income source? | Greatly                 | 64               | 29%        | 29% of the public think the proposed project shall exert great influence on personal incomes. Most of them are villagers of Tianliao village who are asked for resettlement, or whose shrimp ponds are levied. 42% of the public think it shall exert certain influence. Among them, some people's land shall be levied but without resettlement, and some other are villagers from Xinwupo, Beimu Salt Works, Pokoutang and Nanle Village who are asked for resettlement. |
|                                                                      | Certain influence       | 94               | 42%        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                                                                      | Slightly influenced     | 52               | 23%        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                                                                      | No influence            | 0                | 0%         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                                                                      | No idea                 | 12               | 5%         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 3. If you are required to resettle, do you agree to do this?         | Yes with no conditions  | 45               | 20%        | 72% of the public think that if the resettlement is necessary, it must be a resettlement with conditions. Therefore, the resettlement and land requisition working group must                                                                                                                                                                                                                                                                                              |
|                                                                      | Yes but with conditions | 159              | 72%        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                                                                      | No                      | 10               | 5%         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

| Investigation Content                                                             | Answers                           | Number of people | Proportion | Analysis                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------------------------------------------------------------------------------|-----------------------------------|------------------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                   | No idea                           | 8                | 4%         | communicate more with the local villagers to reach effective agreement with them and compensate them in accordance with the relevant compensation standards regulated by the state.                                                                                                                                                                                                                                                                           |
| 4. Do you have any requirement on the resettlement conditions? (multiple choices) | Reasonable compensation           | 171              | 77%        | Judging from the statistic results, the conditions raised by resettlement residents include “reasonable compensation fees, proper resettlement location and sufficient employment opportunities”. Therefore, the resettlement and land requisition working group should communicate with villagers based on these conditions, try to satisfy their reasonable requirement and make sure their living standards shall not decline after resettlement.          |
|                                                                                   | Proper resettlement location      | 130              | 59%        |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                                                                                   | Complete basic living facilities  | 103              | 46%        |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                                                                                   | Transportation convenience        | 94               | 42%        |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                                                                                   | sufficient employment opportunity | 139              | 63%        |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                                                                                   | Others                            | 11               | 5%         |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                                                                                   | No idea                           | 4                | 2%         |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| V. Miscellaneous                                                                  |                                   |                  |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 1. Based on the above issues, will you support the construction of this project?  | Yes                               | 74               | 33%        | In a whole, 88% of the public support the construction of the project, as long as the enterprise meets relevant environmental protection requirements and carries out properly the resettlement and arrangement of villagers. A small number of people, however, are against the project, as they think the compensation scheme is not reasonable, not in compliance with the relevant standards on resettlement and land requisition regulated by the state. |
|                                                                                   | Yes with conditions               | 123              | 55%        |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                                                                                   | Postpone the construction         | 10               | 5%         |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                                                                                   | No                                | 9                | 4%         |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                                                                                   | No idea                           | 6                | 3%         |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

### 20.5.3.2 Feedback Opinions Collected from the Investigation Questionnaire

Judging from the feedbacks collected from the investigation questionnaire, 90 people have given their opinions and suggestions on the environmental protection and resettlement & arrangement issues of this project, as sorted out in Table 20.5-5.

**Table 20.5-5 List of Feedback Opinions Collected from Investigation Questionnaire**

| Opinions and Suggestions                                                                                                                                                                                                                                                                                                                                                                        | Accepted or not |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| <b>Public Opinions and Suggestions on Environmental Protection:</b>                                                                                                                                                                                                                                                                                                                             |                 |
| a. Anything that involves environmental pollution shall be treated as big issues and we hope the enterprise shall try their best to protect the environment.                                                                                                                                                                                                                                    | Accepted        |
| b. The volume of sewage discharged shall be controlled within relevant standards to avoid negative impact on marine species.                                                                                                                                                                                                                                                                    | Accepted        |
| c. The enterprise shall treat the waste gas properly and take effective measures to reduce the negative impact of odor on the surrounding environment to the maximum extent.                                                                                                                                                                                                                    | Accepted        |
| d. The enterprise shall treat the solid waste properly and take full considerations of the protection measures about solid waste handling in transportation.                                                                                                                                                                                                                                    | Accepted        |
| e. The enterprise shall adopt advanced technology in production and environmental protection treatment processes and make sure that the environmental protection funds are in place.                                                                                                                                                                                                            | Accepted        |
| f. As a large plantation area of eucalyptus is required in the project, I'm afraid that it shall do harm to the land species diversity and the agricultural production environment. I hope the enterprise and relevant government shall work out solutions to solve these problems.                                                                                                             | Accepted        |
| g. I suggest the government to objectively view the problems occurring in the Forest-pulp-and-paper Integration Project and adopt the modern forest and paper making technology to reduce the negative impact environment to the maximum extent.                                                                                                                                                | Accepted        |
| h. The local environmental protection administration department shall strength the environmental management and supervision of enterprise and carry out its working procedures in a strictly lawful way.                                                                                                                                                                                        | Accepted        |
| <b>Public Opinions and Suggestions on Resettlement:</b>                                                                                                                                                                                                                                                                                                                                         |                 |
| a. Implement the compensation standards of land requisition and resettlement in accordance with <i>Guidance on Complementation of the Compensation System of Land Requisition and Resettlement</i> (issued by Ministry of Land and Resources, [2004] No. 238) and the <i>Law of Land Administration of the People's Republic of China</i> and other relevant laws and regulations of the state. | Accepted        |
| b. All works shall be carried out on schedule and relevant funds and policies shall be in place. Conduct the resettlement in periods and award the advanced.                                                                                                                                                                                                                                    | Accepted        |
| c. The establishment of compensation standards shall be reasonable, taking into consideration not only the relevant national and local laws and regulations, but also the reality of market price rise, peasants' loss of fixed incomes and life security.                                                                                                                                      | Accepted        |
| d. I hope the decision on selection of resettlement location shall take into consideration of villagers' opinions. The communication and negotiation with villagers shall be carried out and relevant agreements shall be signed before the decision-making.                                                                                                                                    | Accepted        |
| e. I hope the relevant government institutions shall properly solve the employment and children education issues of the resettlement people and provide certain preferential treatment and support in accordance with relevant policies.                                                                                                                                                        | Accepted        |

## 20.6 Solutions to Feedback Opinions

The problems reflected from this public participation investigation mainly cover two aspects: compensation standards of land requisition and resettlement & arrangement scheme. Based on these problems, the following suggestions are proposed:

1. The resettlement and arrangement scheme shall be publicly announced to relevant people. The whole resettlement and land requisition work shall be conducted in a transparent, fair and open way;
2. Reasonable compensation standards shall be established to protect the lawful rights of the residents whose land is levied or whose houses are resettled;
3. The resettlement working group shall do more communication with the resettlement residents, collect public opinions from various channels, consider people's livelihood issues in a long run, especially the education, employment and social security issues;
4. The distribution of compensation fees shall be supervised to guarantee each land requisition and resettlement resident shall get the sum he or she should get;
5. Properly handle the complaint letter and visit from the public with attentions paid to the working attitudes and methods. Insist on people-orientation and build a harmonious society.

## 20.7 Conclusion

The investigation results show that 89% of the public know or know a little about the project, 57% of the public think the production scale of the project is appropriate and 59% of the public think the selection of plant site is reasonable. 86% of the public think the air quality is good, 50% of the public think the marine areas of Tieshan Port District have not been polluted. 80% of the public worry or worry a little about the pollution on air and marine water as well as the solid waste, odor and other environment issues caused by the project. The majority of the public think the slag stockpile shall be located beyond 2km from the residential area. 71% of the public think the construction of the project shall exert great or certain influence on personal income, and 72% of the public express that they shall not agree to resettle their residency unless conditions such as reasonable compensation fees, proper resettlement location, and long-run livelihood security are satisfied. To sum up, as long as the government can properly conduct the resettlement task and the pollutant discharged by the enterprise can be controlled within the environmental protection requirement, 88% of the public shall support the construction of the project.

## 21 Environmental Protection Management and Monitoring System

### 21.1 Environmental management

The environmental management of the project involves the supervision and management over Administrative Department of Environmental Protection and the environmental management over owner and construction unit. The Administrative Department of Environmental Protection at all levels shall conduct forceful environmental supervision for the project based on their different duties; the owner shall not only establish necessary management system and effective function organization, but also set sound regulations on environmental management; the construction unit shall be responsible for the environmental protection throughout the construction process and make sure the implementation of environmental protection measures in the construction period.

#### 21.1.1 Management Institution and Responsibilities

##### 21.1.1.1 Environmental Supervision and Management of the Administrative Department

###### (1) State Environmental Protection Administration

Fully in charge of the environmental management and supervision during the design, construction and operation period of the project, including: examination and approval of the Environment Impact Report; supervision over the implementation of environmental protection measures; final check and acceptance of the environmental protection facilities; confirmation of the environmental protection regulations and standards performed in the project; instructing the environment supervision and management work of Environmental Protection Bureau of Guangxi Zhuang Autonomous Region, Environmental Protection Bureau of Beihai City during the project construction and operation period.

(2) Environmental Protection Bureau of Guangxi Zhuang Autonomous Region, Environmental Protection Bureau of Beihai City, Environmental Protection Bureau of Tieshan Port District

Assist the State Environmental Protection Administration in comprehensive and concrete environment supervision and management.

##### 21.1.1.2 Environmental Protection Management of Owner

###### (1) Establishment of Organization

The owner shall establish a special organization for environmental protection management with one director and several management and supervision personnel. Meanwhile, each functional department and production workshop shall appoint part-time environmental

protection administrators, so as to establish an environmental management network consisting of the enterprise environmental management department, monitoring department, operation department of environmental protection facilities, equipment maintenance, supervision and itinerant inspection, technique and technology improvement, environmental system certification, clean production verification departments, etc.

## (2) Identification of Responsibilities

### a. Responsibilities

#### a) Director

- Grasp the overall dynamic situation of production and environmental protection;
- In charge of the examination and approval of position system, work and annual plan of the enterprise's environmental protection;
- Direct the implementation of environmental protection;
- Coordinate the relationship between departments and organizations inside and outside the enterprise.

#### b) Environmental management Department

- Implement the laws, regulations and standards on environmental protection stipulated by the state. Supervise and check the enforcement.
- Establish rules and regulations of environmental protection management, long term planning and annual plan of environmental protection and be responsible for the implementation.
- Supervise and check the enforcement of environmental protection laws and standards.
- Establish the management system and index system for pollutant discharge and environmental protection facilities. Put forward the management plan on operation of environmental protection facilities as well as improvement suggestions.
- Organize environmental monitoring and check the pollutant discharge at each pollution generation step, the operation status of environmental protection facilities as well as the environmental quality, etc.
- Organize environmental protection education and communications, as well as the

technical training. Carry out the exchange of environmental protection technology and extend the application of advanced technology and experience.

- Be responsible for the investigation and handling of the pollution accidents of the enterprise.
- Properly carry out the statistic work of environmental management and establish environmental protection archives.
- Coordinate and support local environmental protection institutions to carry out relevant work.

### (3) Establishment of Environmental Management System

The enterprise shall establish and improve the rules and regulations on environmental management, including:

- a. Regulations of environmental management, including the environmental management system, organization and assignment of responsibility and the interrelationship, the basic means and methods of the environmental management implementation and control, as well as the check, examination of environmental protection work, and the award & punishment regulations.
- b. Environmental quality management regulations, including the requirements on environmental protection target control, rules of pollution source management and regulations about environmental monitoring (including sampling, analysis, point location and environmental monitoring system).
- c. Environmental technology management regulations, including the principles and technical means of comprehensive prevention and control, pollution prevention measures, control process parameters and the operation regulations of environmental protection devices and equipment.
- d. Environmental protection business management system, including the management system of environmental protection plan, the management regulations of “three-simultaneousness”, regulations on the examination, repair and maintenance of the environmental protection facilities, regulations on management of poisonous and harmful articles, management system and emergency plan for pollution accident, enterprise environment and greening management system as well as the civilized production rules.

#### 21.1.1.3 Environmental Management of Construction Unit

The construction unit shall also establish the internal environmental protection management organization consisting of the chief principal and professional technicians, responsible for the environmental management at each construction step, so as to guarantee the normal operation of environmental protection facilities as well as the fulfillment of various environmental protection measures. The management content of the construction unit involves:

- a. Establish, supervise and carry out relevant rules and regulations of environmental protection management. Carry out the control measures of environmental protection and management of the pollution treatment facilities and preparation of detailed records for inspection.
- b. Report the pollution factors, existing problems, pollution control measures taken and implementation concerning the project construction to the administrative organization of environmental protection or unit head in time and put forward improvement suggestions.
- c. Work out the implementation plan of environmental protection measures for the construction period with the guidance of various environmental protection measures proposed in this report; identify the site location, environmental impact, environmental protection measures and implementation organization (person). Send such environmental plan in written form to relevant personnel so as to guarantee the effective implementation of various measures.

#### **21.1.2 Supervision plan of Environmental Management**

The implementation contents and objectives for the Administrative Departments of Environmental Protection at all levels on the proposed project are listed in Table 21.1-1.



**Table 21.1-1 Supervision Plan of Environmental Management**

| Period                         | Institution                                                                                                                                                                    | Supervision Content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Supervision Objective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Feasibility study period       |                                                                                                                                                                                | Examine and approve the environmental impact report                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | a. Assure comprehensive environmental evaluation, appropriate arrangement of subjects with certain focuses.<br>b. Guarantee that the possible significant and potential problems about the project are all reflected.<br>c. Assure specific and reliable implementation plans are in place for measures to mitigate the environmental impact.                                                                                                                                                                                                                                                                                 |
| Design and construction period | State Environmental Protection Administration<br><br>Environmental Protection Bureau of Guangxi Zhuang Autonomous Region<br><br>Environmental Protection Bureau of Beihai City | a. Examine and approve the preliminary design for environmental protection;<br>b. Inspect the implementation of environmental protection funds;<br>c. Inspect whether the locations of material site and ash soil mixing station are proper;<br>d. Inspect the pollution control of fly ash and noises and determine the construction time;<br>e. Inspect the discharge and treatment of domestic sewage and waste engine oil in the construction site;<br>f. Inspect the treatment of waste residue and the recovery of borrow & waste soil area;<br>g. Inspect the "three simultaneousness" of environmental protection facilities;<br>h. Inspect whether the environmental protection facilities meet the standard requirements. | a. Carry out rigorously the "three-simultaneousness";<br>b. Guarantee the environmental protection investment;<br>c. Guarantee the material site and mixing station meet the requirement for environmental protection;<br>d. Reduce the influence of construction on surrounding environment;<br>e. Guarantee the marine and underground water not to be polluted;<br>f. Guarantee the scenery and land resources not to be seriously damaged;<br>g. Guarantee the implementation of "three-simultaneousness";<br>h. Guarantee the environmental protection facilities to meet the requirements for environmental protection; |
| Operation period               |                                                                                                                                                                                | a. Inspect the implementation of environmental protection measures in the operation period<br>b. Inspect the implementation of environment monitoring plan<br>c. Inspect the sensitive points needed for further environmental protection<br>d. Inspect whether the environment quality of environmental sensitive area meets relevant standards.                                                                                                                                                                                                                                                                                                                                                                                   | a. Carry out the environmental protection measures.<br>b. Carry out monitoring plan.<br>c. Strengthen the environmental management to assure the normal operation of environmental protection facilities and guarantee the discharge meets relevant standards of environment quality.<br>d. Safeguard the health of people.                                                                                                                                                                                                                                                                                                   |

### 21.1.3 Implementation Plan on Environmental Protection and Pollution Prevention and Control Measures

The environmental protection and pollution prevention and control measures for the project construction, as well as the improvement measures proposed in this evaluation report, shall be carried out during the design period for the sake of implementation. While designing the implementation plan, the construction characteristics of environmental protection facilities shall also be taken into consideration, such as the construction cycle, the project integrity and other basic requirements, so as to plan as a whole; the corollary construction to the environmental protection and pollution prevention and control

measures shall also be completed as schedule.

See Table 21.1-2 for the implementation plan of pollution prevention and control measures in the project for details.

**Table 21.1-2 Implementation Plan of Environment Protection and Pollution Prevention and Control Measures**

| Major Environmental Issues |                                                        | Mitigation Measures                                                                                                                                                                                                                                                                                                                                                                                                                                 | Implementation Organization                   | Responsible Organization                    |
|----------------------------|--------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|---------------------------------------------|
| 1                          | Design Period                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                               |                                             |
| 1.1                        | Scheme selection                                       | Select the construction site in consideration of the production scale and process, “three wastes” treatment technology, operation expenses and the environmental impact of the project.                                                                                                                                                                                                                                                             | Design unit and environmental evaluation unit | Stora Enso (Guangxi) Pulp & Paper Co., Ltd. |
| 1.2                        | Air pollution                                          | In the soil excavation and transportation as well as the site leveling, the influence of fly ash and dust on the environmental sensitive targets shall be taken into considerations.                                                                                                                                                                                                                                                                |                                               |                                             |
| 1.3                        | Noise pollution                                        | For the sensitive points within the evaluation area, noise reduction measures shall be designed based on the exceeding standard level.                                                                                                                                                                                                                                                                                                              |                                               |                                             |
| 2                          | Construction Period                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                               |                                             |
| 2.1                        | Air pollution                                          | a. The material site shall be located above 200m away from the residential area and such measures as watering or covering shall be adopted to prevent the pollution of fly ash; trucks with construction material and earthwork shall be covered with canvas so as to avoid leakage on the road; c. The mixing devices shall be with good seal performance, dust-removal device shall be in place and attention shall be given to labor protection. | Construction unit                             | Stora Enso (Guangxi) Pulp & Paper Co., Ltd. |
| 2.2                        | Noise pollution                                        | a. Enhance the labor protection. Workers close to the noise source shall wear earplug and armet, and work in limited hours; b. The construction which may generate large noises shall not be carried out during 22:00-6:00. For special cases, approval from relevant departments is required; c. Improve the maintenance of machine and vehicles so as to keep the noises in a low level.                                                          |                                               |                                             |
| 2.3                        | Construction waste water                               | a. Sewage containing oil generated from repair and replacement of machines shall be discharged after being treated in the oil separation tank to meet certain standard; b. The waste water generated from construction vehicles and machines washing shall be treated in sedimentation tank and be discharged after meeting certain standard in stead of being discharged directly to the flood discharge trench.                                   |                                               |                                             |
| 2.4                        | Sewage and garbage within the construction living area | a. Domestic sewage shall be treated in the septic tank; b. Domestic garbage shall be placed collectively and be transported to designated location for treatment.                                                                                                                                                                                                                                                                                   |                                               |                                             |

|     |                                |                                                                                                                                                                                                                                                                         |                                                                                                                |                                                                                                                                         |
|-----|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| 2.5 | Water and soil loss            | Set up intercepting ditch and sand-sink pool in the construction site. Plant trees and grasses upon completion of the project to prevent water and soil loss.                                                                                                           |                                                                                                                |                                                                                                                                         |
| 2.6 | Transportation management      | Trucks for earthwork and construction material transportation shall be covered with canvas. The construction site and transportation road shall sprinkle with water frequently to reduce the dust pollution.                                                            |                                                                                                                |                                                                                                                                         |
| 2.7 | Construction safety            | Effective safety and precaution measures shall be adopted during the construction period.                                                                                                                                                                               |                                                                                                                |                                                                                                                                         |
| 2.8 | Environmental monitoring       | Monitor the ambient air, noise, etc.                                                                                                                                                                                                                                    | Local environment monitoring organization                                                                      |                                                                                                                                         |
| 3   | Operation Period               |                                                                                                                                                                                                                                                                         |                                                                                                                |                                                                                                                                         |
| 3.1 | Monitoring of pollution source | Waste air                                                                                                                                                                                                                                                               | Environmental management organization of enterprise                                                            | Stora Enso (Guangxi) company                                                                                                            |
| 3.2 |                                | Waste water                                                                                                                                                                                                                                                             |                                                                                                                |                                                                                                                                         |
| 3.3 |                                | Solid waste                                                                                                                                                                                                                                                             |                                                                                                                |                                                                                                                                         |
| 3.4 | Environmental monitoring       | Comply with the national regulations on technical monitoring, monitoring analysis methods and standards as well as the environmental monitoring rules.                                                                                                                  | Local environment monitoring organization                                                                      |                                                                                                                                         |
| 3.5 | Pollution accident             | a. Establish emergency plan for pollution accident and carry out relevant measures;<br>b. In case of pollution accident, take appropriate pollution control measures based on specific situation, and increase the monitoring frequency and conduct tracing monitoring. | Environmental management organization, local environment administrative department and monitoring organization | Stora Enso (Guangxi) Pulp & Paper Co., Ltd., Environmental Protection Bureau of Guangxi, Environmental Protection Bureau of Beihai City |

#### 21.1.4 Environmental Project Supervision

In the construction process, the project may generate various environmental problems. To solve these problems in time shall not only guarantee the smooth progress of the project, but also mitigate the impact on environment brought by the construction to the maximum extent. Therefore, the environmental supervision during the project construction period is a significant safeguard measure adopted by the owner to execute lawfully the “three simultaneousness” system of environmental protection.

During the project construction period, the owner shall entrust a qualified environmental supervision unit for environmental supervision. The responsibility of environmental supervisor is to communicate the environmental problems identified in daily on-site observation with the owner and the construction unit in a timely manner, so that appropriate measures shall be taken to control the problem sources and reduce the negative impact on environment to the lowest level.

### 21.2 Monitoring of Examination & Acceptance of “Three Simultaneousness” of the Project Environmental Protection

The examination and acceptance of project environmental protection aims to supervise the simultaneous putting into production or utilization of environmental protection facilities and the main body project of the project and to implement various environmental protection measures related to the project construction. The examination and acceptance of project environmental protection covers: various environmental protection facilities related to project construction, including the engineering, equipment, device or monitoring means established for or matched with pollution prevention and environmental protection and various ecological protection measures; environmental impact report and other environmental protection measures regulated by the design documents of the project.

Before the project is put into trial production, application shall be submitted to the State Environmental Protection Administration. Upon reception of the approval, the trial production shall commence. The completion environmental protection examination and acceptance shall be applied to the State Environmental Protection Administration in 3 months upon trial production. The examination and acceptance procedure shall be in compliance with the regulations of *Examination and Acceptance Methods about the Environmental Protection for the Project Completed* issued by the State Environmental Protection Administration.

See Table 21.2-1 for the examination and acceptance contents of “three-

simultaneousness” of the project environmental protection.

### 21.3 Environmental Monitoring Plan

The environmental monitoring aims to collect information about the impact on environment quality of the plant site during the construction and operation period, so as to conduct institutional monitoring on those key sectors with the potential of delivering obvious environmental impact. Thus, the possible factors concerning environmental impact may be discovered in time and provide a scientific basis for the environmental management. Besides, the environmental monitoring is also an important basis for the enterprise to establish environmental protection planning, evaluate the environmental treatment effect and carry out effective environmental management.

**Table 21.2-1 List of Examination & Acceptance for “Three Simultaneousness” of Project Environment Protection**

| SN | Environmental protection facilities and equipment                            | Monitoring Items                                                                                                                                                                                          | Investigation Content                                                                     |
|----|------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| 1  | Sewage treatment station                                                     | Sewage flow; water quality: pH value, chemical oxygen demand, biochemical oxygen demand, absorbable organic halogen, suspended substances, ammonia nitrogen, volatile phenol, sulfide and petroleum, etc. | Whether to be constructed as required by “three simultaneousness”                         |
| 2  | Precipitator of boiler and desulphurization equipment in thermal power plant | Flue gas parameter; density of sulfur dioxide, nitrogen dioxide and smoke & dust in flue gas; blackness of flue gas; desulphurization efficiency, dust removing                                           | Whether to be constructed as required by “three simultaneousness”                         |
| 3  | Precipitator of alkali recovery furnace                                      | Density of sulfur dioxide, sulfured hydrogen and smoke & dust in flue gas; dust removing                                                                                                                  | Whether to be constructed as required by “three simultaneousness”                         |
| 4  | Precipitator of rotary limekiln                                              | Density of sulfur dioxide and dust in flue gas; dust removing                                                                                                                                             | Whether to be constructed as required by “three simultaneousness”                         |
| 5  | Vibration and noise reduction measures for the equipment with high noises    | Noise of equipment, noises reduction effect and noise monitoring within the plant boundary                                                                                                                | Whether to be constructed as required by “three simultaneousness”                         |
| 6  | Fugitive emission source                                                     | Density of odor within the plant boundary, sulfured hydrogen; density of TSP inside boundary of coal site                                                                                                 | Whether to reach relevant standard                                                        |
| 7  | Slag stockpile                                                               | Density of TSP within the boundary of site area, density of odor; underground water monitoring well: pH, fluoride, sulfide, chloride and volatile phenol                                                  | Whether to be constructed as required by “three simultaneousness” and project regulations |
| 8  | Sewage drainage outlets                                                      | Sewage flow; water quality: pH value, chemical oxygen demand, biochemical oxygen demand, absorbable organic halogen, suspended substances, ammonia nitrogen, volatile phenol, sulfide, petroleum, etc.    | Whether to be constructed as regulated                                                    |
| 9  | COD online monitor                                                           |                                                                                                                                                                                                           | Whether the operation of instrument pass the metrology certification                      |
| 10 | SO <sub>2</sub> online monitor                                               |                                                                                                                                                                                                           | Whether the operation of instrument pass the metrology certification                      |

### 21.3.1 Environmental Monitoring System and Plan

#### 21.3.1.1 Ozone monitoring

According to opinions of experts from the technology assessment association of this report, the current status of the regional ozone shall be monitored, but taking into account the

existing monitoring capacity of the Guangxi Autonomous Region, this work should be completed before the project design. Based on the relevant provisions of *State Eleventh Five-Year Plan of Acid Rain And Sulfur Dioxide Pollution Control* (Environment Issue (2008) No. 1), the report should include project monitoring plan, in which the monitoring plan for current environment status of regional ozone shall be provided. The monitoring work is required to be accomplished before design completion of the project thermal power station. In case that the regional ozone content can't meet the prescribed standard, then the boiler of the project thermal power plant must be equipped with denitrification device; if the current environment quality status can meet the prescribed standard, the space for installation of denitrification device must be reserved. The EIA (environmental Impact Assessment) proposes following Ozone Environmental Quality Monitoring Plan:

(1) Layout of Monitoring Point

Monitoring points shall be established in Beimu Salt Works, Hamachi and Xinggang town government as well as Nankang town.

(2) Monitoring Factors

Ozone (hour value)

(3) Monitoring Time and Frequency

Monitoring shall be performed for 6 times per day for 7 days continuously, and the sampling time shall respectively be 02:00, 07:00, 10:00, 14:00, 16:00 and 19:00.

During the monitoring period, such meteorological factors including the temperature, the pressure, the wind direction, the wind speed, and the cloud quantity, etc, shall be monitored simultaneously.

21.3.1.3 Monitoring during the Construction Period

(1) Layout of Monitoring Point

a. Ambient air monitoring points shall be established in the construction site, 200m within the sand-stone processing area, 200m within the concrete mixing system and the sensitive points affected by construction (Yaxi Village and Haishan Dam);

b. Noises monitoring points shall be established in the major sensitive points in the construction site and transportation roads;

c. Monitoring sites on water quality, sediment and marine creatures shall be established in the marine areas possible to be affected. To compare with the investigation on current situation carried out in the evaluation, the monitoring and evaluation scope shall keep consistent. The number of monitoring sites may be reduced in specific conditions;

d. Water quality monitoring points shall be established for the underground water possible to be affected.

## (2) Monitoring Factors

Ambient air: total suspended particles

Noise: Equivalent continuous A-weighted sound pressure level,  $L_{Aeq}$

Seawater quality: water temperature, pH value, suspended substances, dissolved oxygen, chemical oxygen demand, inorganic nitrogen, active phosphates and petroleum.

Underground water: pH value, total hardness, permanganate index, ammonia nitrogen, nitrite, nitrate, volatile phenol, total number of bacilli and coliform group.

## (3) Monitoring Time and Frequency

Ambient air: Once every quarter and 5 days every time.

Noise: Once every month and 2 days every time.

Water quality: Once for spring and neap tides in every quarter respectively.

Underground water: once every quarter.

### 21.3.1.4 Monitoring during the Operation Period

#### (1) Layout of Monitoring Point

##### a. Pollution Source

a) To be discharged in an organized order through boiler chimney, exhaust point. The sampling port and sampling platform of exhaust funnel shall be set up in application of the layout technology of monitoring point;

b) Lay monitoring point in the respiration area for workers working in the fly ash discharge source;

c) Lay monitoring point in appropriate position of each workshop, waste water discharge outlet of each process, the inlet and outlet of sewage treatment facilities as well as the sewage discharge outlet;



d) Lay monitoring point around the major noise source;

e) For the odor with fugitive emission source, lay monitoring point in the leeward of the dominant wind direction and the location of point shall reflect its influential area.

#### b. Monitoring of Environment Quality

a) Lay ambient air monitoring points in major sensitive area (Yaxi Village and Haishan Dam);

b) Lay noise monitoring point within the plant boundary;

c) Lay monitoring sites on water quality, sediment and marine creatures in the marine areas possible to be affected or sensitive area;

d) Lay underground water monitoring points around the slag stockpile and plant area.

#### (2) Monitoring factors

##### a. Pollution Source

Waste gas: smoke & dust, fly ash, nitrogen dioxide, sulfur dioxide, sulfured hydrogen, blackness of flue gas, etc.

Waste water: pH value, color, chemical oxygen demand, biochemical oxygen demand, ammonia nitrogen, absorbable organic halogen, suspended substances, volatile phenol, sulfide, petroleum, etc.

Noise source: Equivalent continuous A-weighted sound pressure level,  $L_{Aeq}$

##### b. Environment Quality (major sensitive targets)

Ambient air: nitrogen dioxide, sulfur dioxide, total suspended particles, inhalable particles, etc.

Seawater quality: water temperature, salinity, pH value, suspended substances, dissolved oxygen, chemical oxygen demand, adsorbable organic halogen, inorganic nitrogen, active phosphates, petroleum, volatile phenol and sulfide.

Marine sediment: organic carbon, sulfide, petroleum, arsenic, copper, lead, zinc, cadmium,

nickel, total mercury, total chromium.

Marine creatures: chlorophyl a, zooplankton, phytoplankton, zoobenthos.

Underground water: pH value, total hardness, permanganate index, volatile phenol, ammonia nitrogen, chloride, sulphate, sulfide, nitrite, nitrate, total number of bacilli and total coliform group.

Sound environment: Equivalent continuous A-weighted sound pressure level,  $L_{Aeq}$ .

### (3) Monitoring Time and Frequency

Pollution source: once every quarter; for the monitoring on the odor with fugitive emission source, collect sampling 4 times every day to adopt the maximum value.

Ambient air quality: once a year and 5 days every time.

Sound environment quality: twice a year 2 days every time.

Seawater quality: monitor once during the high-flow period and low-flow period every year respectively;

Marine sediment: once a year simultaneous with the monitoring on water quality.

Marine creatures: once every two years.

Underground water: once a year.

### (4) Analysis Methods of Monitoring

In accordance with the *Specification for Oceanographic Survey*, the *Specification for Oceanographic Inspection* and relevant technical regulations on environmental monitoring of the state, adopt standard monitoring analysis methods and monitoring technology on pollution source. The latest effective edition shall apply.

#### 21.3.1.5 AOX (Absorbable Organic Halides) Monitoring Plan

Before the project is put into production, AOX monitoring shall be carried out to the deep sea drain outlet water area of the project and the water areas of the sensitive protective targets in the sea area (Shankou Natural Reserve of Mangrove, Dugong State Natural Reserve, as well as Yingpan Seal Breeding Farm) in order to understand the background

of AOX in the water body of the project sea areas.

After the projects have been formally operational, the monitoring shall be carried out once in main aquatic breeding and growing season -- spring of each year (mainly taking into account that spring is the growing season of aquatic animals and plants, and they shall be more sensitive to toxic substances at this time). The monitoring sites shall also be located near the project drain outlet and the water areas of the sensitive protective targets in the sea area, namely Shankou Natural Reserve of Mangrove, Dugong State Nature Reserve, as well as Yingpan Seal Breeding Farm.

#### 21.3.1.6 Implementation of Environmental Monitoring

It is suggested to entrust some qualified local environmental monitoring unit to carry out the monitoring during the construction period and the supervision monitoring during the operation period. The routine monitoring during the operation period shall be carried out by the monitoring department within the enterprise.

See Table 21.3-1 for details of the environmental monitoring point, monitoring factors or parameter, monitoring frequency and time. In the case of pollution accident, the monitoring frequency shall increase when necessary and tracing monitoring shall be conducted.

**Table 21.3-1 Environmental Monitoring Plan of the Construction Project**

| Elements for Monitoring | Period              | Layout of Monitoring Point (MP)                                             | Monitoring Factors                                                                                                                              | Monitoring Frequency                                         | Monitoring Organization                         | Monitoring Time                | Responsible Organization                    | Supervision Organization                                                                   |
|-------------------------|---------------------|-----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|-------------------------------------------------|--------------------------------|---------------------------------------------|--------------------------------------------------------------------------------------------|
| Water environment       | Construction period | Lay MP in marine areas where the construction wastewater is discharged.     | Water temperature, pH value, suspended substances, dissolved oxygen, chemical oxygen demand, inorganic nitrogen, active phosphate and petroleum | Once for spring and neap tides in every quarter respectively | Environmental Monitoring Station of Beihai City | During the construction period | Stora Enso (Guangxi) Pulp & Paper Co., Ltd. | Environmental Protection Bureau of Guangxi, Environmental Protection Bureau of Beihai City |
|                         |                     | Lay MP in major construction sites where the underground water is affected. | pH value, total hardness, permanganate index, ammonia nitrogen, nitrate, nitrate, volatile phenol, total number of bacilli and coliform group   | Once every quarter                                           |                                                 | During the construction period |                                             |                                                                                            |

| Elements for Monitoring | Period              | Layout of Monitoring Point (MP)                                                                                               | Monitoring Factors                                                                                                                                                                | Monitoring Frequency                  | Monitoring Organization | Monitoring Time                                                           | Responsible Organization                    | Supervision Organization                                                                   |
|-------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|-------------------------|---------------------------------------------------------------------------|---------------------------------------------|--------------------------------------------------------------------------------------------|
|                         | Operation period    | Seawater quality: monitoring scope is the same as that of environment evaluation. The number of MP may reduce when necessary. | Water temperature, salinity, pH value, suspended substances, dissolved oxygen, chemical oxygen demand, inorganic nitrogen, active phosphates, petroleum, volatile phenol, sulfide | Twice a year and 3 days every time    |                         | Monitor once during the high-flow period and low-flow period respectively |                                             |                                                                                            |
|                         |                     | Marine sediment: same as the layout of MP on seawater quality                                                                 | Organic carbon, sulfide, petroleum, arsenic, copper, lead, zinc, cadmium, nickel, total mercury, total chromium                                                                   | Once per year                         |                         | Simultaneous with the monitoring on water quality                         |                                             |                                                                                            |
|                         |                     | Marine creatures: same as the layout of MP on seawater quality                                                                | Biological quality, chlorophyll a, zooplankton, phytoplankton, zoobenthos                                                                                                         | Once every 2 years                    |                         | Simultaneous with the monitoring on water quality                         |                                             |                                                                                            |
|                         |                     | Underground water: one MP in the upstream of plant site and slag stockpile, two MPs in the downstream                         | pH value, total hardness, permanganate index, volatile phenol, ammonia nitrogen, chloride, sulphate, sulfide, nitrite, nitrate, total number of bacilli and coliform group        | Twice a year, 2 days every time       |                         | Monitor once during the high-flow period and low-flow period respectively |                                             |                                                                                            |
| Ambient air             | Construction period | Lay MP in the sensitive points affected by construction (Nanle Village, Haishan Dam)                                          | Total suspended particles                                                                                                                                                         | Once every quarter, 5 days every time |                         | During the construction period                                            | Stora Enso (Guangxi) Pulp & Paper Co., Ltd. | Environmental Protection Bureau of Guangxi, Environmental Protection Bureau of Beihai City |

| Elements for Monitoring | Period              | Layout of Monitoring Point (MP)                                                                                                                                              | Monitoring Factors                                                                                                                              | Monitoring Frequency                                                            | Monitoring Organization | Monitoring Time                                                                                                            | Responsible Organization | Supervision Organization |
|-------------------------|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|-------------------------|----------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------|
|                         | Operation period    | Lay MP in the sensitive points possible to be affected (Nanle Village, Haishan Dam)                                                                                          | Total suspended particles, inhalable particles, nitrogen dioxide, sulfur dioxide                                                                | Once per year and 5 days every time                                             |                         | Continuous monitoring for 18 hours every day for nitrogen dioxide, sulfur dioxide and 12 hours for inhalable particles     |                          |                          |
| Sound environment       | Construction period | Lay MP in the sensitive points to be affected by construction (Nanle Village, Haishan Dam)                                                                                   | Equivalent continuous A-weighted sound pressure level, LAeq                                                                                     | Once per month and 2 days every time                                            |                         | Twice per day in the construction time, in cases of night construction, once for daytime and night monitoring respectively |                          |                          |
|                         | Operation period    | Lay one MP to the east, west, south and north of the boundaries of plant                                                                                                     | Equivalent continuous A-weighted sound pressure level, LAeq                                                                                     | Twice per year and 2 days every time                                            |                         | Once for winter and summer, once for daytime and night under the normal operation of equipment                             |                          |                          |
| Waste water             | Operation period    | Discharge outlet of waste water treatment facilities, overall discharge outlet of the plant                                                                                  | pH value, suspended substances, chemical oxygen demand, biochemical oxygen demand, ammonia nitrogen, petroleum, sulfide, volatile phenol, color | 1 day per quarter, 3 times per day; online monitoring of chemical oxygen demand |                         | Simultaneous with online monitoring                                                                                        |                          |                          |
| Waste gas               | Operation period    | Electric thermal boiler, alkali recovery furnace and rotary limekiln                                                                                                         | Sulfur dioxide, smoke & dust, sulfureted hydrogen                                                                                               | 1 day per quarter, 3 times per day; online monitoring of sulfur dioxide         |                         | Simultaneous with online monitoring                                                                                        |                          |                          |
|                         |                     | For the odor with fugitive emission source, lay monitoring point in the leeward of the dominant wind direction and the location of point shall reflect its influential area. | Density of odor, sulfureted hydrogen                                                                                                            | Once per year and 5 days every time                                             |                         | Sampling 4 times per day to adopt the maximum value                                                                        |                          |                          |

## 21.4 Environmental Monitoring Instrument & Technical Document Management

### 21.4.1 Monitoring Instrument

In order to carry out the environmental monitoring work smoothly, the owner shall be equipped with the key monitoring instruments as listed in Table 21.3-2, including the online monitoring instrument of pollutant as well as the basic devices needed for routine laboratory monitoring and analysis of enterprises.

### 21.4.2 Management of Technical Documents

In the process of environment monitoring and management, the enterprise shall establish the following technical archives:

- a. The technical documents recording the pollution source and environmental quality monitoring;
- b. Operation and management technical documents concerning the design, examination & acceptance, routine inspection, repair and maintenance of environmental protection facilities;
- c. The archives of monitoring instruments as well as the inspection/calibration records of such instruments;
- d. Technical documents recording the pollution control measures adopted, generator of pollution accident as well as relevant investigation, treatment and tracing.

**Table 21.3-2 List of Key Instruments**

| Category                              | Key Instruments                                                                                                                                                                                                                                                                                                         | Usage                                                                                                                                                                              | Investment (yuan) |
|---------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| Online monitoring of pollution source | Online monitor for chemical oxygen demand and online monitor for sulfur dioxide                                                                                                                                                                                                                                         | Automatic monitoring on the density of chemical oxygen demand at the waste water discharge outlet as well as the density of sulfur dioxide in the flue gas from the exhaust funnel | 2,500,000         |
| Laboratory equipment of enterprise    | Atomic absorption spectrophotometer, UV-Vis spectrophotometer, pH meters, biochemical incubator, noise monitor, electronic balance, flue gas monitor, chemical oxygen demand analysis instrument, atmosphere sampling device, total suspended particles sampling device, water distiller, dry box, glass hardware, etc. | For routine monitoring and analysis carried out by the enterprise                                                                                                                  | 1,000,000         |
| Total                                 |                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                    | 3,500,000         |

## 21.5 Management of Waste Discharge Outlet

The setup of every waste discharge outlet of the enterprise shall follow the principle and standardized requirements of “easy for sampling, meter monitoring and routine onsite supervision and inspection” based on the national standards of *Graphical Signs for Environmental Protection Discharge Outlet (Source)* and the technical requirements of *Circular on Standardizing Pollutants Outlets* (trial) stipulated by the State Environmental Protection Administration. Establish appropriate environmental protection graphical signs and draw the discharge outlets distribution map. Meanwhile, equip the sewage discharge outlet with flowmeter and online monitoring system for industrial waste water treatment. Equip the treatment facilities with operation and monitoring device. The standardization of waste discharge outlet shall meet relevant environmental protection requirements.

### 21.5.1 Standardized Requirements on Waste Discharge Outlets

#### (1) Waste Water Discharge Outlet

In principle, only one waste water discharge outlet shall be set up. A sampling port shall be reserved within the plant boundaries of project (radius above 150mm). In cases where the discharge pipe is under pressure, sampling valve shall be installed.

#### (2) Waste Gas Discharge Outlet

The waste gas discharge outlet shall be established at the required height and comply with the *Technical Requirements of Pollution Source Emission Monitoring* to satisfy the sampling and monitoring requirements. The diameter of sampling port shall be no less than 75mm. Otherwise the sampling port needs to be confirmed with the environmental monitoring departments.

### (3) Fixed Noise Source

Treat the fixed noise source in accordance with relevant regulations and set up signs in the noise sensitive boundary point receiving the most serious influence.

### (4) Solid Waste Storage Site

Special storage site shall be reserved for common solid waste and domestic garbage and secondary fly ash prevention measures shall be taken; special storage area shall be set up for the hazardous waste with prevention measures for flying, loss or leakage.

## 21.5.2 Requirements on Signs Setup at the Waste Discharge Outlet

For pollutant discharge outlets and solid waste stockpiling site, the signs shall be set up in accordance with the national regulations of *Graphical Signs for Environmental Protection* (GB15562.1-1995 and GB15562.2-1995). The graphical signs for environmental protection shall be produced by manufacturer designated by the State Environmental Protection Administration and be ordered by the environmental monitoring departments based on the pollution discharge situation of enterprises.

(1) The graphical signs for environmental protection shall be set up close to the pollutant discharge outlet and the solid waste treatment area or sampling point, with a typical height of 2m to the ground from the upper border of the sign;

(2) Upright signs are mainly erected at the pollutant discharge outlet or solid waste storage (treatment) area of the key waste discharge units, while at the pollutant discharge outlet or solid waste storage site of the ordinary waste discharge units, upright or plane and fixed signs may be set up based on different situations;

(3) Suggestive graphical signs for environmental protection shall be set up at the general pollutant discharge outlet or solid waste storage site;

(4) Warning graphical signs for environmental protection shall be set up at the outlet where carcinogen with severe toxicity or other seriously harmful materials are discharged or the hazardous article storage and treatment site.



### 21.5.3 Archive Establishment Management of Waste Discharge Outlets

(1) Adopt the *Standardized Waste Discharge Outlet Sign Register of People's Republic of China* printed by State Environmental Protection Administration and fill in relevant information;

(2) As the requirement on waste discharge outlet management, after the project is put into production, the enterprise shall report to the Administration Department of Environmental Protection the number, location of waste discharge outlets as well as the type, quantity, discharge direction of major pollutants and file the standards establishment and facilities operation status.

## 21.6 Quality Assurance Measures to Investigation and Monitoring of Current Situation of Environmental Quality

In order to get accurate and reliable monitoring data and reflect objectively the environmental quality of the area being evaluated, effective quality assurance measures shall be adopted to exert quality control over the whole process of monitoring, including the layout of monitoring point, sample collection, transportation & storage, laboratory analysis & testing, data processing, etc.

### 21.6.1 Monitoring Unit

Units undertaking the monitoring tasks must be the monitoring stations having passed the metering authentication of the governmental metering administrative departments above provincial level or having been accepted by China National Accreditation Committee for Laboratories and being able to meet the requirements of the monitoring task concerning this project.

### 21.6.2 Monitoring and Analysis Methods

Adopt the technical regulations and standard on environmental monitoring as well as uniform monitoring and analysis methods. The latest effective edition shall apply.

### 21.6.3 Sampling and Sample Management

#### (1) Layout of Monitoring Point

Optimize the layout of monitoring point on the basis of on-spot inspection and in accordance with the national technical regulations and standard on environmental

monitoring as well as uniform monitoring and analysis methods, so as to guarantee the representative and operational nature of the monitoring point.

## (2) Sampling

- a) Sampling instrument shall meet certain requirement, pass the metering verification and be within the validity period
- b) Choose the sampling container accordant with requirements
- c) Keep the sampling device and sample container clean and tidy
- d) Prepare sample absorption solution according to the technical requirement
- e) Make flow calibration before using the atmospheric sampling device
- f) Sampling personnel shall pass the examination of relevant department and work with the post certificate
- g) Identify the sampling frequency and time based on the technical requirements
- h) Take down the sampling records

## (3) Sample management

- a) Add stabilizer or preservative to samples based on the technical requirements
- b) Send the samples in time to lab for analysis and testing
- c) Apply appropriate means of sample transportation, prevent the sample from being damaged, polluted or leaking during transportation
- d) Take down the sample handover records and mark the sample testing status
- e) Store samples based on the technical requirements
- f) Carry out necessary pre-treatment for samples based on the technical requirements
- g) Distribute samples to related personnel in time for analysis and testing

#### 21.6.4 Requirements for On-site Monitoring

- a) Conduct on-site monitoring for project necessary for on-site monitoring
- b) On-site monitoring instrument shall pass the metering authentication and be within the validity period
- c) On-site monitoring environment meets the relevant technical requirements
- d) Check the status of monitoring instrument before on-site monitoring is carried out. Conduct the monitoring upon all relevant requirements are met
- e) Calibrate the noise device before and after noise monitoring. Only when related requirements are met, shall the monitoring data be valid
- f) On-site monitoring personnel shall pass the examination of relevant department and work with post certificate
- g) Take down the on-site monitoring records

#### 21.6.5 Internal Quality Control of Laboratory

##### (1) Basic Requirement

- a) Laboratory shall be equipped with necessary condition monitoring facilities to guarantee the environmental conditions meeting certain requirements
- b) Experiment reagent, water and gas shall meet relevant requirement
- c) Analysis and testing instrument for metering purpose shall pass certain authentication and be in the validity period
- d) Apply standard article with certificate and in validity period to assure the accurate and reliable delivery of quantum
- e) Prepare and store the standard solution and laboratory reagent based on the technical requirements
- f) Analysis and testing personnel shall pass the examination of relevant department and work with post certificate

## (2) Internal Quality Control Methods

### a. Blank Experiment

Conduct blank experiment for each batch of samples at the same time and control the value of blank experiment to make the result 1/2 below the lower limit of concentration obtained in normal methods.

### b. Quality Control Samples and Adding Standard Recovery Analysis

Make parallel double samples analysis or adding standard recovery measurement on at least 10% of the samples. The tolerance difference or adding standard recovery rate of the parallel samples shall meet related requirements.

### c. Drawing and Verification of Calibration Curve

Before sample determination, the determination and drawing of calibration curve shall be carried out at first. The sample analysis results should be within the linear range of the calibration curve with correlation coefficient  $r \geq 0.999$ .

## **21.6.6 Data Processing and Auditing**

a. Keep integrity of the data. Except for the monitoring data, all original records, necessary weather and hydrographic data, quality control data (such as calibration instrument, blank sample, measurement results of parallel samples) shall be complete.

b. Conduct data processing in time. Whenever problems are discovered, take effective measures to make remediation for the phenomenon of low representative and reliable data due to factors such as location distribution, sampling frequency or incidental error in sampling.

c. Round off monitoring data according to number rounding off rules, so as to guarantee the standardization of data processing and the accuracy of monitoring results.

d. Report correctly the monitoring data by using the legal metering units.

e. Carry out three-level auditing system, including check, auditing and verification.

## 22 Evaluation Conclusions

### 22.1 Industrial Policies & Planning Compliance Analysis

The proposed project is located in Tieshan Port Offshore Industrial Zone, Beihai City with an annual productivity of 900,000 tons of pulp and 900,000 tons of paper and cardboard; 160,000 hm<sup>2</sup> of fast-growing and high-yield raw material forest shall be set up as integrated project. The site selection, construction scale and product structure are all in accordance with *Policies on Development of Paper Making* (Bulletin No. 71, 2007) issued by National Development and Reform Commission, the *Tenth-Five-Year and 2010 Special Plan of National Forest-Paper Integrated Project Construction*, *An Overall Plan for the Development of Forestry-Pulp-and-Paper Integration Industry of Guangxi from 2005 to 2015*. It is a project categorized as “the encouraged projects with certain economic scale for the forest-pulp integrated production of pulp, paper and cardboard” listed in *Guiding Catalogue of Industrial Structure Regulation (2005)*, No. 40 document issued by National Development and Reform Commission.

Beihai City is the frontier region of the Pan-Beibu Bay economic cooperation zone. The project is located in Beihai city of Guangxi province, its layout is in line with national development strategy of western development, and is also in line with the idea of “an axis, two wings” regional economic cooperation pattern and the strategic deployment of developing the maritime industries in the *Guangxi Pan-Beibu Economic Zone Development Plan*.

The *Beihai Overall Plan* has clearly pointed out that with the development orientation towards new high-tech industry, Tieshan Port shall be constructed to become a large coastal industrial base and port base of southwest thoroughfare to the sea. The proposed project is located within the land area allocated for the development of “forest-pulp-and-paper integration” and conforms to the *Beihai Overall Plan* as well as other relevant local planning.

### 22.2 Conclusion of Analysis on the Construction Project

#### 22.2.1 Project Overview

##### (1) Project Name

The 900,000 Ton Pulp and 900,000 Ton Paper and Cardboard Project of Stora Enso (Guangxi) Pulp & Paper Co., Ltd

##### (2) Owner

Stora Enso (Guangxi) Pulp & Paper Co., Ltd.

### (3) Construction Nature

Newly-built project

### (4) Construction Site

Tieshan Port Offshore Industrial Zone, Beihai City, Guangxi

### (5) Total Investment

The total investment on the proposed project amounts up to 20,395,623,900 Yuan ---.

### (6) Land and Building Area

The proposed project is to cover an area of 236.3hm<sup>2</sup>, with 198 hm<sup>2</sup> of plant site, and 564,506m<sup>2</sup> of building area.

### (7) Product Scheme and Scale

The proposed project is to be carried out in three phrases, including a production line with annual productivity of 900,000 tons of bleached eucalyptus chemical pulp (Phrase I), a production line with annual productivity of 450,000 tons of high quality card packing paper (Phrase II) and a production line with annual productivity of 450,000 tons of high quality fine paper (phrase III, 200,000 tons of dry static duplicating paper and offset printing paper and 250,000 tons of coated paper shall be produced annually). Part of the chemical pulp produced in phase I shall be allocated in the Group (Such as Stora Enso Suzhou Paper Co., Ltd.)), while the other part shall be sold as a commodity pulp outside. The second and the third phase engineering mainly take bleached eucalyptus chemical pulp, commodity softwood pulp boards, and bleached chemical-mechanical pulp as raw material. The bleached eucalyptus chemical pulp will mainly be provided by the first phase of the project, and the commodity softwood pulp boards and bleached chemical-mechanical pulp will mostly come from allocation within the group with a small amount outsourced from the international market.

### (8) Project Composition

Phrase I project involves the construction of main and auxiliary facilities such as raw material yard, raw material preparation workshop, pulp making workshop, pulp board workshop, alkali recovery workshop, chlorine dioxide preparation workshop and warehouse installations, as well as the public facilities such as thermal power plant, water supply purification station, circulation cooling water station and sewage treatment station;

Phrase II project involves the construction of main and auxiliary facilities such as pulp preparation workshop, paper-making workshop, finishing workshop and warehouse

installations, as well as the public facilities such as thermal power plant, water supply purification station, circulation cooling water station and sewage treatment station;

Phrase III project involves the construction of main and auxiliary facilities such as pulp preparation workshop, paper-making workshop, as well as the public facilities such as thermal power plant, circulation cooling water station and sewage treatment station.

### 22.2.2 Project Analysis

#### (1) Waste Water

The total water consumption of the proposed project shall reach 124,659m<sup>3</sup>/d. The waste water pollution source mainly involves pulp making, pulp board, alkali recovery, chemical preparation, paper-making workshops, thermal power plant, cooling water system, water supply treatment station and public facilities. 109,158m<sup>3</sup>/d of waste water shall be generated in Phrase III, where the volumes of major pollutants COD<sub>Cr</sub>, BOD<sub>5</sub> and SS are 43896, 15399, 21307t/a respectively.

The sewage treatment station of the proposed project is designed to reach the scale of 145,000m<sup>3</sup>/d with the application of physicochemical + biochemical secondary + physicochemical treatment process. The waste water after treatment can meet relevant requirements of GB3544-2008, the *Discharge Standard of Water Pollutants for Pulp and Paper Industry* (release version). The waste water up to standards shall be discharge to deep sea.

#### (2) Waste Gas

The waste gas pollution source of the proposed project involves mainly the flue gas discharged from the alkali recovery boiler, limekiln and circulating fluidized bed boiler, as well as the process waste gas discharged from the bleaching workshop. The flue gas discharged from alkali recovery boiler and limekiln shall be controlled by the electrostatic precipitator with three electrical fields at the dedusting efficiency up to 99%. The flue gas is discharged to the upper air through double-flue chimney (120mH); the flue gas discharged from circulating fluidized bed boiler shall be controlled by the electrostatic precipitator with four electrical fields at the efficiency of 99.75%. Limestone is added to the boiler for desulfurization with the desulfurization efficiency above 82%. The flue gas is discharged to the upper air through three-flue chimney (120mH×Φ2.7m). The acid gas from the bleaching workshop is washed with lye before emission.

The major odor pollution source of the proposed project: cooking system, evaporation station, alkali recovery boiler and limekiln. The total reduced sulfur with controlled emission

source shall be about 6.0kg/h.

### (3) Solid Waste

Main solid waste of the proposed project: cortex and wood chip from raw material preparation workshop; pulp residue from the pulp-making, pulp board and paper-making workshop; green mud from the causticization section at the alkali recovery workshop; coal fly ash from thermal power plant; sludge from sewage treatment station. Upon completion of phase III project, 484,429t/a of solid waste shall be generated, most of which can be comprehensively utilized except for green liquor dregs, lime residue and Class III sludge in need of landfill treatment (about 99642t/a).

The proposed project is to set up an open coal yard (6000m<sup>2</sup>) with the storage capacity of 7,500 tons and build a slag stockpile (300mu) 500m away from the southeast of the plant site, which may serve as the spare ash stack yard and landfill yard for green mud, lime residue and Class III sludge.

#### 22.2.3 Discharge Volume of Major Pollutants

After completion of the proposed project, the volume of waste water shall be 38.64 million t/a, and the emission amounts of COD<sub>Cr</sub>, BOD<sub>5</sub> and SS shall respectively be 3476 t/a, 771.7 t/a and 1161.1 t/a; the volume of waste gas shall be 1.18×10<sup>6</sup> ten thousand Nm<sup>3</sup>/a, and the emission amounts of SO<sub>2</sub>, smoke dust and NO<sub>x</sub> shall respectively be 3070 t/a, 526.3 t/a and 1325 t/a; all the solid wastes can be reasonably utilized and treated with discharge amount of zero.

### 22.3 Investigation and Evaluation of Current Environmental Quality

#### 22.3.1 Ambient Air

The monitoring results for environment in the evaluation area indicate: the air quality within the evaluation area is good. Both the average concentration per hour and the monitoring value of daily average concentration of sulfur dioxide at each environmental monitoring point reach Class II standard of GB3095-1996 *Ambient Air Quality Standard*; the daily average concentration of total suspended particles reaches Class II standard of GB3095-1996 *Ambient Air Quality Standard*; the monitoring value of sulfureted hydrogen in the environmental monitoring points (Yaxi Village and Binchi Village) is within the highest permission concentration limits of poisonous or harmful substance in residential area regulated in TJ-79 *Hygienic Standards for the Design of Industrial Enterprises*; the monitoring concentration values of sulfureted hydrogen and odor at 4 plant boundaries are



all below the (plant boundary) standard value listed in GB14554-93 *Emission Standards for Odor Pollutants*.

### 22.3.2 Underground Water Environment

The main surface water within the evaluation scope is the Nankang River about 6km west of the plant site. Because that the proposed project drainage (including sewage and rainwater) does not enter the river, and the river is also not the water-taking source of the project, therefore during this evaluation, investigations shall not be made to the current environmental conditions of the Nankang, but only be made to the underground water quality of the areas which are affected by the project. Judging from the investigation results, various monitoring indices of each monitoring point all reach the Category II standard regulated in GB/T14848-93 *Quality Standard for Ground Water* except pH value. The underground water within the area where the proposed project is located turns to be weak acid-neutral with a pH value ranging from 5.5~7.0, which is due to the regional geological conditions.

### 22.3.3 Marine Water Environment

15 water quality monitoring points are established within the marine areas being evaluated. Indices such as pH, dissolved oxygen, chemical oxygen demand, volatile phenol, inorganic nitrogen, active phosphates, sulfide, and petroleum are monitored according to 4 tide periods of ebb and flow of spring and neap tides. The monitoring results indicate that the concentration value of various indices in different tide periods at different monitoring point are all reach the standard requirements on corresponding functional area regulated in GB3097-1997 *Sea Water Quality Standard*, which means the current water environmental quality of marine areas being evaluated is good.

### 22.3.4 Marine Sediment

The location of investigation stations for marine sediment is the same as those water quality monitoring stations. The monitoring results indicate that the concentration values of every monitoring item at every site all reach the standard limits for appropriate functional areas regulated in GB18668-2002 *Quality Standard for Marine Sediment*.

### 22.3.5 Current Marine Biological Quality

According to the survey and analysis results, the single index for all other evaluation factors are all lower than 1 with the exception of Pb over-standard in some sites, which means the marine creatures' quality in the area being evaluated is generally good.

### 22.3.6 Current Marine Ecological Environment

The monitoring and investigation results and the history data of marine area being evaluated indicate:

(1) The content of chlorophyll a and the concentration of nutrient salt are far below the rich nutrition level and the primary productivity is comparatively stable, which shows that the overall waters environment quality of the marine area being evaluated are good;

Species in the marine area being evaluated are rich with high diversity.

(3) In recent years, the fishery resource in the marine area being evaluated is very rich. However, influenced by the over fishing in the inshore area, the number of fishes is declining year by year.

(4) The mangrove forest in the marine area being evaluated is in good growth condition. The seaweed used to grow in an unbalanced way, but tends to be more stable with the reinforced protection this year.

Generally speaking, the current marine biological environment situations of the evaluated marine area are good, the species are rich, the populations are well-structured, and the eco-environmental functions are basically stable within the region which only changes with seasons and the biological characteristics of lives. However, the overall change is little, showing relatively stable trend.

#### 22.3.7 Ecological Environment on Land

##### (1) Vegetation

The classification of land vegetation is simple dominated by the artificial vegetation. Species is lack of diversity. The amount of resource is insufficient and the quality is poor. There is no prophyta vegetation in the evaluation area and the existing vegetation includes secondary forest and artificial forest with crops and eucalypt as the majority. The investigation shows that no national key protected wild plants have been discovered within the evaluation area.

##### (2) Animal Resource

According to relevant information, investigation and consultation, there are few kinds of land wild animals within the evaluation area and fewer wild animals with key preservation of the state and autonomous region. It is hard to find any kind of preserved beast. The existing wild animals are mainly widespread species. The investigation shows that no

national key protected wild animals have been discovered within the area being evaluated.

### (3) Soil environment

The regional soil environmental quality can meet the requirements of secondary standard in the *Soil Environmental Quality* (GB15618-1995).

#### 22.3.8 Sound Environment

The noise values for daytime and nighttime at each monitoring point around the plant boundaries all reach the Category III standard regulated in GB12348-92 *Standard of Noise at Boundary of Industrial Enterprises*. The noise values for daytime and nighttime at each environmental noise monitoring point all reach the Category III standard regulated in GB3096-93 *Standard of Environmental Noise of Urban Area*.

## 22.4 Conclusions of Environmental Impact Prediction and Evaluation

### 22.4.1 Main conclusions of the Environmental Impact Report on project forest bases,

Environmental impact assessment of raw material forest base construction is accomplished by the China Environmental Science Research Institute upon entrustment of the owner with a separate review, and this report will only extract the main evaluation findings.

The designed pulp raw material forest base is at a scale of 160,000 hm<sup>2</sup>, which is planned to be located in 8 state-owned forest farms under Guangxi Gaofeng Group as well as 15 countries (cities and districts) under 4 cities including Beihai, Fangchenggang, Yulin and Chongzuo in the southern region of Guangxi. In small classes According to small class statistics result of forestry, the forestry meeting environmental requirements with small class strategy implemented covers an area of 132,400hm<sup>2</sup>, accounting for 82.7% of the planned raw material forest base area.

The varieties of trees selected for this project are eucalyptus and acacia trees, planning new afforestation of 123056.0hm<sup>2</sup> and raising the existing eucalyptus forest of 36944.0hm<sup>2</sup>. The designed rotation is 6 to 7 years and the designed average annual timber volume is 3.1184 million m<sup>3</sup>, which can meet the wood demand of the pulp factory.

The project construction is coordinated with the *Tenth-Five-Year and 2010 Special Plan of National Forest-Paper Integrated Engineering Construction*, the *Overall Plan of Fast-growing and High-yielding Timber Forest Base Construction in Key Areas*, the *Development Plan of Fast-growing and High-yielding Timber Forest in the Eleventh-Five-Year and 2020 for Guangxi Province*, the *General Plan of Ecological Construction in Guangxi Province*, the *Opinions of Guangxi Zhuang Autonomous Region People's Government on Speeding Up Forest Pulp and Paper Raw Material Forest Base Construction in the Coastal Areas*.

No damage of regional primitive and secondary natural forest will be caused in the forest land selected for this project, and the project construction will not produce adverse effects on the regional species diversity. The project construction will increase the eucalyptus plantations by an area of 129,000hm<sup>2</sup>, and the eucalyptus planting proportion of the project area will increase by 8.8%, which may lead to a single species distribution of the project area. Through the scientific cultivation of eucalyptus, and by adopting scientific forest management measures, such adverse environmental impacts including biodiversity, soil fertility decline, soil erosion and so on caused by the forest base construction can be avoided.

If seen from overall, the raw material forest base has evaded the ecologically sensitive areas even in the site selection and design phase, the project area is rich in forest resources, the project construction will have a certain influence on the existing forestry distribution changes to a certain extent, and the artificial forest management measures to be taken shall have greater disturbance to the project area and will have a certain degree of influence to the integrity and the stability of the ecosystems of the project area, especially to the integrity of the plant communities. In the raw material forest base construction process, if the afforestation is performed in accordance with the forest management specifications with various ecological protection measures implemented, the impacts to the ecological environment shall be acceptable.

## 22.4.2 Environmental Impact during the Construction Period

### (1) Impact on Ambient Air

The working processes exerting impact on air environment during the construction period are: transportation, loading and unloading of construction material, site leveling, concrete mixing and construction living area. The major pollutants to be discharged are total suspended particles (TSP), nitrogen oxides, carbon monoxide, total hydrocarbons and oil smoke. With relevant pollution prevention and control measures, their impacts on environment are reduced to a slight level.

### (2) Impact on Sound Environment

With various types of construction and application equipment, the range of noise level in the construction period shall change greatly. The noise impact in earthwork and stonework period is the most followed by the structuring period and decoration period.

The prediction results of mechanical noises during the construction period indicate: When several equipment with high level of noises are under operation at the same time, the daytime and nighttime noise value in Yaxi Village and other 5 sensitive points within the distance of 200m may exceed the standard.

### (3) Impact on Water Environment

Based on different working types and intensity during the construction period, when the average number of construction workers is about 1000 persons/day. On the basis of a per capita water consumption of 200L and the drainage volume accounting for 80% of water consumption, the domestic sewage discharge volume shall be about 160m<sup>3</sup>/d. The main pollutants are chemical oxygen demand, biochemical oxygen demand and suspended solids, and if not handled and directly discharged outside, will exert few impacts on the environment.

The construction time of the first phase engineering shall be up to a total of 28 months, the first 5 months is mainly for excavation and leveling with mechanical construction as the main content, the number of the construction workers is few (less than 100 people), and the life sewage can be treated in the septic tanks and used for irrigation of surrounding cassava land at this time. In the following 23 months of construction, the project's wastewater treatment facilities shall be completed 6 months earlier than other engineering (debugging requirements), which means that the construction sewage in the final 6 months of the construction can be discharged into the sea through the sewage facilities of the operation

period, and the sewage of the rest 17 months shall be treated by the integrated sewage treatment facilities and stored in the emergency pool of 60000m<sup>3</sup> (being given priority for construction) for natural evaporation. The life and construction sewage in the second and third phases of construction shall enter directly into the sewage treatment system constructed in the first phase engineering and be discharged after being treated, and no separate sewage facilities shall be constructed.

#### (4) The impact of offshore pipeline construction period

In the submarine construction process, a direct result shall be causing the death of the benthic organisms, the suspended sediment resulted will affect the water quality, and have a certain influence on the marine ecology, affecting an area of about 450m or so on both sides of the pipe. After the pipe laying, the effect of the suspended sediment on the marine environment shall disappear, and since this project pipeline construction time is only about 7 days, so the impact on the environment is extremely limited. As the linear range of the pipeline construction area is small, the marine life can move about in a large area. Partial construction will produce a small amount of biological hazards, but will not have a big negative impact on the marine life. The mangroves are scattered on the beaches along the pipeline, the pipeline excavation work will cause some damage to them, so in the pipeline construction, the mangroves should be transplanted into the surrounding beaches to reduce its adverse effects.

### 22.4.3 Prediction and Evaluation of Impact on Marine Areas

(1) Judging from the **prediction** results of the impact on water environment brought by COD from sewage discharged during each phase of project, COD may only exert partial impact on the water environment in normal operation conditions. COD with the concentration above 2.0mg/L in **Phase I**, II and III shall bring impact to the maximum area of 0.02km<sup>2</sup>, 0.03km<sup>2</sup>, 0.04km<sup>2</sup> respectively, which shall not create superposed impact with the COD in sewage discharged in the planned discharge outlet A; besides, no direct impact to the Dugong reserve, mangrove reserve and pearl oyster reserve shall be made. In the case of accidental drainage, COD in sewage shall bring widespread influence, but it only goes beyond the water quality standard of four kinds of seawater in some mixing areas. Therefore, more rigorous management shall be carried out and relevant prevention facilities shall also be established.

(2) After completion of the three phases of construction, the impact area of the BOD discharged to the water environment in this project is limited to the partial surrounding area of the sewage outfall B<sub>3</sub>, the maximum impact distance of water with BOD concentration greater than 1mg/L is about 110m, which will not exert a direct impact on the water

environmental protection objectives.

(3) The affected region of the AOX discharged to the water environment in this project is the sea area in the downstream direction of the sewage outfall B<sub>3</sub>, the maximum impact distance of water with AOX incremental concentration greater than 0.01mg/L is about 1.0km. In case of accident, the maximum impact distance of water with AOX incremental concentration greater than 0.1mg/L is about 500m; and the maximum impact distance of water with AOX incremental concentration greater than 0.01mg/L is about 3.12km. The AOX exerts small range of impact on the water environment and its impact on pearl oyster reserve, Dugong reserve and mangrove reserve is quite slight.

(4) The impact area of dioxin to the water environment is the sea area in the downstream direction of the sewage outfall B<sub>3</sub>, and the maximum impact distance of water with dioxin incremental concentration greater than 0.01pgTEQ/L is about 2.2km.

(5) In various working circumstances, SS only brings slight impact when it is above the standard limits for water quality of Class I and II seawater. SS exerts small range of impact on the water environment and its impact on pearl oyster reserve, Dugong reserve and mangrove reserve is quite slight.

(6) After completion of the three phases of construction, the impact area of the inorganic nitrogen, total nitrogen and total phosphorus discharged to the water environment is only limited to the partial surrounding area of the sewage outfall B<sub>3</sub>, the maximum impact distance of water with inorganic nitrogen concentration greater than 0.3mg/L is about 110m and the maximum impact distance of water with inorganic nitrogen concentration greater than 0.2mg/L is about 700m; the maximum impact distance of water with total nitrogen concentration greater than 0.3mg/L is about 170m, and the maximum impact distance of water with total nitrogen concentration greater than 0.2mg/L is about 950m; the maximum impact distance of water with total phosphorus concentration greater than 0.015mg/L is about 150m; all of these will not exert a direct impact on the water environmental protection objectives.

(7) After completion of the three phases of construction, an color incremental impact of pollutant in water is only limited to the partial surrounding area of the sewage outfall B<sub>3</sub>, the maximum impact distance of water with color increment greater than 1.0 is about 120m.

#### 22.4.4 Prediction and Evaluation of Impact on Air Environment

(1) The evaluated areas are located in the coastal areas, where the terrain is flat and open, the static wind frequency is low, the annual average wind speed is high, and the atmospheric transmittance and diffusion ability is strong, all of which are conducive to the spreading of air pollutants.

(2) In normal production, the waste gas discharged after all phases of project are put into production shall not exert great impact on the air quality for the evaluation area and various sensitive points. The regional air quality shall not be degraded.

(3) Project emissions of **odor** within the boundary of 500m of the plant have a certain influence on the air quality. According to the analogy investigation, the **odor** shall not create obvious influence to the area 4500m away from the plant's sewage treatment station in the leeward. Therefore, the health protection zone for **odor** shall be 500m away from the outer wall of sewage treatment station.

(4) As the water content of coal designed to be used in the project is 10% with a wind speed for dust flying above 9.3m/s, the wind speed in the evaluation area can hardly go beyond this rate. Therefore, the fly dust of coal yard may make few impacts. The regional ground-level concentration can reach the requirements of *Integrated Emission Standard of Air Pollutants*. It shall exert slight impact on the regional air environment and the health of working personnel. The concentration of coal dust for each workshop around the coal yard can also meet the requirements of *Hygienic Standards for the Design of Industrial Enterprises*.

(5) The height of chimney for boiler, alkali recovery boiler and limekiln reaches the requirements for environmental protection with reasonable design.

(6) In case of no desulfurization of the circulating fluidized bed boiler, although the concentration contribution value of the sulfur dioxide discharged to various interest points of the proposed second and third phase engineering is bigger than that under the desulfurization conditions, but after being superimposed with the background value, it's still within the limits of class 2 standard.

#### 22.4.5 Impact on Ecological Environment of Marine Area

The waste water drainage in the project shall only exert certain influence on the species distribution of phytoplankton, zooplankton and zoobenthos in some marine areas nearby the sewage discharge area. It shall not make great influence the marine creatures in the



marine area being evaluated and may bring slight influence to the key environment protection targets (three reserves and aquaculture area). It shall not damage the stability of the ecological system and thus is environmental acceptable.

Besides, few studies about the accumulative influence on various creatures exerted by AOX in papermaking waste water have been carried out. Therefore, tracing monitoring and study shall be carried out on the project after its operation.

#### 22.4.6 Impact on Ecological Environment on Land

##### (1) Impact on Vegetation

The annual contribution value of sulfur dioxide concentration is  $0.0029\text{mg/m}^3$  after the completion of Phase III project, to be superposed with the maximum monitoring background value of  $0.013\text{mg/m}^3$  for the evaluation area with the superposed value of  $0.0159\text{mg/m}^3$ , much lower than the concentration of chronic damage to vegetation, thus creating no obvious chronic effect on vegetation.

##### (2) Impact on Ecological Integrity

The major kinds of vegetation in the evaluation area are artificial forest and agricultural vegetation with artificial cultivation species. These are common, widespread species and artificial cultivated, which may not cause negative impact on the diversity of plant species. No rare preserved species have been discovered. No species extinction shall be caused. The majority kind of wild animals are birds. The project construction shall only exert slight impact on the biological diversity.

##### (3) Impact on Agricultural Production

In normal discharge circumstances, the daily average concentration of  $\text{SO}_2$  in air shall be in the range of  $0.0294\text{mg/m}^3$  and arrive at the maximum value of  $0.0424\text{mg/m}^3$  after being superposed with the background value. The maximum contribution value of primary concentration shall be  $0.0339\text{mg/m}^3$  and arrive at the maximum value of  $0.0509\text{mg/m}^3$  after being superposed with the background value, which is much lower than the standard limits regulated in GB9137-88 *Maximum Allowable Concentration of Pollutants in Atmosphere for Protection Crops*. Therefore,  $\text{SO}_2$  discharged from the project production shall not bring obvious impact to the crops within the area.

### 22.4.7 Analysis on Regional Social and Economic Impact

(1) The direct social impact exerted by the forest-pulp-and-paper integration project of Stora Enso (Guangxi) Pulp & Paper Co., Ltd. mainly refers to the impact on agricultural production and resettlement residents due to the land requisition and resettlement for preparation of plant site. Beihai Municipal Government has worked out *Detailed Rules and Scheme* for implementation concerning the project land requisition and resettlement compensation issues in accordance with relevant national regulations and standards. As long as the compensator properly carries out the resettlement compensation and arrangement for relevant residents while abiding by the requirements on land requisition, resettlement compensation and the arrangement scheme, the work and living of resettlement residents shall not be greatly influenced for a long period.

(2) The project construction is significant for solving the supply-and-demand contradiction in the coming 10 years of China. It is of great significance to the improvement of the industrial and equipment level of pulp and paper making in Guangxi and even whole China, as well as the grade improvement of the paper and cardboard products. Meanwhile, it shall facilitate the development of the forestry and paper making industry of Guangxi and enhance vigorously the economy of Guangxi; the construction of the project shall directly increase the local economic aggregate and bring more national and local financial incomes. It may promote the development of other related industries indirectly, to create more employment opportunities and help enhance the living standards and living quality of local residents.

### 22.4.8 Impact on Sound Environment

After the proposed project is put into production, except for the over-standard of the nighttime noise value at the west plant boundary, the noise values of other plant boundaries and area around the plant site all reach the evaluation standards. However, if compared with the current background value, the sound environment shall be changed greatly. The project noise may create certain impact on the sound environment at the environmental sensitive points within the evaluation area. However, the project noise may exert few impacts on other sensitive targets after these sensitive points are relocated according to the requirement of health protection zone.

### 22.4.9 Analysis on Impact of Solid Waste

In the design scheme of the proposed project, various solid wastes are properly handled with reasonable site selection of slag stockpile to satisfy the requirements of GB18599-

*2001 Standards for Pollution Control on the Storage and Disposal Site for General Industrial Solid Wastes*. Therefore, the solid wastes generated from the project shall not cause great impact to the surrounding environment.

#### **22.4.10 Conclusion of Environmental Risk Analysis**

The environmental risks involved in the project include the leakage, fire or explosion of methanol and the fire or explosion of liquefied petroleum gas. The risk identification results show that the leakage, fire or explosion of methanol storage tank, as well as the fire or explosion of liquefied petroleum may bring the most serious damage. They are ranked as maximum credible accident.

It is calculated that the maximum area radius for the fatal accident of methanol and liquefied petroleum gas explosion is 75m. People exposed within the area of fatal radius are the working personnel in the plant site. Judging from the impact on outer environment, fire and explosion bring slight influence to the nearby sensitive points. The over-standard range of methanol in the leakage accident may reach 500m in the leeward. The air quality in Yaxi Village and Haishan Dam shall be influenced to certain extent, but below the concentration causing acute poisoning.

By adopting the project design, safety evaluation as well as the various risk prevention measures and emergency rescue measures proposed in the evaluation, the occurrence rate of accidents may be reduced. The impact on surrounding environment can be mitigated with acceptable environment risks.

### **22.5 Water Resources Appraisal and Water Intake Impact Analysis**

The designed pumping water flow of upper dam pumping section in the water source engineering of Tieshan Port is  $6.0\text{m}^3/\text{s}$ , with years of average pumping flow at  $1.25\text{m}^3/\text{s}$ , taking up only 1.02% of years of average inflow of upper dam pumping section. The water source engineering of Tieshan Port delivers few impacts to the regional water resource, water ecological environment and other water users. The water intake for the project depends wholly on the water supply system of Tieshan Port Offshore Industrial Zone. Therefore, it shall not exert great impact on the regional water resource, water ecological environment and other water users.

### **22.6 Conclusion of Clean Production Evaluation**

The proposed project is to construct the largest single production line in the world with world leading technology and production equipment. To analyze and compare from various aspects from resource and energy consumption index of the proposed project, characteristic index of production technology, index of the comprehensive utilization of

resource, pollutant generation index to the production process and equipment requirements, it indicates that the proposed project has reached the advanced level of international clean production.

## 22.7 Pollution Prevention and Control Measures and Economic Feasibility Analysis

### 22.7.1 Waste Water Treatment Measures

All the production waste water and domestic sewage of the proposed project shall be treated in the sewage treatment station of the plant. The sewage treatment station of the proposed project is designed to reach the scale of 145,000m<sup>3</sup>/d with the application of physicochemical + biochemical secondary + physicochemical treatment process. The waste water after treatment shall meet relevant requirements of the *Discharge Standard of Water Pollutants for Pulp and Paper Industry* (GB3544-2008) (release version) and be discharged to deep sea.

By analogy comparison with the pulp and paper making enterprises of the same kind (i.e. Indonesia PRW pulp-and-paper making plant of P.T. Indahklat Pulp & Paper, Sinar Mas Group), it also adopts mixed method in treating the waste water generated in pulp and paper making. Secondary biochemical process is applied in the sewage treatment station. Based on its operation data, suppose the lowest removal rate of the biochemical treatment is 80%, COD<sub>Cr</sub> of the water flowing out after secondary biochemical treatment upon completion of the Phase III project shall be lower than 228mg/L. After a third physicochemical treatment, the removal rate may reach 60%, satisfying the discharge requirement of COD<sub>Cr</sub> 90mg/L. According to overseas research reports, the three physicochemical treatment is quite effective in removing suspended solids, and it's feasible for the SS to reach the discharge requirements of 30mg/l after undergoing the secondary biochemical treatment and the three physico-chemical treatment.

The project is only to add a small amount of biological nitrogen and phosphorus nutrients in the sewage treatment station selector so as to meet the needs of biochemical reactions. Therefore, the sewage discharged from the sewage treatment station will contain a small amount of ammonia nitrogen, total nitrogen and total phosphorus. Through the study of the water quality after tertiary treatment discharged by the sewage treatment stations of same type of foreign companies, and in combination with the requirements of discharge

standards for the project site, it's determined that the wastewater discharged from this project shall reach the standard limit value of ammonia 6mg/L, total nitrogen 8mg/L and total phosphorus 0.8mg/L.

In summary, after completion of three phases of construction, it's feasible for the water discharged from the sewage treatment station of the proposed project to meet relevant requirements of the Discharge Standard of Water Pollutants for Pulp and Paper Industry (GB3544-2008) (release version), namely pH value ranging from 6 to 9, color 50, COD<sub>Cr</sub> 90mg/L, BOD<sub>5</sub> 20mg/L, SS 30mg/L, ammonia nitrogen 8mg/L, total nitrogen 12mg/L, and TP 0.8mg/L.

The project wastewater discharge belongs to deep sea discharge. As special design of the ocean discharging engineering (including pipe laying) is not yet completed, so the actual outfall, direction, location, shape, size, length (the length on land and in sea) and others are still undetermined. To estimate according to the possible alignment of the sewage discharging pipe, the pipeline on the land area (including the land area formed by sea filling) is about 6km long, the pipeline for the sea areas is about 3km long, and the total length is about 9km. According to the coordinates of the channel knee and the sewage outfall, it shows that the B<sub>3</sub> sewage outfall is located in the west side of the existing channel and doesn't cross the channels.

### 22.7.2 Waste Gas Treatment Measure

The flue gas discharged from alkali recovery boiler and limekiln shall be controlled by the electrostatic precipitator with three electrical fields at the efficiency above 99%. As for SO<sub>2</sub>, most of the sulphur in the alkali recovery boiler may be recovered by the alkaline substance in the boiler. Therefore, only a little sulphur shall be discharged. White mud calcined in the limekiln shall generate limestone, which may react with SO<sub>2</sub> under high temperature, thus reaching the removal rate above 70%. The flue gas discharged from the alkali recovery boiler meets the requirement of Section III (resource comprehensive utilization boiler) in GB13223-2003 *Emission Standard of Air Pollutants for Thermal Power Plants*, i.e., smoke & dust 200mg/m<sup>3</sup> and SO<sub>2</sub> 800 mg/m<sup>3</sup>; the flue gas discharged from the limekiln meets Class II standard of GB9078-1996 *Emission Standard of Air Pollutants for Industrial Kiln and Furnace*, i.e., smoke & dust 200mg/m<sup>3</sup> and SO<sub>2</sub> 850 mg/m<sup>3</sup>.

The flue gas discharged from circulating fluidized bed boiler shall be controlled by the electrostatic precipitator with four electrical fields at the efficiency up to 99.7%. Limestone

is added to the boiler for desulfurization and the desulfurization rate can reach above 82.3%. The flue gas is discharged to the upper air through chimney (120mH×Φ2.7m). The emission of flue gas from circulating fluidized bed boiler meet the requirement of Section III in GB13223-2003 *Emission Standard of Air Pollutants for Thermal Power Plants*, i.e., smoke & dust 50mg/m<sup>3</sup>, SO<sub>2</sub> 400 mg/m<sup>3</sup> and Nox 450 mg/m<sup>3</sup>.

Sprinkling is adopted in the coal piling yard for dust controlling. Taking into account that the coal yard is located at seaside, where the wind speed is high, it's difficult to satisfy the dust-proof requirement only by water spraying and constructing green belt. Therefore, it's suggested to adopt the network for preventing and controlling dust and wind in the coal yard.

### 22.7.3 Odor Treatment Measure

The handling of odor involves the processes of collection and treatment. By improving the tightness of production line, the outer emission of TRS (total reduced sulfur) and other odor can be reduced. Then, collect TRS and other non-condensable gas generated at each section; send the odor of high concentration for burning in the alkali boiler and the odor of low concentration and gas discharged from smelt tank for burning treatment in the alkali boiler. At the same time, a spare scheme on odor treatment is also in place, i.e., to install a spare burner in the circulating fluidized bed boiler. In the case of default in alkali recovery boiler, the odor may go to the power boiler for burning. In case that both burning devices stop operation, the odor can be burnt with application of oil torch.

### 22.7.4 Noise Control Measure

The basic principle for noise control is that the equipment with noise level above 95dB (A) shall be installed in the special noise isolation zone; the equipment with noise range of 85-95dB (A) shall be equipped separately with muffler device to mitigate the noise below 85dB (A). The noise level at plant boundaries upon completion of the project may reach the requirement of Category III standard regulated in GB12348-90 *Standard of Noise at Boundary of Industrial Enterprises*.

### 22.7.5 Disposal Measures of Solid Wastes

(1) Sludge mainly comes from the sedimentation tanks at all levels and shall be treated with boiler burning or landfill.

(2) The green mud mainly comes from the green liquid sediment in the causticization section with the key contents of calcium carbonate and other nonsoluble substances. The main composition of lime mud is also calcium carbonate. It shall be landfilled in the solid

waste landfill site outside the plant.

(3) The main component of pulp residue is fiber, which can be sold to local small paper making factories for the production of low grade paper and egg tray; wood chip and other wooden wastes shall be thrown into the multi-fuel fluidized bed boiler to provide some heat so as to reduction the consumption of coal. As the pulp output of the first phase engineering (the thermal station is still under construction) is not at large amount, it shall be sold outside together with the wood waste.

(4) The lime ash can replace the clay or replace part of the clay for the preparation of cement raw material. The lime ash enjoys a wide range of comprehensive utilization. It is feasible to use treated lime ash in a comprehensive way.

(5) The solid waste landfill yard shall be tamped through backfilling layer by layer. The leakproof film shall be laid down. Install the seepage liquid flow dividing system in the leakproof layer in the slag stockpile. Discharge the seepage liquid collected to the sewage treatment station within the pulp making plant 500m far away from the solid waste landfill yard for treatment. The measures above all meet the requirements of GB18599-2001 *Standards for Pollution Control on the Storage and Disposal Site for General Industrial Solid Wastes*. The disposal scheme is feasible.

## 22.8 Pollutants Total Quantity Control Index

The total quantity indexes for pollutant emission of this project are: Sulfur dioxide 3070t/a; Chemical oxygen demand 3476t/a.

During the "Eleventh Five-Year" period, there is no SO<sub>2</sub> emission index in Beihai city. For the sulfur dioxide discharged in the proposed project, the non-thermal emission index of 1473t and the thermal emission index of 1597t/a shall be collectively arranged by the Autonomous Region with the total index of the project satisfied. The COD emission target of 3476t/a shall be solved by emission reduction of the existing project.

## 22.9 Rationality of Project Location, Discharge Outlet and General Layout

### 22.9.1 Rationality of Project Site Selection

The project is located in Tieshan Port District, Beihai City with superior region advantages, convenient transportation, good infrastructures, high environmental quality as well as sufficient raw material and water resources. The pollution dispersion capability of atmosphere and sea water is also very strong. Based on the analysis on the environmental capacity and pollutants discharge total quantity index, the emission volume of sulfur

dioxide and chemical oxygen demand does not exceed the total quantity control index of Beihai's 11<sup>th</sup> Five Year. There is still environmental capacity in the area where the project locates. To sum up, the site selection of the project is evaluated as reasonable.

### 22.9.2 Rationality of General Layout

From the perspective of environmental protection, process procedure, material transportation and the plant scenery, the general scheme is evaluated as reasonable. The shortcoming is that thermal power plant locates in the north of the plant, while the coal yard lies in the northwest of the plant in the windward direction of perennial dominant wind (north wind), which makes the plant easy to be influenced perennially by fly ash (dust). The liquefied petroleum gas station is in the middle of the plant and between the pulp board warehouse and timber storage yard with high risks of fire. It is suggested to locate the timber and hub storage yard in the leeward.

### 22.9.3 Site Selection of Discharge Outlet

According to the Program Demonstration Technical Report for the Sewage Outfall Layout of Tieshan Port Industrial Base formulated by the Tianjin Research Institute of Water Transport Engineering under the Ministry of Transportation and the Environmental Protection Research Institute of Guangxi Zhuang Autonomous Region, it is recommended to locate the waste water discharge outlet in B<sub>3</sub>, while meeting the following basic requirements:

(1) The discharge outlet is set up within the discharge area of Tieshan Port District in compliance with requirements of *Division of Functional Region in Guangxi Sea Area*.

(2) The hydrodynamic condition near the discharge outlet can facilitate the transfer and dispersion of pollutants to outer sea. Judging from the prediction results of the impact on water environment as well as the calculation results of substance migration trace, the sewage dispersion at the discharge outlet has slight impact on the water quality of adjacent waters. Nor shall it influence the usage of the approved discharge area.

(3) The calculation results indicate that the river estuary where the discharge outlet locates carries an obvious feature of back and forth flow. During the ebb and flow of tides, the substance migration trace is mainly shown at the right side of the estuary, which shall not influence the Dugong reserve and mangrove reserve.

(4) Avoid the existing sea route with the distance from the central line of sea route above



200m, without affecting normal navigation of sea routes.

## 22.10 Project Environmental Economic Profit & Loss Analysis [removed]

---

## 22.11 Public Participation

The results of public participation investigation show that 89% of the public know or know a little about the project, 51% of the public think the production scale of the project is proper, and 59% of the public think the plant site is proper. 86% of the public think that the local air environmental quality is good, and nearly 50% of the public think that the water quality of the Tieshan port is unpolluted. About 80% of the public worry or worry a little about the pollution on air and sea water as well as the solid waste, odor and other environment issues caused by the project. 71% of the public believed that the construction of the project will have a significant impact or have a certain influence to the economic income of the individual, and 72% of the public express that the only compensation for they will agree to relocate only under conditions of reasonable compensation, appropriate relocation sites and long-term livelihood is guaranteed. In general, if the Government do a good job in land acquisition and business-related emissions meet environmental protection requirements, 88% of the public to support the project construction.

## 22.12 Comprehensive Evaluation Conclusions

To sum up, the construction scale and technology scheme of the proposed project are in accordance with national industrial policies. The construction site is within the Tieshan Port Offshore Industrial Zone, Beihai City. It complies with such industry development planning as the *Tenth-Five-Year and 2010 Special Plan of National Forest-Paper Integrated Engineering Construction* in terms of layout and conforms to the *Beihai Overall Plan*, the *Regional Plan of Tieshan Port District*, as well as the local environmental functional division plan. The ambient air quality index for the evaluation area meets Class II standard of GB3095-1996 *Ambient Air Quality Standard*. The water quality for the marine area being evaluated reaches appropriate standard for functional area stipulated in GB3097-1996 *Sea Water Quality Standard*. The ecological environment in the marine area being evaluated is pretty good and the ecological system is basically stable. The proposed project is to apply the advanced process, technology and equipment with a world leading clean production. Sophisticated and reliable environment protection measures are adopted to guarantee that the pollutants emission reaches the national discharge standards, as well as the pollutant total quantity control requirement of Beihai City. It is verified that the seawater alternation capacity in the recommended discharge area is great. In normal circumstances of sewage

discharge, it shall exert a few impacts on the environment of sea area, no impact on the environmental function of adjacent marine area and slight influence on the environmental protection targets within the marine area; The exhaust gas and noise in the operating period shall have slight influence on the sensitive points in the evaluation scope.