

## SECTION A: INTRODUCTION AND BACKGROUND

### CHAPTER A5: ALTERNATIVES ANALYSIS

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## 5. ALTERNATIVES ANALYSIS

### 5.1 INTRODUCTION

The IFC Performance Standards on Social and Environmental Sustainability<sup>1</sup> specify the requirements for the assessment of feasible alternative configurations for a project:

*“Projects with potential significant adverse impacts that are diverse, irreversible, or unprecedented will have comprehensive social and environmental impact assessments. This assessment will include an examination of technically and financially-feasible alternatives to the source of such impacts, and documentation of the rationale for selecting the particular course of action proposed.”*

EBRD specifies similar conditions in its Performance Requirement 1: Environmental and Social Appraisal and Management<sup>2</sup>.

For the Oyu Tolgoi Project (“the Project”), the following are the major activities for which a number of alternatives have been evaluated:

- Mining options and production scale alternatives;
- Water supply and pipeline options;
- Power supply and transmission lines;
- Tailings management;
- Airport locations;
- Transport of concentrate to Chinese border (representing the point of sale); and
- Workforce accommodation.

This section also describes the “no project” scenario under which the Project would not take place.

### 5.2 “NO PROJECT” SCENARIO

Under the “no project” scenario, mining licenses would not be granted, approval for the Project would be denied, and the Project would therefore not be undertaken. *Table 5.1* below provides a summary of the Project versus no project scenario for key social, economic and environmental indicators.

**Table 5.1: Comparison of the No Project and With Project Scenarios**

Impact Category	No Project Scenario	With Project
<b>Fiscal &amp; National Economic Impacts</b>	<p>No change to current situation; fiscal revenue in Khanbogd <i>soum</i> area remains largely based on herding and low intensity agriculture.</p> <p>Development status of Khanbogd <i>soum</i> remains relatively low with little opportunity to for residents to receive training or acquire new skill sets.</p> <p>On a national scale, economy remains reliant on agriculture, and unemployment and underemployment remain high.</p>	<p>Government draws significant revenue from taxation, royalties and dividends from operation of the Project and from associated economic development and support industries.</p> <p>No significant loss of revenue from existing agriculture. Potential for increased agricultural productivity.</p> <p>Benefits may be summarized as follows:</p> <ul style="list-style-type: none"> <li>▪ Significant government revenue from taxes, royalties and dividends;</li> <li>▪ Increased tax revenue and economic activity from increased indirect commercial activity in Omnogovi <i>aimag</i>;</li> <li>▪ Introduction of best mining technology in Mongolia with wider application in the region;</li> <li>▪ Opportunity for Mongolian professionals currently underemployed to work in their profession within Mongolia;</li> </ul>

<sup>1</sup> Performance Standard 1, paragraph 9.

<sup>2</sup> Performance Requirement 1, paragraph 9.

Impact Category	No Project Scenario	With Project
		<ul style="list-style-type: none"> <li>■ Exposure, training and management expertise for Mongolian personnel in new technology and for the extractive industry generally; and</li> <li>■ Development of local enterprise and support industries throughout the Project Area of Influence and Mongolia (e.g. market for agricultural produce, catering and food supplies, infrastructure works and building projects, vehicle maintenance, services for Project activities including waste management ,etc.).</li> </ul> <p>Potential negative aspects:</p> <ul style="list-style-type: none"> <li>■ Focus of Government on extractive industry wealth generation to the detriment of the development of other business and services leaving the country vulnerable to commodity fluctuations;</li> <li>■ Inflationary pressures due to the increase in disposable income; and</li> <li>■ Increased wealth disparity across the population if poor Government planning results in inequitable distribution of taxation and royalties.</li> </ul>
<b>Socio-Economic Impacts</b>	<p>No change to current situation; adverse impacts of current situation include:</p> <ul style="list-style-type: none"> <li>■ Limited opportunities for employment;</li> <li>■ Exodus of trained and technically-competent workers to major cities and projects outside their home area;</li> <li>■ Exodus of younger generation resulting in changing demographic;</li> <li>■ Constraints on agricultural production imposed by limited water resources, harsh winters and overgrazing conditions;</li> <li>■ Low level of productive agriculture constrains ancillary commercial activities (e.g. markets, sales of fertilizers etc.); and</li> <li>■ Without the Project the mineral resources will remain undeveloped; no benefits will arise from development, nor will negative impacts accrue either at national or regional level.</li> </ul>	<p>The Project offers a major source of employment for a workforce sourced in preference from the area local to the Project, the Khanbogd <i>soum</i> and Omnogovi <i>aimag</i>. The construction workforce peaked at approximately 14,800 in December 2011, making the project the largest employer in Mongolia at that time. Almost 10,000 workers, equalling 67% of the total workforce were Mongolian citizens. In addition, Oyu Tolgoi is undertaking training for an additional 3,300 Mongolian workers from which it can recruit staff, while providing additional trained workers into the Mongolian economy. The workforce will be approximately 3,000- 4000 during operations.</p> <p>Positive impacts include:</p> <ul style="list-style-type: none"> <li>■ Major opportunities for employment; over 60% of the construction workforce will be Mongolian and 90% of the total operational workforce will be Mongolian;</li> <li>■ Retention of the major part of the Project workforce resident in their home base;</li> <li>■ Stimulation of local economy in towns and villages through retention of the resident population, increased disposable income and increased opportunities for local commerce;</li> <li>■ Increased market for local agricultural produce; and</li> <li>■ After closure and reclamation, potential benefits include access to secure water supply from deep wells, potential re-use of buildings and accesses, access to land restored to achieve agricultural productivity.</li> </ul> <p>Negative aspects:</p> <ul style="list-style-type: none"> <li>■ Influx of non-local workforce to established towns and villages including a potential increase in health risks;</li> <li>■ Increased pressure on local facilities by resident families (resident off-site) for medical facilities and schooling; and</li> <li>■ Loss of pastureland and disrupted access to pastureland and herder wells.</li> </ul>
<b>Depletion of Water Resources</b>	<p>Water resource availability will continue to be a general constraint for commercial and agricultural development in the South Gobi.</p>	<p>Water for operational use will be abstracted from the deep Gunii Hooloi aquifer which is not used for, and (based on the findings of this ESIA) only has limited connection to the surficial aquifers used for drinking water or herder supplies. No significant impacts on drinking water supplies or herder water wells are anticipated.</p> <p>Neutral Impacts:</p> <ul style="list-style-type: none"> <li>■ Operations will not result in adverse impacts on water</li> </ul>

Impact Category	No Project Scenario	With Project
		<p>users in the Gunii Hooloi aquifer area; and</p> <ul style="list-style-type: none"> <li>▪ New boreholes will be provided for herders if these are required.</li> </ul> <p>Positive Impacts:</p> <ul style="list-style-type: none"> <li>▪ An independent piped water supply is planned to be developed for Khanbogd as a joint Oyu Tolgoi /ADB project;</li> <li>▪ Benchmark for government and other potential users on the process of exploration, identification and permitting of water use in accordance with Mongolian and International good practices for large scale industrial operations; and</li> <li>▪ Source of expert advice from Oyu Tolgoi for local communities on water issues.</li> </ul> <p>Negative Impact:</p> <ul style="list-style-type: none"> <li>▪ An increase in the resident local population related to the improved employment opportunities will increase demand on local potable water supplies.</li> </ul>
<p><b>Destruction/ Deterioration of Natural Habitat</b></p>	<p>The current land use will largely remain unchanged; landforms will continue to experience erosion and gulleying as a result of seasonal rainfall, wind erosion, poor soil productivity and correspondingly poor vegetation cover and limited agricultural productivity. Land use will largely be constrained to limited grazing of herds.</p>	<p>There will be direct impacts within the Mine Operations Area, Oyu Tolgoi/Gashuun-Sukhait infrastructure corridor and Gunii Hooloi pipeline route.</p> <p>A restoration strategy will be applied across the mine site and other modified and developed areas after closure.</p> <p>Positive Impact:</p> <ul style="list-style-type: none"> <li>▪ Restoration will aim to establish areas across the site that have improved native vegetation, suitable to support a managed programme of productive grazing; and</li> <li>▪ The concentrate transport road to the Chinese border will be constructed as a paved road. This will reduce dust and avoid the development of multiple, parallel unsurfaced tracks.</li> </ul> <p>Negative Impacts:</p> <ul style="list-style-type: none"> <li>▪ Direct loss of habitat represented by the physical footprint of Project features including 64 km<sup>2</sup> in the Mine Licence Area, 1.5 km<sup>2</sup> for the airport and 1.3 km<sup>2</sup> for the borefield/pipeline corridor. The additional direct footprint of the road upgrade to Gashuun Sukhait is small, primarily comprising 19.4 km of linear infrastructure of ca.15 m width, as the remainder of the road will be constructed over an existing track;</li> <li>▪ Mine Licence Area footprint will also destroy ca. 52 ha of the ephemeral Undai river habitat, including the Bor-Ovoo Spring, and ca. 7 ha of numerous small ephemeral water courses which flow into Budaa water course;</li> <li>▪ The single largest biodiversity impact of the Oyu Tolgoi project is likely to be fragmentation of habitat and animal populations due to construction and operation of linear infrastructure associated with the project. The road upgrade to Gashuun Sukhait is, over time, predicted to act as a strong barrier to animal movement. While little empirical data is available for the Gobi region, traffic volumes of &gt; 2,000 vehicles/day have been shown to have a barrier effect to wildlife; and</li> <li>▪ Indirect habitat loss due to avoidance of infrastructure is categorized as a Critical Risk impact for Asiatic wild ass and goitered gazelle and a High Risk impact for argali and houbara bustard. Many priority biodiversity features are predicted to avoid areas close to project infrastructure and activities.</li> </ul>

### 5.3 MINING OPTIONS

As part of the development and evaluation of the Project, a range of different mining methods have been considered.

Two deposits (the Southern Oyu deposit and the Hugo Dummett deposit), have been identified within the overall mineral resource of the Project. The mining options available for mining these deposits include block caving and open pit excavations which are dictated by the depth of the deposits.

For mine planning purposes, the Southern Oyu deposit will be mined by open pit methods and block caving will be used at the Hugo Dummett deposit.

#### ***Open Pit Mining***

Given the shallow nature of the Southern Oyu deposit and the relative low grade (copper concentration) of the ore, these deposits will be mined by conventional open pit mining methods. An open pit mining operation is the only feasible means of mining and extracting ore in near-surface deposits. Additional reserves have been identified at depth beneath the surface zone and this deeper zone may be mined via a block caving approach.

#### ***Block Caving***

The deeper portions of the Southern Oyu deposit and the Hugo Dummett deposit are present at depths which are not accessible through open pit mining. Given the size and homogeneous nature of the Hugo Dummett deposit the most appropriate mining methodology is block-caving. This method has the advantage of being one of the least costly of all underground mining methods per tonne of ore produced. Block caving mining methods facilitates extraction of a greater proportion of an ore body relative to waste rock; no additional waste rock dumps will be required beyond those constructed for the process of ore from open pit mining. All mining material will be processed and waste will be deposited into the Tailings Storage Facility. Block caving also has the advantage of reducing surface impacts, with a surface subsidence area rather than an open pit.

Caving with a flat footprint is a proven, safe, and low-cost mining method currently used at several operations around the world. Examples of other companies using this method under similar conditions include Deep Ore Zone Mine in Indonesia, Henderson Mine in Colorado, Northparkes Mine in Australia and Palabora Mine in South Africa.

Block caving does not require excavation of an open pit, but a “zone of depression” will form immediately above the area where minerals are removed via block caving as a result of the ground subsiding.

### 5.4 WATER SUPPLY OPTIONS

Water is considered one of the most critical aspects of the Project in relation to environmental and social management. The company is absolutely committed to working with communities for the life of the operation to ensure that the community is not negatively impacted by Oyu Tolgoi use of water and that best water management practices are applied by all users.

The Project is located in the South Gobi Region, a region which has limited surface water resources due to the low annual precipitation. Groundwater resources are also limited, particularly potable supplies of groundwater which tend to be found in shallow near-surface aquifers. Studies indicate that pressure on potable water resources (surface and shallow aquifers) will increase as the local population increases as a result of increases in mining developments. Additionally, although mining operations utilise water from deeper aquifers the majority of the deeper groundwater in the area is fossil or ‘non-renewable’ in the short term, in essence taking hundreds or thousands of years to be replenished. The issues associated with the limited water supply in the South Gobi is recognised by the various levels of the Government of Mongolia and international organisations such as the World Bank<sup>3</sup>.

In recognition of these water supply issues, Oyu Tolgoi has carefully considered the potential sources of water available; assessing available options at a high level and then evaluating these in more detail. In addition to the evaluation of alternative water sources, the Project is also very aware that water represents a valuable asset and seeks to minimise water use through all aspects of the mine operations

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<sup>3</sup> Tuinhof, A. and Buyanhisnig, N. 2010. *Groundwater Assessment of the Southern Gobi Region*. Mongolia Discussion Papers, East Asia and Pacific Sustainable Development Department. Washington, D.C.: World Bank.

as discussed further in *Sections C5: Water Resources Impact Assessment* and *D7: Water Resources Management Plan*.

#### 5.4.1 Regional Environmental Assessment - Water Demand and Water Resources

Water supply depends almost exclusively on groundwater in the South Gobi region. Water for livestock and public supplies is extracted from traditional wells set into aquifers that are recharged by rain and snow. As a result, any use of groundwater for industrial water supply has to rely on deep aquifers with sufficient capacity for industrial supply purposes – surface water and shallow aquifers cannot meet this demand.

The World Bank has recently undertaken a regional environmental assessment of the southern Gobi<sup>4</sup> and conducted a supporting regional groundwater assessment<sup>5</sup>. These World Bank studies provide a framework for the identification, planning and management of groundwater resources within the South Gobi region. This section provides an overview of the World Bank's discussion on groundwater demand and water resources within their regional environmental assessment, followed by an overview of the World Bank's regional groundwater assessment.

The World Bank's regional environmental assessment considered a wide range of environmental issues related to land, water resources, public infrastructure and air emissions. Impacts were evaluated against two scenarios:

- A “base-case” scenario, that assumes the current operating and planned mining projects (including the Project) continue; and
- A “high-case” scenario which assumes that a range of other mines and other developments take place.

##### **Potential Impacts Related to Groundwater Abstraction Identified by the Regional Assessment**

The regional environmental assessment identifies a number of potential impacts related to groundwater abstraction by mining operations including:

- Dewatering of areas immediately surrounding mine sites where open pit excavations lead to a “cone of depression” which could lower the water table and adversely impact springs and deep-rooted plants that depend on the surface water table in a radius of from 3 to 7 km around a mine; and
- The use of deep aquifers for process water supply, where in virtually all cases, the mineral content of the water makes it non-potable and drinking water for mine workforces must be obtained from other sources.

Based on the base-case scenario, the assessment estimated a total process water demand of 136,000 m<sup>3</sup>/day, while no estimate for the high-case could be provided due to the high degree of uncertainty and limited information available with regard to many of the additional proposed projects.

The increased water demand from the development that is forecast under the high-case scenario could exceed the South Gobi Region groundwater potential (i.e., the amount that can be abstracted from the aquifers under reasonable criteria to avoid rapid, excessive depletion) by as early as 2020<sup>6</sup>. This could happen sooner in some parts of the Region and later in others; the timing depends on the match or mismatch between local or sub-regional demands and the supplies available from aquifers that are accessible to those demand centres at reasonable cost. Water supply could thus become a limit to growth in the South Gobi Region, and some planners would advocate that such a limit be observed in reviewing proposals for future development.

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<sup>4</sup> Walton, T. 2010. *Southern Gobi Regional Environmental Assessment*. Mongolia Discussion Papers, East Asia and Pacific Sustainable Development Department, Washington, D.C.: World Bank.

<sup>5</sup> *Op cit*.

<sup>6</sup> Acacia Water, 2009. Referenced in Tuinhof, A. and Buyanhisnig, N. 2010. *Groundwater Assessment of the Southern Gobi Region*. Mongolia Discussion Papers, East Asia and Pacific Sustainable Development Department. Washington, D.C.: World Bank.

One alternative discussed in the assessment is to import additional water from other regions. Pre-feasibility studies have been completed on two schemes to transfer surface water from river basins in the northern parts of Mongolia. The Herlen-Gobi Pipeline Project would carry 1,500 litres per second, or 130,000 cubic meters per day through a 540 km pipeline to Shivee Ovoo, Shainsand, and Zamin-Udd, with a side branch to Tsagaan Suvarga copper mine. The Orhon-Gobi Pipeline Project would transport 2,500 litres per second, or 215,000 cubic meters per day through a 740 km pipeline to Tavan Tolgoi and Oyu Tolgoi, with side branches to Mandalgovi and Dalanzadgad. Herlen-Gobi Pipeline and Orhon-Gobi Pipeline are included in the high-case scenario developed by the regional environmental assessment study.

As outlined above, the assessment concluded that sustainability of regional groundwater supplies for process water supply depends on maintaining a balance between demand and supply. While the region is rich in minerals, the ability to exploit those mineral resources is principally constrained by the availability of water supplies. With limited precipitation, no significant permanent surface water bodies and uncertainty over the impacts of changing climatic conditions on annual precipitation, the regional assessment determined that development decisions in the region must consider water supply from the outset.

### **Regional Water Availability**

The World Bank's regional groundwater assessment determined that the public water needs depends almost exclusively on the shallow groundwater supply in the South Gobi Region. Water for livestock and public supplies is taken from traditional, shallow and deep wells from aquifers that are recharged by rain and snow. For the large quantities of water required for mining and mineral processing, deeper aquifers are available. Many of these contain fossil water—that is, they have at some time in the past been cut off from sources of recharge by geologic changes—and many because of high salinity are not suitable for drinking water supplies.

Estimates of groundwater potential in the South Gobi Region are continually subject to change as new information becomes available, for example, as mining companies explore for new sources and test potential yields. A recent estimate, based on conservative assumptions, is that the groundwater potential is 500,000 cubic meters per day for the next 25 to 40 years<sup>7</sup>. However, because so much of this resource is fossil groundwater, extraction at that rate cannot proceed indefinitely. About 285,000 cubic meters per day can be withdrawn from the South Gobi Region's shallower aquifers altogether, assuming recharge at the conservative rate of 1 millimetre per year<sup>8</sup>.

### **Present and Projected Water Consumption**

The World Bank's assessment estimates that 240,000 cubic meters per day of water is used by existing mining and mineral processing operations and in those that will come into operation in the near future. The present total water consumption for livestock and rural and urban water supply is approximately 40,000 cubic meters per day. The three urban centres in the South Gobi Region jointly consume 6,500 cubic meters per day from boreholes. Average per capita consumption in the urban centres ranges from 110 to 130 litres per day. Rural consumption includes individual supplies from herder wells and water points and deep wells for *soum* centres and totals approximately 6,200 cubic meters per day, with average per capita consumption between 10 and 30 litres per day. Livestock consumption is estimated at 32,000 cubic meters per day<sup>9</sup>.

Approximately 30,000 small wells are thought to exist in the desert and desert steppe regions, and numerous mechanical wells were drilled during the collective era and maintained by the government. Most mechanical wells (i.e., engine and pump or Archimedes screw wells) have fallen into disrepair, or the underground water source has failed.

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<sup>7</sup> Tuinhof, A. and Buyanhisig, N. 2010. *Groundwater Assessment of the Southern Gobi Region*. Mongolia Discussion Papers, East Asia and Pacific Sustainable Development Department. Washington, D.C.: World Bank.

<sup>8</sup> Acacia Water, 2009. Referenced in Tuinhof, A. and Buyanhisig, N. 2010. *Groundwater Assessment of the Southern Gobi Region*. Mongolia Discussion Papers, East Asia and Pacific Sustainable Development Department. Washington, D.C.: World Bank.

<sup>9</sup> *Ibid.*

Based on conservative assumptions, there is considered enough groundwater to sustain projected regional development until 2020<sup>10</sup>. There is insufficient information to support an analysis of the detailed spatial distribution of groundwater potential across the South Gobi Region. Although the aggregate figures cited in the World Bank's assessment provide insight to the constraints of the Region's water supply on development, these figures are insufficient for land use planning. Clearly, the cumulative demand that several mines would exert if they abstract from the same aquifer needs to be considered in project-specific environmental assessments and regulatory approvals for water abstraction. The extent to which mining will compete with other uses - livestock and also rural and urban public supply - depends on the specific characteristics of the aquifer that any individual mine will utilise.

### ***Vulnerability of Water Resources***

In addition to decreases in precipitation that may result from climatic variability, the regional assessment considers that the South Gobi Region groundwater resources are vulnerable to the projected mining development and the population growth that will result from it in a variety of ways:

- The aquifers containing fossil groundwater are a one-time reserve that, once exhausted or so reduced as to be unproductive, will not be replenished. They therefore warrant special care in their exploitation;
- Prolonged exploitation of other deep aquifers, where there is a vertical connection to the surficial aquifers, can result in lowering of the water table and failure of shallow wells on which rural residents and livestock depend<sup>11</sup>;
- The possibility of horizontal interconnection between aquifers needs to be considered as well, though the Southern Gobi Region's geology is such that many of the deeper aquifers such as Gunii Hooloi are bounded by relatively impermeable rock formations that would limit interconnectedness;
- Mine dewatering lowers the water table in a large area—a radius of 3 to 7 km around the mine is assumed in the regional assessment report, based on information from Oyu Tolgoi - and this is likely to impact shallow water resources including springs and wells;
- Wells that tap a surficial aquifer and are too close together will interfere with one another because of the cone of depression or drawdown that forms around each well as it is being pumped. Moreover, if the estimated rate of recharge is correctly assumed at 1 millimetre per year, water table aquifers cannot sustain heavy drawdowns, because a recharge area of 1 square km would only add 1,000 cubic meters of new water in one year; and
- Finally, the shallow aquifers are vulnerable to pollution from wastewater, leachate from solid waste dumps, and chemical spills. The potential for pollution, while low at present, will increase with population growth and urban development.

### ***Impacts of Mine dewatering and Water Consumption***

The regional environmental assessment identifies the issue that mine site dewatering will directly lower the water table over an estimated 70,000 hectares. Local water sources such as wells and springs used by livestock, wildlife, and herder families would be impacted in the areas immediately surrounding mine operations. Vegetation that depends on the surface water table might not survive, with resulting impacts on habitat, plant cover, and desertification. In the aggregate, given the geographic scale of the South Gobi Region, the regional assessment considers that the impact on available pastureland is small. There is a possibility, on a local scale, that herders might find themselves displaced from some grazing land that is used for project facilities.

The assessment concludes that the potential impact is moderate, local/regional, and long term (persisting for some years after mine closure). The overall impact on the water table cannot be mitigated, but there are mitigation measures for some of the resulting impacts, mainly in the form of offsets to be provided by the mining companies including:

- The provision of new water supply points where existing wells or springs are impacted;

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<sup>10</sup> *Ibid.*

<sup>11</sup> *Ibid.*

- Improvement and protection of other springs in the vicinity of mine operations, such as South Gobi Sands is doing at Ovoot Tolgoi; and
- Monitoring the growth of plants such as saxaul and Siberian elm, with replanting and protection programs outside the zone of dewatering impact area to replace those plants that do not survive.

Overall the regional assessment considers that the South Gobi Region groundwater resources can sustain the development forecast in the base-case. Not enough is known about regional variations in groundwater availability to enable identification of areas of potential water supply shortfall in the short to medium term. The information needed to make these determinations will be collected to better inform water use planning strategies and help ensure that some aquifers are not over-utilised. The establishment of a central repository to accumulate and manage information on groundwater is recommended. In the long term, water resources planning on a national scale is important, because development planners recognise that growth in the South Gobi Region is likely to exceed available water resources. The constraints that water availability imposes on growth in the South Gobi Region must be understood in order to inform medium and long-range planning, and wide stakeholder participation is needed for identifying impacts to traditional water uses and needs. In addition, the best available information on climate change effects must be factored into the planning, and, where there is uncertainty, adopting a precautionary approach is considered appropriate by the regional assessment.

The regional assessment stresses that lack of data on groundwater resources makes predictions difficult and that water consumption information is not available for some of the mines. Nonetheless, it is possible that the demand for water from the developments in the high-case scenario will exceed the overall South Gobi Region groundwater potential. There are several uncertainties under this scenario:

- Insufficient data on groundwater availability that make it difficult to define resource limits;
- Unknown timing of new mining developments and related population growth; and
- Decisions still to be made regarding processing (e.g., will the various mines export washed or unwashed coal?).

The regional assessment concludes that there is little doubt that there is adequate groundwater to support development anticipated in the next 10 to 12 years and perhaps, given the conservative assumptions underlying the estimates, up to 25 years. It is probable, though, that planned development plus necessary supporting development (housing, for example) will generate demand that exceeds the potential of sub-regional or local groundwater sources. Continual data collection is required during construction and operations, and water availability needs to be an ingredient in planning and review of all major developments.

### ***Long-Distance Transfer of Surface Water to the South Gobi Region***

The regional assessment considers that if there is insufficient water within the South Gobi Region to support sustainable economic development, then planners must evaluate options for importing water from other regions

The assessment presents two long-distance water pipeline proposals - the Herlen-Gobi Pipeline and Orhon-Gobi Pipeline projects to augment water supply and support development in the South Gobi Region. In addition to feasibility studies, environmental impact assessments, and other necessary preparatory work, it is noted that the pipeline proposals should be analysed with respect to three “big picture” development planning concerns:

- The first of these is the sustainability of development in arid regions. In addition to relying heavily on groundwater, cities that exist in arid regions depend heavily on dams and reservoirs to capture water in nearby (or distant) mountains and use canals and pipelines to transport water to the region at considerable cost. Mongolia needs to be sure that the costs of maintaining cities in arid regions of the country are justified and sustainable;
- The second concern is large-scale water resource management. Transferring a significant fraction of the flow of two rivers (which also flow in the Russian Federation) to the South Gobi Region will have impacts on the flow regime and consequently on the ecology of the rivers. These impacts may have implications for future water use and development in the exporting river basins. Planning must be undertaken at a broad enough scale to reveal impacts and balance water needs for both ecology and economic activities in both the importing and the exporting regions; and

- The third concern is impacts of and adaptation to climate change. Here again, more data and more analysis are needed. The implications of climate change are not clear or simple in Mongolia; there is little doubt that average temperatures are changing but the implications for precipitation could vary across the country. In view of the uncertainty in exactly what ways climate change will affect Mongolia, a precautionary approach is essential in making major natural resource allocation decisions such as allocating surface water for interbasin transfers. A National Integrated Water Resource Management Plan that should examine these questions is in preparation.

The Long Distance Transfer options are evaluated in the subsequent sections of this chapter in the context of the Oyu Tolgoi project.

#### 5.4.2 Regional Groundwater Assessment

A regional groundwater assessment was prepared by the World Bank as a supporting study to the regional environmental assessment<sup>12</sup>. The groundwater assessment provides further detailed information on regional groundwater supply and demand and the relevant sections of the assessment are summarised below. The regional groundwater assessment estimates that annual total water consumption in Mongolia is approximately 443 million m<sup>3</sup> as summarised below.

**Table 5.2: Total Annual Water Use in Mongolia, based on 2005/6 Data**

Sector	Use	Total Water Use (million m <sup>3</sup> )
<b>Drinking water supply</b>		71
<b>Agriculture</b>	Livestock	80
	Crop Irrigation	52
<b>Industrial water supply</b>	Industry	36
	Mining	94
	Power production	27
	Hydro power	80
<b>Tourism water supply</b>		2
<b>Green areas</b>		<1
<b>Water for environmental functions</b>		-
		<b>443</b>

Source: NWC 2008, quoted in *Groundwater Assessment of the Southern Gobi Region*, World Bank.

Within the South Gobi Region, water supply is almost entirely from groundwater and springs as surface water sources are ephemeral. The main water use was traditionally for domestic water supply and livestock farming. The current demand for urban water supply to Dalanzadgad, Mandalgobi and Sainshand is 6,500 m<sup>3</sup>/day (total population 55,000). The supply is from well fields with treatment where necessary to achieve drinking water standards. The assessment derives a water consumption figure of 100-130 litres per capita per day, assuming that 50% of the population is served with house connections and the remaining through local "water kiosks".

Rural water supply is mainly from individual water points (herder wells) and from deep wells with pipelines that supply the *soum* centres. Water supply in the *soum* centres is mainly through kiosks, although some of the *soum* centres have a limited number of house connections. The total rural water supply is estimated at 1,000- 3,000 m<sup>3</sup>/day assuming a daily consumption of 10-30 litres per day for a rural population of 95,000. The total water use for livestock water supply is around 32,000 m<sup>3</sup>/day.

Groundwater use for agriculture is limited and confined to subsistence farming in villages and hamlets. Irrigated agriculture is applied on a small scale with surface water from springs and stream flow during

<sup>12</sup> Eco-Trade LLC, 2004. Referenced in Tuinhof, A. and Buyanhisnig, N. 2010. *Groundwater Assessment of the Southern Gobi Region*. Mongolia Discussion Papers, East Asia and Pacific Sustainable Development Department. Washington, D.C.: World Bank.

and after the rains. The present water demand for tourism and wildlife are also small compared to the mining, drinking water and livestock water demand.

The reported water demand of the mining industry in the South Gobi Region is around 190,000 m<sup>3</sup>/day of which approximately 180,000 m<sup>3</sup>/day for the four main mines: Oyu Tolgoi (67,000), Tavan Tolgoi (76,000), Tsagaan Suvraga (32,000) and Shivee-Ovoo (6,480)<sup>13</sup>. There is still uncertainty about the accuracy of these figures and to what extent they include water demands for current or planned mining operations.

**Table 5.3: Estimated Mine Water Demand in the South Gobi Region**

Mine	Type	Estimated 2010 Demand (m <sup>3</sup> /day)	Groundwater Source
Oyu Tolgoi	Copper, Gold	67,000	Gunii Hooloi
Tsagaan Suvarga	Copper	32,000	Tsagaan Tsav
Olon Ovoot	Gold	2,500	Bayan Hoshuu
Tavan Tolgoi	Coal	76,000	Balgasiin Ulaan Nuur Tavan Zag Tavan Ald Khurment Tsagaan Naimant
Nariyn Suhayt	Coal	-	-
Host	Coal	-	-
Shivee Ovoo	Coal	6,480	Jargalant Nuur Morit Spring
Odvog Hudag	Coal	3,440	Morityn Bulag Morit Spring
Tevsh Gobi	Coal	-	-
Omnogovi Ovoo	Khklmorit	950	Dugui Ulaan
Hamort	Lead	950	Dugui Ulaan
Urgun	Fluospar	860	-
Lugyn Gol	Rare earth metals	1,050	-

Source: Jadambaa 2007, quoted in *Groundwater Assessment of the Southern Gobi Region*, World Bank.

Detailed information on current and forecast water demand is only available for Oyu Tolgoi with consumption reported by *Tuinhof* at 67,000 m<sup>3</sup>/day or 600 litres per tonne of concentrate processed.

The copper mine in Tsagaan Suvarga (open pit mine) has an annual planned extraction capacity of 20,000 tpd (7.5 million tons/year and a reported water demand of 32,000 m<sup>3</sup>/ per day. This indicates a water use of 1,600 litres per tonne which is much higher than Oyu Tolgoi (600 litres per tonne). Applying the more reliable figure of Oyu Tolgoi, the Tsagaan Suvraga water demand is much lower (13,000 m<sup>3</sup>/day).

Information on water demands for coal mining is not readily available. Mining operations in the Tavan Tolgoi and Nariin Sukhait area are still modest but given the enormous coal reserves in the area, the mining production is expected to increase sharply in the coming years.

### **Future Water Demand**

Future water demand depends on the economic and infrastructure development of the region, but it is evident that the mine development will be the most important regional water consumer and the trigger for

<sup>13</sup> Jadambaa, 2007. Referenced in Tuinhof, A. and Buyanhisnig, N. 2010. *Groundwater Assessment of the Southern Gobi Region*. Mongolia Discussion Papers, East Asia and Pacific Sustainable Development Department. Washington, D.C.: World Bank.

population increase in regional towns and additional industrial and commercial development. Mining water demand will depend on the number of new mines, rate of expansion and the type of technologies used. For the main mining areas, an attempt is made to estimate the 2015 water demands based on the currently know expansion plans:

- **Oyu Tolgoi:** planned extraction of 110,000 tpd will be reached in the next 4-6 years with a corresponding water demand of 70,000 m<sup>3</sup>/day;
- **Tsagaan Suvarga:** the planned extraction capacity is 7.5 million tpa, which would require 13,000 m<sup>3</sup>/day (using the Oyu Tolgoi unit figures);
- **Nariin Sukhait/Ovoot Tolgoi:** 15 million tpa of which 50% is processed (average demand 600 litre/ton), giving a water demand of 25,000 m<sup>3</sup>/day;
- **Tavan Tolgoi:** 30 million tpa using 600 litres/ton, giving 50,000 m<sup>3</sup>/day; and
- Other mines : 20,000 m<sup>3</sup>/day.

Assuming an annual increase of 10% in the period 2015-2020, the 2020 water demand would reach 300,000 m<sup>3</sup>/day in 2020. Urban water supply will grow around the mines and in the *aimag* capitals and *soum* centres. The assessment cites expected population increase in the vicinity of the main mines of 110,000 by 2020. Assuming an overall increase of the urban population to 200,000 in 2020, the urban water supply demand will reach 25,000 m<sup>3</sup>/day.

Increased demands for water associated with other economic activities such as additional industrial development, deep-well agriculture to produce specialty crops and animal feed, more intensive livestock production near provincial cities, tourism development, etc. are difficult to estimate without more detail on the timing, size and specific nature of these activities. As for the urban water supply, water demands are also expected to increase in response to population growth in the area of mining activities and around the existing urban areas.

Environmental water demands have not been sufficiently studied or mapped to define the future water needs for sustaining environmental conditions in the South Gobi Region. In total, the assessment estimates a total water demand of 425,000 m<sup>3</sup>/day in 2020 as outlined in *Table 5.4*.

**Table 5.4: Estimated Current and Future Water Demand in the South Gobi Region**

Sector	Est. 2005/10 Demand (m <sup>3</sup> /day)	Trends	Est. 2020 Demand (m <sup>3</sup> /day)
<b>Mines</b>	40,000	Some main mines coming into operation in the next 5 years. Annual increase 2015-2020: 10%	300,000
<b>Industry</b>	Small	Increase expected around mining areas	12,500
<b>Urban water supply</b>	6,500	Urbanisation around mining areas will increase	12,500
<b>Rural water supply</b>	3,000	Annual increase of 5%	5,000
<b>Livestock water supply</b>	32,000	Annual increase of 5%	50,000
<b>Irrigated agriculture</b>	Small	Vegetable production around urban centres. Assumption of 1,000 ha @ 10,000m <sup>3</sup> /yr	30,000
<b>Tourism</b>	Small	Remains small and localised	15,000
<b>Total</b>	<b>85,000</b>		<b>425,000</b>

Source: *Groundwater Assessment of the Southern Gobi Region, World Bank.*

### Water Resources in the South Gobi Region

Aquifers are layers of water-bearing permeable rock or unconsolidated materials (gravel, sand, silt, or clay) through which groundwater can flow and from which groundwater can be usefully extracted using a water well. The occurrence of groundwater (and its quality) in the aquifers and its movement depends not only on type of formation but also on the recharge mechanisms. All groundwater must have had a source of recharge at some point. This is normally rainfall but can also be seepage from rivers, canals or lakes.

Infiltrating water percolates to the water table and flows from the points of recharge to the points of discharge (such as springs). The aquifer flow regime depends on the hydraulic characteristics of the rocks (media) and the hydraulic gradient and may vary widely with the geology and the recharge conditions. Groundwater systems are dynamic with groundwater continuously in slow motion from zones of recharge to zones of discharge, tens, hundreds or even thousands of years may elapse during this process, especially in arid and semi-arid regions.

All aquifers have two fundamental characteristics: a capacity for groundwater storage (productivity) and a capacity for groundwater flow (continuity). Productive aquifers have good hydraulic characteristics and usually a distinction is made between highly, moderate and low productivity to classify the aquifers in a region. Continuous aquifers have a regional extension and are usually referred as major aquifers. Aquifers with a smaller extension (as is the case in the South Gobi Region) are called minor aquifers or local aquifers.

In some cases aquifers are cut off from their source of recharge due to geological events or climatic changes. These are called fossil (or non-renewable) aquifers. For fresh groundwater abstraction the term non-renewable can be interpreted in two ways, quantitatively and qualitatively:

- Quantitatively: when fresh groundwater is not replenished which results in a continued decline of the water level (both in the pumping well and regionally); and
- Qualitatively: when fresh groundwater is (partly) replenished by more brackish or saline groundwater resulting in an increased of salinity.

“Fossil” groundwater requires special care in its exploitation as it comprises a one-time reserve which is not replenished.

The geological formations of particular interest for groundwater resources in the South Gobi Region are the Permian, Triassic, Jurassic, Cretaceous, Paleogene, Neogene and Quaternary rocks and sediments, which form a complex set of local aquifers at different depths and extent. Of most relevance to this assessment are the shallow aquifers used as the primary drinking water and livestock watering resources, and the deeper Cretaceous sandstone aquifers from which the majority of industrial/mining water supply is derived. Typically, aquifers in the South Gobi Region are not extensive and are surrounded by low permeability rocks. Recharge of the aquifers from rainwater infiltration feeds the shallow aquifers, while the deeper aquifers are primarily “fossil” water with little or no rainfall-driven recharge.

The low annual rainfall in the region (100-150 mm/year) leads to limited recharge, but still represents a significant amount of renewable water given the large surface area of the region. A number of studies have indicated recharge of 1-2 mm/year. The effects of changes in climatic regimes on groundwater resources are still little understood, but the deep groundwater resources to be used by mining operations are fossil and therefore will not be affected by current changes in climatic regimes as the aquifer was filled during other climatic conditions and is now effectively trapped in the deeper layers.

Estimates suggest that the total groundwater potential abstraction in the region is 250-500 million m<sup>3</sup>/year. The assessment suggests that the lower figure can be considered as a conservative figure as it is based on the results of studies and investigations and safe assumptions of the usable proportion of groundwater. The assessment goes on to say that it may be expected that further studies and investigations will reveal the presence of yet unknown deeper aquifers or that a better knowledge of the recharge will lead to an increase of the useable fraction of shallower groundwater. The assessment concludes that despite the uncertainties in the estimated groundwater reserves and water production potential, the likely presence of substantial amounts of groundwater in the South Gobi Region at different depths makes it worthwhile to investigate the large-scale exploitation of groundwater.

The assessment identified groundwater potential (the potential to supply groundwater) in the range of 200-500 million m<sup>3</sup>/year and current water demand in the order of 80,000 m<sup>3</sup>/day which will increase to 400,000 to 450,000 m<sup>3</sup>/day in 2020. Based on this, the assessment concluded that the groundwater potential for the South Gobi Region as a whole is sufficient to meet water demands over the next 10-12 years. Meeting water demands on a sustainable basis will require active water management to match supply and demand, which will require a mix of instruments and actions including water use efficiency, exploration for further groundwater resources, the development of alternative (surface) water supply options, and effective permitting control to ensure that water supply and demand remain in balance.

The following sections consider water resources from the perspective of the Oyu Tolgoi project and summarise the key steps that have been undertaken to assess and identify the most appropriate water supply options.

### 5.4.3 Mine and Process Water Requirements

The average make-up water demand required for the initial 110,000 t/d mine production is modelled to be 696 litres per second (L/s), with a peak demand of 785 L/s (summer demand). This is based on the conservative assumption that there is no water recovery from the underground or open pit mines. In reality there will be some seepage into the open pit and any rainfall events on the site will potentially provide additional water, however as these cannot be guaranteed these are assumed to make a zero contribution to the mine water demands.

### 5.4.4 Construction Phase Water Supply Alternatives

During the construction phase of the Project, water will be obtained from the shallow surficial aquifers and the deeper weathered bedrock aquifers within the project construction fence line. The alternative of trucking water into the site was not considered feasible given the distance to alternative wells in the region. Also, there would be potential cumulative impacts of using existing potable water wells, for example in Khanbogd *soum*. There are no other users within the fence line and the area of influence of the construction phase wells is contained within the fence line. The use of this water will also result in a depletion of water in the weathered bed rock aquifer which has the advantage of partially dewatering the immediate area within the construction area in advance of the open pit being started.

### 5.4.5 Operational Process Water Supply Alternatives

The identification and evaluation of water supply options for mine operations has been an ongoing activity by Oyu Tolgoi since the discovery of a commercially viable copper deposit in 2002. Oyu Tolgoi has an active water resource identification and evaluation programme that is continuing to look at both water supply and also waste water minimisation through water use efficiency, reuse and recycling.

#### **Strategic-Level Assessment**

A number of alternative sources of water supply for the operation phase have been considered at the site. At a high level the alternatives considered are set out below.

**Table 5.5: Strategic Water Supply Alternatives**

Alternative	Assessment
<b>Damming of local watercourses</b>	<ul style="list-style-type: none"> <li>■ This was deemed unfeasible as there is no significant surface water course in the area of the mine, and the main ephemeral water course in the area (the Undai) only flows for a few hours a year.</li> <li>■ There is also no suitable valley section near to Oyu Tolgoi in which a dam could be constructed, and furthermore the low rainfall and high evaporation rates would make an open dam unsustainable.</li> </ul>
<b>Use of local groundwater resources</b>	<ul style="list-style-type: none"> <li>■ The current population in Khanbogd <i>soum</i> rely on shallow groundwater for their potable water and animal husbandry needs. This shallow groundwater could not supply the necessary water flow to the Project to meet the operational demands.</li> <li>■ Exploration by Oyu Tolgoi identified a number of new deep groundwater resources in the vicinity of the mine site which are not used by the local population and which are generally too saline to be used for potable water or for animal watering. Testing of these aquifers demonstrated that they had the potential to satisfy the water demands of the project.</li> </ul>
<b>Development and use of a national water supply pipeline</b>	<ul style="list-style-type: none"> <li>■ No national water supply pipelines exist in Mongolia and for such a source to be used for the mine supply it would require a pipeline connection to a permanently flowing river. The permanent rivers such as the Kherlen or the Orhon exist in the north of Mongolia; therefore any pipeline would need to be over 500 km long and buried along its entire length so the water would not freeze in the pipes during winter. This would involve significant capital costs, significant environmental and social impacts, a lengthy permitting and construction process and, if only laid as a single pipeline, then it would</li> </ul>

Alternative	Assessment
	<p>leave the project at risk to supply disruption.</p> <ul style="list-style-type: none"> <li>Some planning by the Government has been carried out for water supply pipelines, but the plans are at a conceptual pre-feasibility level and need further study and analysis to satisfy critical socio-economic, financial and environmental questions<sup>14</sup>. Such supply may become an option in the next decades if there is a strategic plan by the Government of Mongolia to develop a national water supply network; however this timescale is too great for the immediate requirements of the mine.</li> </ul>

The provision of fresh surface water is more suitable and necessary for community supplies and horticulture than for use in industrial applications. From a sustainability of water resource perspective it makes little sense in using fresh water for mine processing purposes where non-potable, saline, water resources can be used which will not compete with potable water demands. In addition, there is likely to be substantial environmental constraints in relation to surface water (pipeline) projects using northern rivers, many of which flow internationally. This is discussed in more detail in both the World Bank regional groundwater assessment and regional environmental assessment as described above.

Based on this initial strategic review, it was concluded that a local deep groundwater resource was the only realistic source of groundwater supply for the Project and within the proposed project development timetable and these resources were then subject to more detailed appraisal.

#### **Regional Assessment of Water Demand**

Water demand scenarios to 2020 have been developed and these estimate overall water demand in the South Gobi at 6,000 litres per second as follows.

**Table 5.6: Estimated Regional Water Demand, 2020**

Water User	Estimated Demand (l/s)
<b>Energy and Mining Industry</b>	
Shivee-Ovoo	616
Tsagaan Suvarga	604
Oyu Tolgoi	1060
Tavan Tolgoi	951
<b>Subtotal</b>	<b>3231</b>
<b>Urban Water Supply</b>	
Madalgobi	50
Dalanzadgad	70
Choir	40
Sainshand	85
Zamiin-Udd	50
Soum Centre and rural	104
<b>Subtotal</b>	<b>399</b>
<b>Agriculture and Environment</b>	
Livestock	200
Agriculture	1750
Environment	300
<b>Subtotal</b>	<b>2250</b>

<sup>14</sup> Mongolian National Water Programme Support Centre. 2007. Long Distance Water Transmission Pipelines and Applications for the Gobi and Steppe Regions of Mongolia. Ulaanbaatar.

Water User	Estimated Demand (l/s)
Other	120
<b>Total</b>	<b>6000</b>

Source: *Groundwater Assessment of the Southern Gobi Region, 2010.*

Based on the above analysis, Oyu Tolgoi will utilise approximately 18% of the regional water demand of 6,000 l/s in 2020.

Water supply pipelines are being considered at a conceptual level by the Government and are still at a very early stage of development, and are not yet at a commercially viable stage. Initial cost estimates suggests that regional water pipeline projects may cost in the region of \$1 billion with annual operation and maintenance costs of \$230 million<sup>15</sup>. A comparison of groundwater and surface water supplies is set out below.

**Table 5.7: Comparison of Groundwater and Surface Supply Options**

Option	Positive Issues	Negative Issues
Groundwater supply	<ul style="list-style-type: none"> <li>▪ Estimated potential sufficient for the next 10-15 years, plus additional potential in deeper aquifers;</li> <li>▪ Available near the point of use;</li> <li>▪ Lower investment cost;</li> <li>▪ Phased implementation;</li> <li>▪ Security of supply (decentralised); and</li> <li>▪ No transboundary issues.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Resource potential not fully known: continued investigations / mapping needed;</li> <li>▪ Data and information scattered;</li> <li>▪ Need for management, regulation and monitoring;</li> <li>▪ Water quality often poor for domestic purposes: treatment needed;</li> <li>▪ Mainly fossil water: mining; and</li> <li>▪ Energy supply may be costly at certain locations.</li> </ul>
Surface water conveyance	<ul style="list-style-type: none"> <li>▪ One source (dam, reservoir) and intake;</li> <li>▪ Secured quantity;</li> <li>▪ Controlled supply along the pipeline; and</li> <li>▪ Constant water quality.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Resource sustainability (climate change, impacts, sedimentation);</li> <li>▪ High initial investment (no phased implementation);</li> <li>▪ Security of supply (back-up storage);</li> <li>▪ User's commitment required (specially mining sector);</li> <li>▪ Transboundary issues; and</li> <li>▪ Feasibility of irrigation component (social, economic).</li> </ul>

Source: *Groundwater Assessment of the Southern Gobi Region, 2010.*

Further assessment and study is required on a regional basis to seek to balance supply and demand into the medium-term. In the short-term, groundwater appears to represent the most viable water supply option, but ongoing investigation and evaluation of the full range of potential water supplies will be required to provide sustainable and secure water supply into the long term.

The Project under assessment has a 27-year life and, as a result, this assessment has adopted Oyu Tolgoi's approach that, in the short-term, groundwater resources represent the only viable water supply option for the Project.

#### **Detailed Assessment of Local Groundwater Resource Options**

The next stage of the alternatives assessment undertaken by Oyu Tolgoi was to evaluate the available deep groundwater resources within the vicinity of the Oyu Tolgoi site. There are very significant reserves of groundwater stored in nearby Cretaceous sedimentary basins, which are considered to offer the most favourable options in terms of environmental impact, sustainability and quality of supply, economics and

<sup>15</sup> Tuinhof, A. and Buyanhisnig, N. 2010. *Groundwater Assessment of the Southern Gobi Region*. Mongolia Discussion Papers, East Asia and Pacific Sustainable Development Department. Washington, D.C.: World Bank.

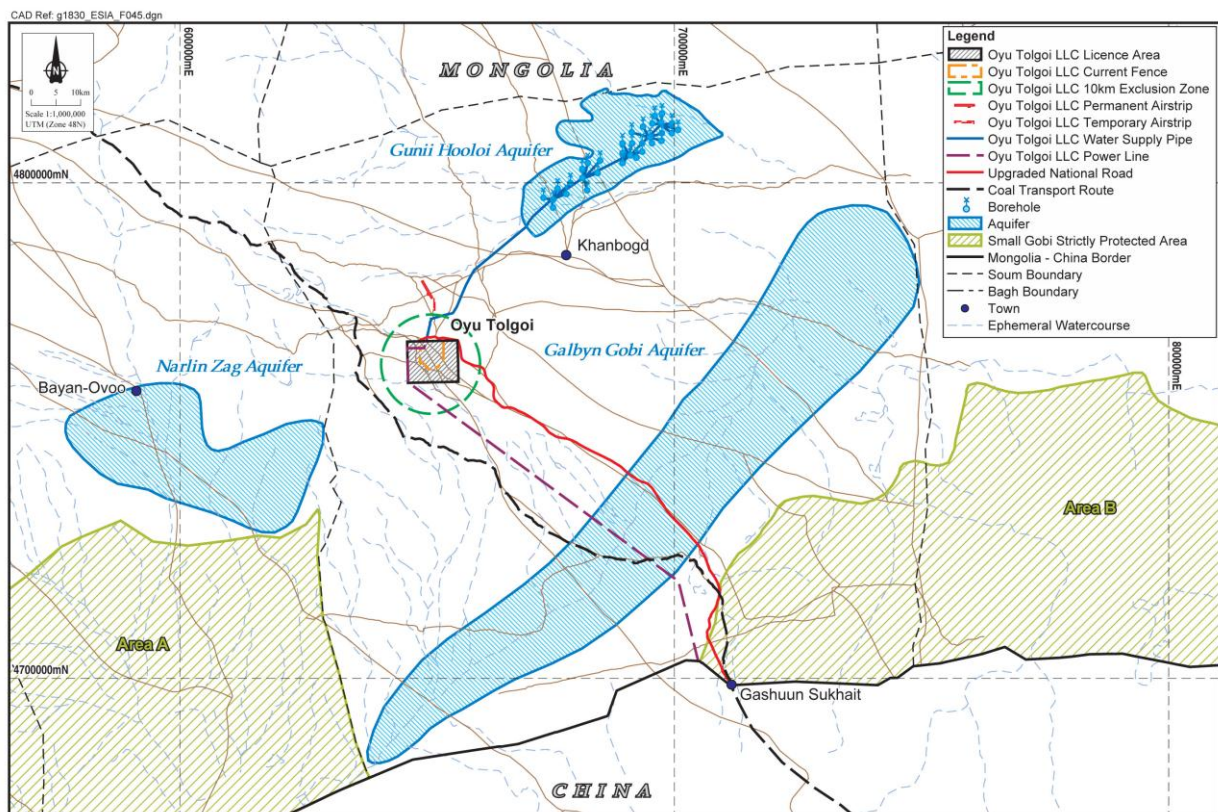
supply capacity<sup>16</sup>. The alternatives considered for groundwater supply to the Project have been as follows:

- The Gunii Hooloi aquifer (referred to in tables as 'GH');
- The Nariin Zag aquifer; and
- The Galbyn Gobi aquifer (referred to in tables as 'GG').

Figure 5.1 illustrates the potential alternative aquifers for the Project's water supply.

The initial drilling programme across the three basins indicated that the Nariin Zag basin did not contain groundwater of sufficient volume or permeability. Therefore this basin was not evaluated further.

**Figure 5.1: Location of Potential Water Supply Aquifers for the Project**



The initial assessment of the Gunii Hooloi and Galbyn Gobi aquifers indicated that both had the potential to provide the Project's water supply. Further evaluation considered the pros and cons of the two aquifers to allow identify the most appropriate water supply for the Project, as presented in Table 5.8.

<sup>16</sup> Aquaterra: Gunii Hooloi Aquifer Groundwater Investigation and Resource Assessment – 2007 (Revised Water Demand), Prepared for: Ivanhoe Mines Mongolia Inc XXK, Ref: 658/F/331a, March 2008.

**Table 5.8: Comparison of the Gunii Hooloi and Galbyn Gobi Aquifers**

Evaluation Parameter	Gunii Hooloi	Galbyn Gobi
<b>Water reserves</b>	GH water resource capacity has been conservatively estimated in excess of 812.5 L/s (70,200 m <sup>3</sup> /day) over 25 years of use.	GG has an estimated capacity of 370 L/s (32,000 m <sup>3</sup> /day) over 25 years of use. This is insufficient to supply all the project needs without significantly expanding the well field.
<b>Water quality</b>	Overall the GH aquifer is not suitable for potable water with concentration of dissolved salts up to 2.8 g/L.	GG groundwater quality varies with depth and laterally from 0.9 g/L in the unconfined aquifer to more than 8 g/L in the confined aquifer.
<b>Surface/deep aquifer connections</b>	The connection between the deep aquifer and shallow, near-surface aquifers is limited, with potential connections indicated in the eastern extents of the proposed borehole field. There are no areas of groundwater dependant vegetation in the area.	There is reasonably strong evidence of a connection between the shallow aquifers and the deeper regional aquifer, with upward hydraulic gradients which could present a long-term risk to shallow-water depletion of herder wells and impacts on potentially groundwater-dependant vegetation in the basin.
<b>Vegetation/ecological impacts</b>	The saxaul plants ( <i>Haloxylon ammodendron</i> ) in GH are not considered at threat from regional aquifer drawdown as they are shallow-rooted and access near-surface soil moisture. Saxaul may be impacted if abstraction from the deep aquifer causes a corresponding drawdown in the shallow aquifer, however, the likelihood of this occurring in areas of saxaul is considered to be low.	Use of the GG presents a risk to deep-rooted vegetation within the low-lying terminal drainage basins. The GG saxaul groves access water beneath the terminal drainage basins.

Based on the review summarised in *Table 5.8*, it was determined that the Gunii Hooloi aquifer could provide the Project's groundwater supply without having a significant impact on the groundwater levels in the aquifer, shallow water users or on groundwater dependant vegetation. A single deep herder well at the eastern extent of the borefield area was identified as the most likely well where a "draw down" impact on well water levels could be incurred and has been monitored for a number of years. These potential impacts are discussed and addressed in *Chapter C5: Water Resources* and mitigation measures in *Chapter D7: Water Resources Management Plan*. A commitment was made by Oyu Tolgoi in 2005<sup>17</sup> to ensure continuity of water supply to existing wells within the Gunii Hooloi borefield and a similar requirement to maintain the quality and quantity of existing potable and livestock water supplies is also included in the Investment Agreement<sup>18</sup>.

### **Regional Context**

The evaluation of potential aquifers has focused on those within 100 km of the mine site; i.e. a commercially feasible distance. Oyu Tolgoi has not considered the water resources outside of this area, including the eastern extensions of the Gunii Hooloi and Galbyn Gobi aquifers, which both extend east of the Oyu Tolgoi groundwater study area and are undefined. Within the Southern Gobi region the full extent of the fossil water supplies has not been fully defined; the study by the World Bank<sup>19</sup> provides an estimate of the available resource of 200-500 Mm<sup>3</sup>/year, although this is recognised to have significant uncertainties and a lack of detailed exploration of the deeper aquifers similar to Gunii Hooloi which may exist. This is further discussed in the *Chapter C13: Cumulative Impacts* of this ESIA.

<sup>17</sup> Oyu Tolgoi Project EIA Volume II: Water Supply from the Gunii Hooloi and Galbyn Gobi Groundwater Aquifer Areas.

<sup>18</sup> Oyu Tolgoi Investment Agreement. Section 6.19.2.

<sup>19</sup> Tuinhof, A. and Buyanhisnig, N. 2010. *Groundwater Assessment of the Southern Gobi Region*. Mongolia Discussion Papers, East Asia and Pacific Sustainable Development Department. Washington, D.C.: World Bank.

## **Conclusions**

The evaluation of water supply options has demonstrated that in the short-term there are no realistic alternatives to the use of groundwater resources to supply the Oyu Tolgoi project. The groundwater resources of the South Gobi are still little investigated and there are likely to be additional groundwater resources in the region. Nevertheless, Oyu Tolgoi, the Government of Mongolia and other projects in the region will need to continue the exploration and investigation of water resources to ensure balanced, secure and sustainable water supplies into the long-term.

## **5.5 POWER SUPPLY**

Initial investigations to assess options for the supply of power to the Project began as early as mid-2002. Three primary options were identified as follows:

- Obtaining power from the Mongolian Central Electricity System (CES) located approximately 560 km to the north of the Project;
- Obtaining power from the Inner Mongolian Autonomous Region (IMAR) grid in China, approximately 150 km to the south of the Project; and
- Generating power at or near the Project fuelled by local coal resources.

Studies of these options by independent consultants and engineering firms Teshmont and Fluor (power plant pre-feasibility study)<sup>20</sup> reached the following conclusions:

- Considering the current load resource balance, the condition of existing generation equipment, and the significant power load of the region, CES will require additional generation capacity in the future;
- The cost of construction for a dual-circuit 220 kV transmission line from the CES to the Project site is in the range of US\$150 million to US\$200 million. There is no apparent, readily available funding to the CES for this construction. Furthermore, there is a substantial risk that the line will not be operational in time to meet the needs of the Project;
- Substantial and reliable power (wind and coal) is readily available from IMAR and can be obtained in a timely manner and a new switching station is to be built at Bayinhanggai to service the wind farms; and
- The construction of coal-fired power plants in the vicinity of The Project is both technically and economically feasible but with significant implementation time and cost.

On the basis of these conclusions, electrical power to the Project, in accordance with the Investment Agreement, will be supplied for the first four years from IMAR by the Inner Mongolia Power Company, after this period Oyu Tolgoi is committed to seeking a Mongolian solution for their power supply.

### **High Voltage Transmission Line**

The option to provide power from IMAR requires the development of a 95 km 220 kV transmission line to transmit electrical power to the Oyu Tolgoi project. The transmission line will consist of pylons and three phases of suspended transmission wires with two conductors for each phase. The pylons are approximately 50 m in height and are positioned up to 300 m apart depending on the terrain.

It is anticipated that the high voltage transmission line will be transferred to the Government of Mongolia after 4 years of operation and following the sourcing of project power from a Mongolian supply.

### **Route Options**

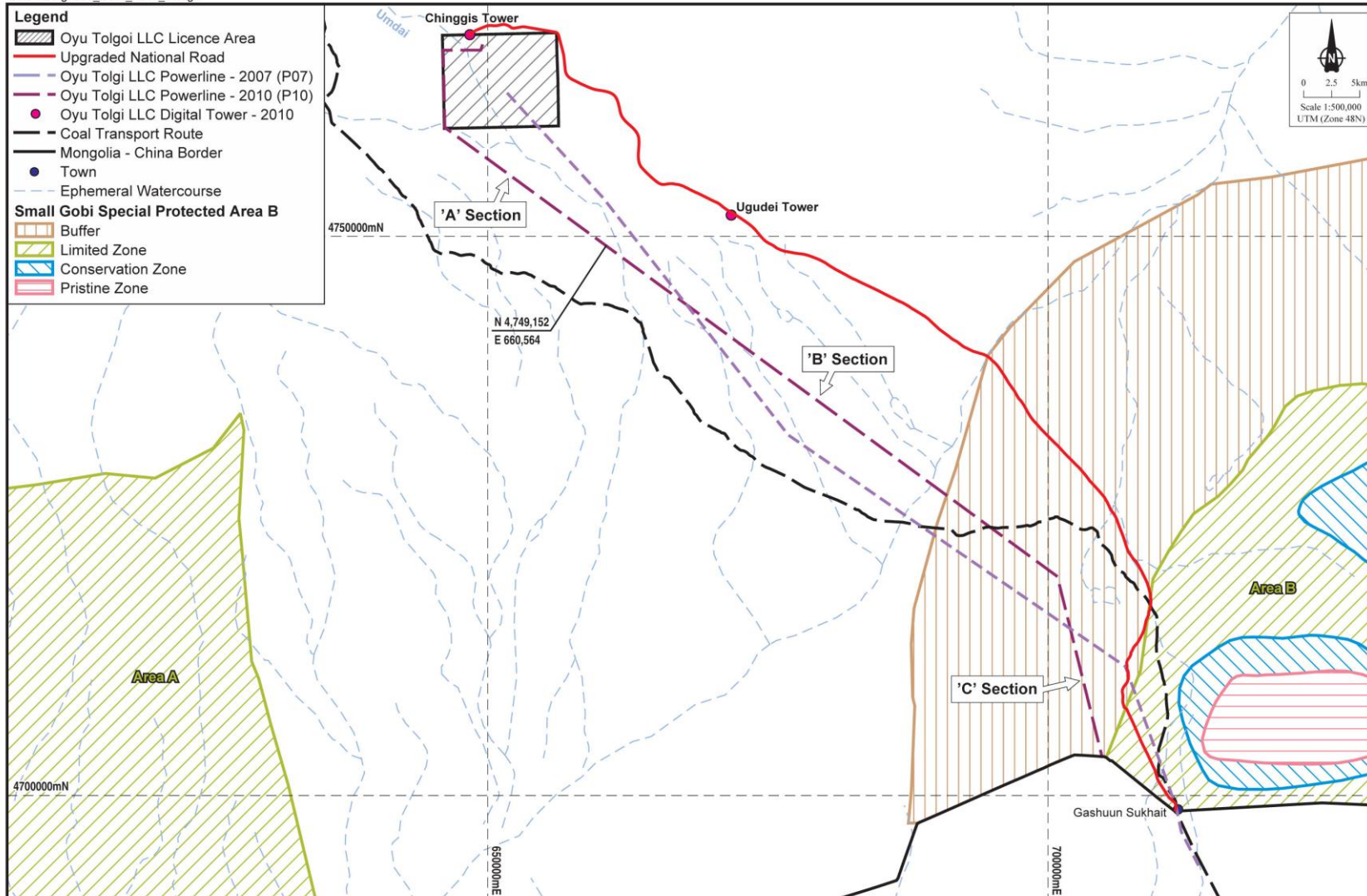
Two transmission line routes have been assessed throughout the project planning phase and are provided in *Figure 5.2*.

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<sup>20</sup> Internal studies for Oyu Tolgoi.

**Figure 5.2: High voltage transmission line route options**

CAD Ref: g1830\_ESIA\_F017\_01.dgn



The transmission line was originally planned to cross the border at Gashuun Sukhait during early project planning and permitting undertaken in 2003. A DEIA<sup>21</sup> was completed in 2003 for this route which included the transport and power corridor from the Mongolian-Chinese border to the Oyu Tolgoi project.

The 2003 route was subject to environmental, social and cultural heritage surveys carried out by Mongolian DEIA consultants and the Mongolian Academy of Science Institute of Archaeology (MASIA). The route was selected to avoid identified archaeological sites, herder camps and sensitive environmental features associated with saxaul and tamarisk vegetation within the terminal drainage basins of the Galbyn Gobi. The 2004 Volume I DEIA identifies the following objectives for route selection:

- Minimise ground disturbance by making the alignment as straight as possible;
- Avoidance social infrastructure including camps and wells for the 13 families identified in the 2003 field surveys;
- Avoidance of elm trees, tamarisk and saxaul groves associated with rivers features and terminal drainage basins; and
- The selection of the route to minimise possible disturbance of archaeological sites of 52 archaeological and cultural features identified from the 2003 field surveys.

An amendment of the 2004 Volume I DEIA was completed in 2007 to revise the road transport options. This amendment made no changes to the approved transmission line route. However, the transmission line was subjected to further route analysis in 2010 with the preferred option being selected such that the transmission line avoids the Small Gobi Strictly Protected Area (SGSPA) and minimises the distance where the transmission line is near to the Tavan Tolgoi to Gashuun Sukhait coal road and the Oyu Tolgoi concentrate road. There are two prime considerations for placing the transmission lines away from roads: avoidance of vehicle collisions with pylons; and, avoiding high dust areas which may result in dust deposition on pylons and higher incidents of pylon fires during electrical storms. The Tavan Tolgoi coal road and the Oyu Tolgoi concentrate road were unsealed roads at the time of route selection.

The 2010 high voltage transmission line route was adjusted to avoid the high dust environment near Tsagan Khad, located north of the SGSPA, due to potential coal dust impacts on the transmission line. The route was then selected to follow a similar route as the original 2003 option, but the transmission line route was changed at the southern boundary of the Oyu Tolgoi mine license to follow the western license boundary to the switching yard and sub-station within the Oyu Tolgoi project area. The re-routing within the Oyu Tolgoi project Mine Licence Area was to avoid infrastructure conflicts with roads and elevated structures.

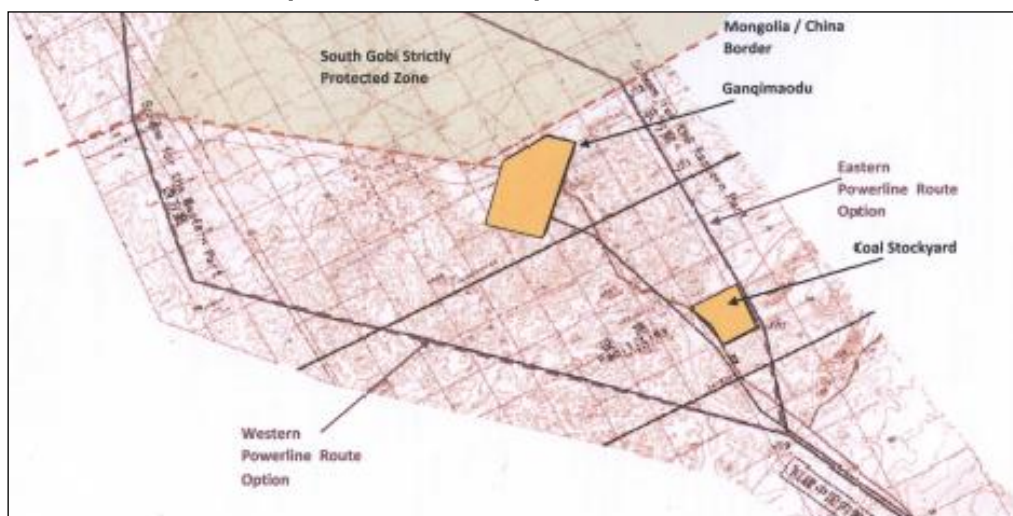
Electrical power for the 220 kV line to Oyu Tolgoi will come from a switching station (called Bayinhanggai Switching Station) adjacent to the Gashuun Sukhait border crossing (Ganqimaodu in China). This provides the starting point for the 220 kV line to Oyu Tolgoi and is the most economically feasible location from which to obtain electricity for Oyu Tolgoi as it is the closest such switching station.

Two options were considered for the power route to the border from the switching station. These are referred to as the “east” and “west” options, both of which enable the power lines to run around the town of Ganqimaodu as illustrated in *Figure 5.3*.

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<sup>21</sup> Eco Trade (2003); Oyu Tolgoi Project Environmental Impact Assessment Volume 1 Road and Power Infrastructure Corridor.

**Figure 5.3: Power Line Route Options around Ganqimaodu**



Following a review of the power line alignments and consultations with the local military authorities the preferred option set out by the Chinese authorities was the western route. The advantage of this route is that it avoids any future rail developments on the eastern side of the coal stockyards and also allows the power line to cross the border outside of the SGSPA, avoiding this protected area.

The transmission line route from the border to Oyu Tolgoi intersects the Galbyn Gobi an Important Bird Area (IBA) (see Figure 5.4) which was identified in 2007 and as discussed in a report by Birdlife International from 2010<sup>22</sup>. The IBA was recommended due to the importance of the area to the Houbara Bustard and the Saker Falcon. The transmission line route was designed and approved by the Government of Mongolia prior to identification of the IBA. Specifically, the original transmission line route was selected in 2004 on the basis of the Detailed Environmental Impact Assessment (DEIA) undertaken in accordance with the Mongolian Law on EIA. The DEIA considered the results of community consultations, heritage surveys and environmental values in the selection of the transmission line route. However, limited baseline fauna data was available for the DEIA.

As the Government of Mongolia had substantial input and direction in the selection of the transmission line route various alternatives were not considered. Additionally, a revised alignment avoiding the IBA would have led to a substantial increase in the length of the route, which would have substantially increased impacts arising from the construction and operation of the transmission line. Changes that did occur to the original transmission line route, which resulted in avoidance of the Small Gobi Strictly Protected Area, were due to changes to the agreed point of border crossing for the international transmission line.

Oyu Tolgoi will undertake to complete line stringing in the Galbyn Gobi IBA by the end of April 2012 (subject to weather and other circumstances not under its direct control) and to minimise impacts during the lekking season of the Houbara bustard (15 April – 30 June). Two contractor teams will be used with both teams starting from the centre of the powerline route and they will work in opposite directions in order to complete work in the IBA as quickly as possible and before the end of April.

Oyu Tolgoi will also limit line stringing work to discrete line pulling points that will be checked for nearby bustard activity prior to being established; ensure that a Houbara bustard surveyor is active during the stringing work to identify any specific Bustard lekking site; where any individual lekking sites are identified, Oyu Tolgoi will consult with a Bustard specialist in order to determine the most appropriate action to avoid disturbance. The risks posed to the Houbara Bustard during the line stringing activity require these specific measures due to the potential for direct interaction at ground level where the lekking activities occur. Other significant bird species, including the Saker falcon, are expected to avoid

<sup>22</sup> Nyambayar B., Bayarjargal B., Stacey J. and Braunlich A. (2010) Houbara Bustard and Saker Falcon Surveys in the Galba Gobi IBA, in Southern Mongolia,

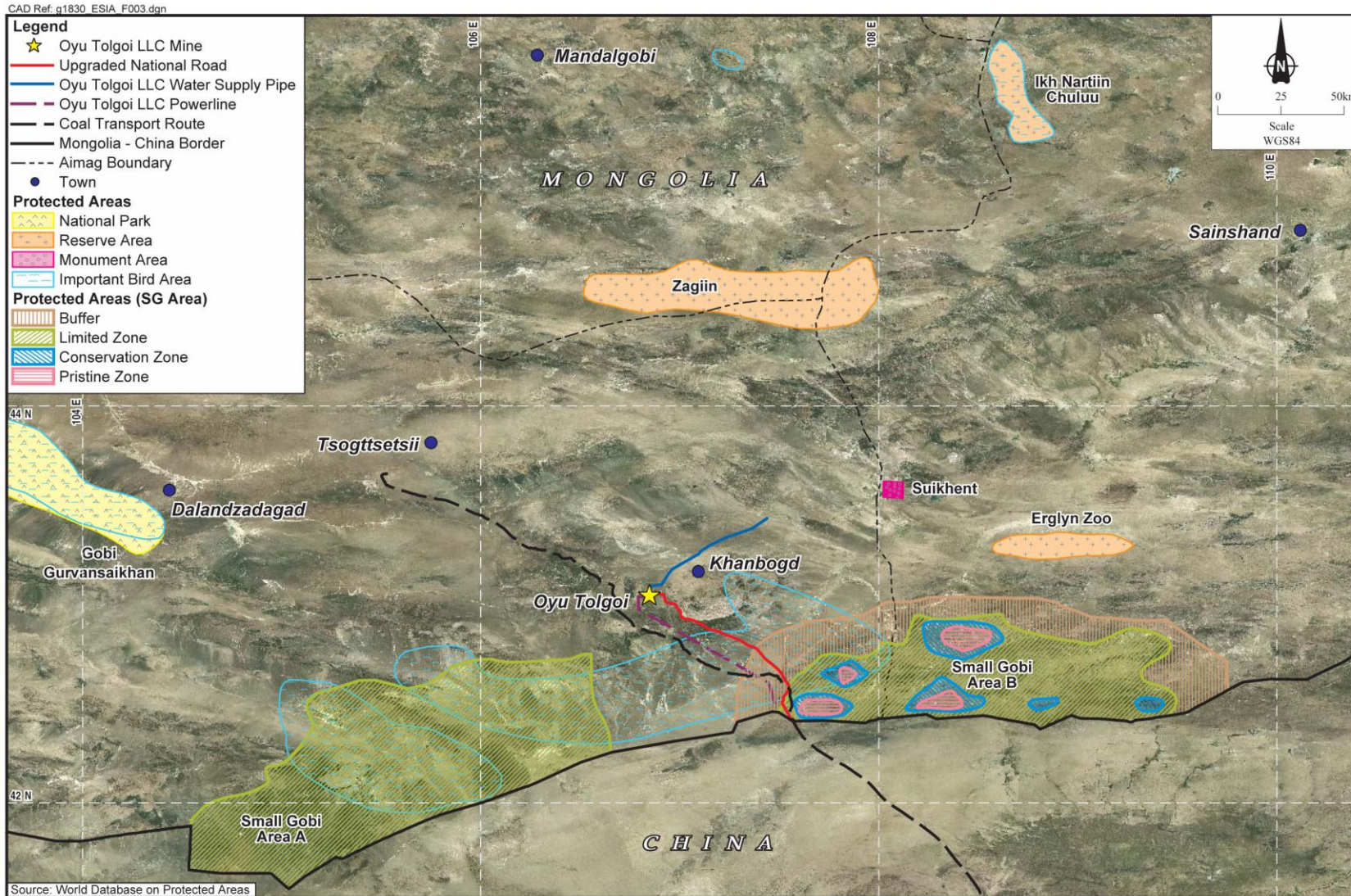
ground disturbance activities during construction and would not require specific construction management measures to be implemented

Oyu Tolgoi is undertaking survey work outside the bustard breeding season and this will be supplemented by the support of a specialist bustard surveyor during line stringing activities during the prime breeding season. Surveys will be continuous throughout the line stringing work such that activities can be responsive to any bustard activity that is observed by the surveyors. The response will be dependent upon the scheduled activity at the time and will be communicated to the line stringing contractor through immediate verbal and written communications. The options available to avoid a specific observed site will be assessed and determined in consultation between the observers, contractors and Oyu Tolgoi. The key mitigation actions will be situation-specific, but will include:

- Adjusting line pulling points away from identified sites;
- Adjusting access routes around identified sites; and
- Avoiding work until breeding activity is complete (although potentially at the expense of completing work in the IBA as quickly as planned).

Further details on the full range of management and mitigation measures being implemented are provided in *Chapter C6: Biological Resources and Ecosystem Services Impact Assessment*.

**Figure 5.4: Location of the Important Bird Area in relation to project high voltage transmission lines**



Oyu Tolgoi commissioned further biodiversity studies in May 2011, the Rapid Biodiversity Assessment, to identify biodiversity impacts and mitigation options available for project related infrastructure, including the high voltage transmission lines. The Rapid Biodiversity Assessment was undertaken by a consortium of international and national specialists through Flora and Fauna International, The Biodiversity Consultancy and the Wildlife Conservation Society. The results of these field surveys are detailed in the biodiversity baseline and impacts assessment chapters of this report (*Chapters B7A: Biodiversity Baseline and C6: Biological Resources and Ecosystem Services*). Significant biodiversity impacts were identified from the high voltage transmission line specific to:

- Indirect habitat loss due to avoidance around power transmission line;
- Direct mortality from collision with power transmission line; and
- Indirect mortality from increased populations of natural predators.

### **Design options**

The recommendations of the Rapid Biodiversity Assessment to mitigate these impacts were limited to transmission line design and management aspects that reduced the likelihood of fauna collisions with transmission lines and prevent natural predators from nesting in the pylons. These design and management options include:

- Installation of bird flight diverters on power lines to avoid collisions;
- Regular removal of bird nests of species that predate Houbara Bustard; and
- Regular removal of collision carcasses that may attract predators.

Underground burial of the power transmission line would avoid many of the biodiversity impacts detailed but would create other impacts related to habitat loss (requiring restoration), and has much higher construction and maintenance costs. The burial of the transmission line from Oyu Tolgoi to the Gunni Hooloi borefield is estimated to cost USD \$685,000 per kilometre as opposed to USD\$233,000 per kilometre for overhead transmission lines<sup>23</sup>. Burial of the power transmission lines is therefore not considered realistic. Significant pylon design changes were limited as the structure was chosen by Oyu Tolgoi from a limited ready approved list available from the government, rather than seeking (potentially lengthy) approval for tower designs novel to Mongolia.

## **5.6 TAILINGS MANAGEMENT**

### **5.6.1 Tailings Storage Facility Options**

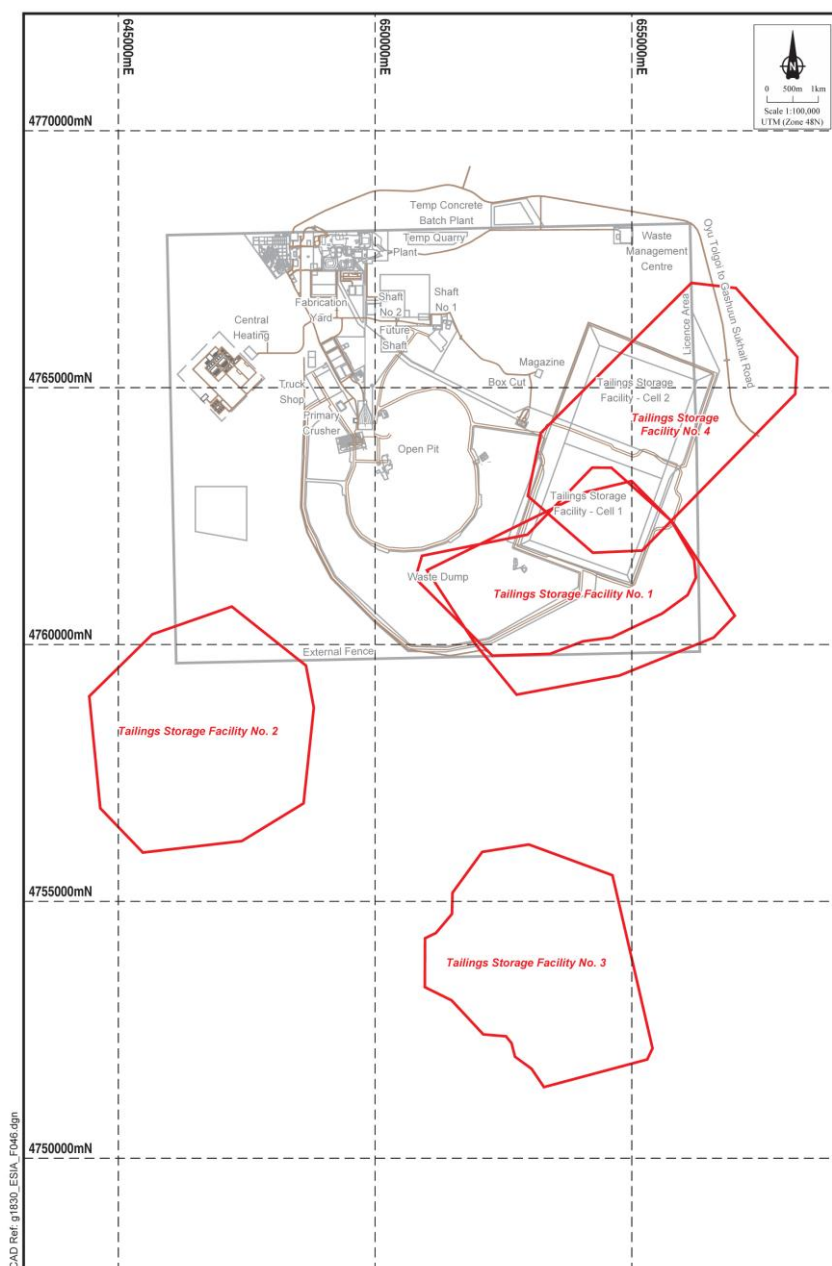
Options and design studies have been conducted to determine the most suitable site and design for the Tailings Storage Facility (TSF). Potential sites were identified both inside and outside the current Mine Licence Area. Ultimately, the Mine Licence Area boundary limited the options for the location study. The initial options assessed in 2004<sup>24</sup> are set out in *Figure 5.5* below.

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<sup>23</sup> Pers Comm.2011, Ivanhoe Mines Senior Project Engineer

<sup>24</sup> Ivanhoe Mines Mongolian Inc, Oyu Tolgoi Project Feasibility Study Tailings Facility, Ref: PE601-00001/14, December 2004, by Knight Piésold Pty Ltd

**Figure 5.5: TSF Option Study Locations, 2004**



Source: IDP 2005

A summary of the advantages and disadvantages of the options are presented in *Table 5.9*

**Table 5.9: TSF Options Analysis Summary**

Item	TSF 1	TSF 2	TSF 3	TSF 4
Cost (NPV \$Millions)	45	55	52	38
<i>Environmental Risk</i>				
Close to Major ephemeral water course	Diverted	Adjacent	Close	Far
Seepage potential to ephemeral water course	Low	High	Low	Low
Distance of Pipeline From Plant and distribution around TSF (km)	14	15	17	10
<i>Clash with other infrastructure</i>				
Block Cave Subsidence	No	No	No	Possibly

Item	TSF 1	TSF 2	TSF 3	TSF 4
Mine Plant or Village	No	No	No	No
Airport (Western Option)	No	Possible	No	No

Source: Knight Piesold, 2004.

These options were evaluated and developed further to address environmental and infrastructure constraints. During 2007 and 2008 a design alternative studies<sup>25 26 27</sup> were undertaken by Klohn Crippen Berger Ltd to determine the most suitable site and design option for the TSF using the updated mine and concentrator plan as a background. The study was based on various sites identified previously and was completed in a three phase programme to accommodate the changing Project design criteria and to progressively consider various design and construction options based on current water, environmental, and cost considerations. Variation in construction method and subsurface conditions were also considered at each site to determine the lowest-cost, environmentally-safe, and most efficient design. The site layouts selected for further evaluation were informed by the previous studies to minimise the environmental and infrastructure constraints previously identified (for the sites previously identified and referenced as TSF 1 to 4).

The selected TSF site is adjacent to the open pit for operational reasons and to maximise the use of suitable land within the Mine Licence Area that will not compromise future mining activities and would not be within the potential subsidence zone associated with underground block caving activities.

In all cases the assumption was that the TSF will be lined or make use of the presence of a low permeability naturally occurring Cretaceous Clay across the majority of the area. In the southern part of Cell 1 where the clay was absent, clay from the northern part of the site will be used to engineer the liner beneath this cell of the TSF. During the earthworks, where feasible permeable sediments associated with stream courses will be removed. A clay liner was considered to be the most technically and environmental effective solution given the presence of in situ clay materials, the extreme weather conditions encountered, the logistical and technical difficulties in importing and installing an effective synthetic liner and the extensive area of the TSF.

## 5.6.2 Tailings Management Options

Tailings management options were evaluated in terms of paste (thickened and semi-solid) tailings and conventional (wet slurry) tailings, location of spigot and pond size and location<sup>28</sup>. Key points from the options analysis were as follows:

- Paste tailings would result in reduced water discharge to the TSF. Initial evaluations identified that the thickening of the tailings would result in reduced water losses through evaporation and infiltration<sup>29</sup> as less water requires recovery from the tailings pond; and
- The evaluation indicated that although the use of paste was recognised as preferable due to the potential increased water recovery and savings, the review of alternatives concluded that conventional tailings was the most appropriate tailings management option. The reasons were due to operational constraints; there were significant concerns related to paste distribution and deposition in the TSF during severe winter conditions and the difficulties of recommencing tailings pipeline flow after an interruption in winter if paste was used.

Un-drained sedimentation tests by Knight Piesold<sup>30</sup> showed that the tailings have a moderately fast settling rate (95% of final settled density within five days) and that relatively high final settled densities are

<sup>25</sup> Klohn Crippen Berger Ltd (2007). Oyu Tolgoi Tailings Storage Facility Feasibility Study, January 17 2007.

<sup>26</sup> Klohn Crippen Berger Ltd. (2008a). Oyu Tolgoi Tailings Storage Facility Design, Alternative Assessment Report, April 8 2008.

<sup>27</sup> Klohn Crippen Berger Ltd. (2008b). Oyu Tolgoi Tailings Storage Facility Design, Interim Design Report, April 11 2008.

<sup>28</sup> Oyu Tolgoi (2009), Mongolian Feasibility Study, Attachment Section 10, Process - Tailings Storage Facility Subsection 7

<sup>29</sup> Golder (2005): Draft Report on "Review of Feasibility Design, Tailing Storage Facility, Oyu Tolgoi Project Mongolia" Project No 05-1362-126, Prepared by Golder Associated Ltd., May 2005

achievable. For water conservation purposes, KCBL's current design for the facility uses thickened tailings with 64% solids slurry at discharge. Settlement tests of tailings continued to show relatively rapid settling rates with solids content increasing from 64% at discharge to 72%-75% within several days.

Permeability testing of the tailings at low stresses indicates that permeability will initially be around  $7.40 \times 10^{-5}$  to  $8.95 \times 10^{-6}$  m/s; with this decreasing quickly over time from the consolidation effects of overlying tailings.

In conclusion, Oyu Tolgoi decided to develop the tailings management design using conventional thickener technology to maximise solids content whilst ensuring that the tailings can be pumped by centrifugal pumps suitable for solids content up to 65%. Maximising the discharge density within the constraints of the equipment selected will be the basis of process control for tailings thickening and maximising the recovery of water from the tailings along with minimising pond size in the TSF to reduce evaporation. The option selected represents an optimised combination of practicality, year-round operability, low permeability, dust control and supernatant water recovery.

## 5.7 HAZARDOUS WASTE MANAGEMENT

There is no licensed hazardous waste management facility in Mongolia and therefore Oyu Tolgoi will have to develop its own solution to dealing with this waste. Hazardous wastes produced by the Project include medical waste, oily wastes (such as rags and filters) and fluorescent tubes. The current methodology of handling the hazardous wastes during the exploration and construction phase has included the use of burning, burial and incineration. Currently there is a small incinerator next to the truck work shop which is used to burn oily rags and filters etc., as well as medical waste. These are temporary measures only and will be replaced as soon as possible with long term alternatives. The options for the full operational of the site include:

- Operation of an incinerator which complies with international air quality standards (such as EU); and
- Creation of a hazardous waste landfill within the Waste Management Centre planned for the Project.

The assessment of the hazardous waste management options is presented in *Table 5.10* below.

**Table 5.10: Hazardous Waste Management Appraisal**

	Hazardous Landfill	Incinerator
<b>Advantages</b>	<ul style="list-style-type: none"> <li>▪ The amount of waste generated by the project will be limited and therefore any landfill option would be small;</li> <li>▪ Will enable the Project to deal with difficult wastes such as fluorescent tubes (which contain mercury salts) that could not be incinerated or buried in the non-hazardous landfill;</li> <li>▪ No risk of hazardous air emissions (e.g. dioxins) through poor incineration; and</li> <li>▪ Lower cost.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Does not require the licensing of a hazardous landfill;</li> <li>▪ Acceptable practise in Mongolia;</li> <li>▪ No risk of soil and groundwater contamination; and</li> <li>▪ Treats all combustible hazardous wastes.</li> </ul>
<b>Disadvantages</b>	<ul style="list-style-type: none"> <li>▪ Combustible medical wastes would require incineration on-site or shipment to Ulaanbaatar for incineration;</li> <li>▪ Medical sharps require disposal in Ulaanbaatar;</li> <li>▪ Potential for soil and groundwater contamination; and</li> <li>▪ Long term future commitment to monitoring post closure.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Air monitoring capacities in Mongolia are limited and may not be able to comply with international monitoring requirements;</li> <li>▪ Medical sharps require disposal to Ulaanbaatar;</li> <li>▪ Cannot deal with difficult non-combustible hazardous wastes; and</li> <li>▪ Moderate cost and requirement for maintenance and calibration.</li> </ul>

<sup>30</sup> Knight Piésold (2004) Feasibility Study Tailings Storage Facility, Report PE601-0001/14, December 2004.

Although both options have pros and cons and could both present a solution that poses a minimal risk to site employees and the environment, based on an appraisal of the options Oyu Tolgoi has determined that the use of a hazardous waste incinerator on the site to support landfill disposal and recycling of other wastes is the most appropriate waste disposal option given the site location and Mongolian regulatory regime.

## 5.8 AIRPORT LOCATION

The original Oyu Tolgoi Airport within the mining license required relocation as the current location is required for the open pit and crusher. The assessment of the various alternative sites considered for the new location took into account the local topography and relief, herder camps, habitats and flora and aircraft clearance (in terms of approaches and mine infrastructure etc.).

Site studies indicated that it is unsafe to locate the new airstrip anywhere on the mine lease due to possible conflicts with aircraft approaches and proposed mine infrastructure such as Shaft 2 and future shafts, power lines and heavy surface mining equipment. The selected location is approximately 7 km north of the Mine Licence Area, and is located on a gravel plain used for summer pasture grazing and no herder winter shelters. Given the need for a large relatively flat area in close proximity to the Oyu Tolgoi site, and the need to meet international and national aviation safety requirements, this was the only feasible option that would also not require significant ground disturbance and contained no herder winter shelters.

## 5.9 GUNII HOOLOI PIPELINE ALIGNMENT

Based on the water supply options discussed above, the corridor between the borefield and the mine will include a buried water pipeline, medium-voltage power distribution line and gravel surface road. The borefield and pipeline system will consist of 28 main boreholes, four standby boreholes, two 200,000 m<sup>3</sup> covered storage lagoons, collection and break tanks and pumps, and 149 km of underground pipeline. Each borehole will include a bore covering 8 x 8 m and a pump house covering 4.8 x 8 m and 4.4 m height, in a fenced 25 x 25 m compound. The pipeline will include 67 km from the field pumps to the collection tank pump and 82 km from the collection tank pump to the mine site. The pipeline will be buried at a minimum depth of 2.2-2.7 m in a trench. A total of 1.5 km<sup>2</sup> will be affected by trench digging but this area will be rehabilitated. The pipeline has been constructed as a single open-cut trench with multiple pipeline construction crews to minimise the construction time, reflecting the limited construction "weather window" and to minimise the length of time that pasture grazing areas will be affected.

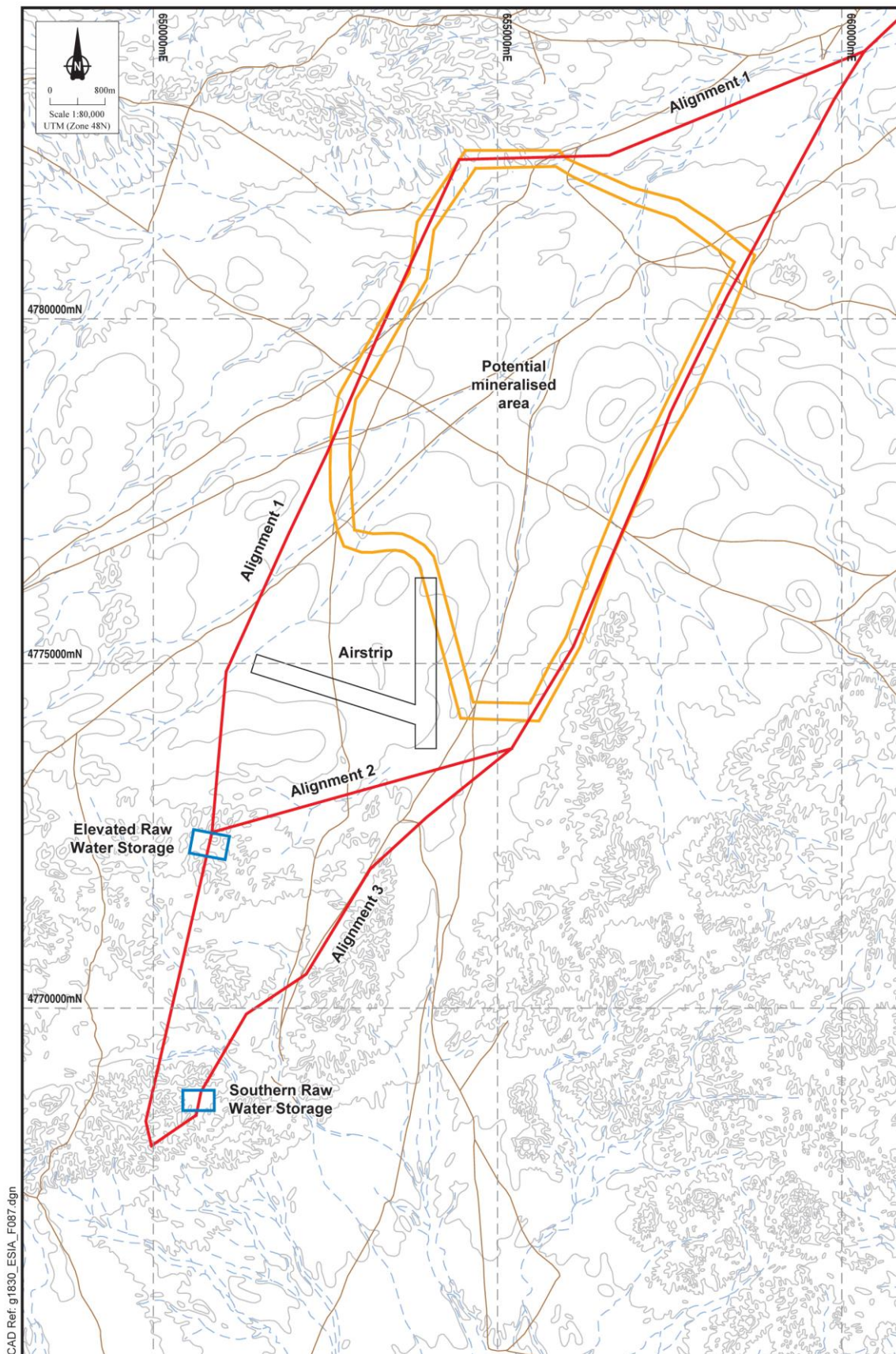
Two 200,000 m<sup>3</sup> capacity covered emergency storage lagoons will be constructed on elevated ground approximately 5 km to the north of the mine site, each with a basal area of 90 m x 120 m. The construction area for the lagoons and associated infrastructure will cover 0.6 km<sup>2</sup>. Excavation of the lagoons will generate spoil rock.

The medium-voltage power distribution line will be 110 kW. This will be routed on the other side of the maintenance road from the water pipelines. This is to avoid electric-current induced corrosion risks to the pipeline. Various pole and pylon designs will be used along the route for different purposes, but the predominant design is an 8-9 m high concrete and metal pole construction with three conductor wires. Some minor sections of the medium voltage line will be buried to avoid over-head power line safety concerns near the airport and for major road crossings within the Oyu Tolgoi Mine Licence Area.

A total of 143 km of roads will be built, comprising the main 67 km maintenance road from the borefield to the mine and another 30 branch roads on the borefield totalling 76 km. The roads will be 4.5 m wide with a 1 m shoulder on each side, and cover 0.7 km<sup>2</sup>. The road surface will be a graded gravel surface, with concrete surface across the river. The maximum slope will be 5.7%, and all road construction material will be sourced from the nearby area. Regular traffic to the borefield will be limited to light vehicles, with occasional heavy equipment and trucks for routine inspections and maintenance. It is assumed here that traffic volumes will be negligible.

A number of options for the pipeline alignment were examined to address various constraints as illustrated in *Figure 5.6* and *Figure 5.7* below.

Figure 5.6: Alternative Alignments around Potentially Mineralised Area and Airport



The alternatives for the southern part of the route needed to consider the potential for interference with future mineral resources, the airport and the location of the raw water storage. The alternative considered can be summarised as follows:

- **Alignment 1:** This alignment has the main pipeline following the northern and western boundaries of the potentially mineralised area and the proposed airport then connecting to the elevated raw water storage pond (located to the south west of the airport). From the elevated raw water storage pond, the main pipeline follows a southerly route to the concentrator located within the mine site.
- **Alignment 2:** This alignment has the main pipeline following the eastern boundary of the potentially mineralised area and the proposed airport and then goes in a westerly direction to the elevated raw water storage pond. The linkage from the storage pond to the mine is as for Alternative 1.
- **Alignment 3:** This alignment is similar to Alignment 2 except that the main pipeline continues southwards to connect to the southern raw water storage pond which is located outside the northern fence of the mine site. From the southern raw water storage pond, water will need to be pumped to the concentrator tank.

Alignment 1 crosses a significant number of active natural drainage channels. The pipeline then crosses and re-crosses a major natural water course. With the development of the access road within the pipeline corridor, the number of crossings of water courses can generate the need for a significant number of cross drainage structures. Combined with the inherent difficulties of installing a major pipeline within active major watercourses, the installation of the pipeline can lead to potential interference with subterranean flows and in so doing expose the pipeline to potential freezing conditions. The increased number of surface drainage crossings is also likely to increase the risk of impacts to shallow herder wells which access groundwater within the sediments of these stream beds. Therefore Alignment 1 was rejected, similarly as the preferred location for the raw water storage was at the elevated location to allow natural gravity flow to the site Alignment 2 was adopted and Alignment 3 rejected.



In addition to the detail described above, the route of the pipeline from the borefield to the raw water storage has been subject to a series of options assessments to establish a route which minimises the impacts to herders, fauna, flora and soils. One of these is illustrated in *Figure 5.7*. Herder wells, camps<sup>31</sup> and cultural heritage sites<sup>32</sup> were identified through field surveys of the likely infrastructure corridor options in 2005. The results of these surveys were used to select a preferred route that minimises disturbance to herder wells, camp locations and sites of potential heritage significance.

In the example presented in *Figure 5.7* the two alternative alignments considered the presence of the ephemeral water course and associated surficial aquifer and habitats, herder winter camps and wells sensitive fauna, flora and soils. Based on this review the alignment of the pipeline was deviated to avoid the ephemeral stream, and take a more southerly route through the edge of the area of sandy hummocks (*Nitraria sibirica* vegetation) and crossing ephemeral streams perpendicular to their courses. The impact to the sandy hummocks (*Nitraria sibirica* vegetation) was considered acceptable as the pipeline passes through the western extent of the vegetation with the most significant vegetation occurring in the east away from the pipeline route and this soil type is regionally common and the disturbed area is relatively simple to revegetate following the pipeline installation.

Additional field surveys of the Gunii Hooloi area, undertaken by the Rapid Biodiversity Assessment, of environmental and anthropological issues in early 2011 raised the need for further amendments to the designed borefield infrastructure and pipeline route. Primarily the re design of the borefield near CTPS#2, (see *Figure 5.8*) was due to the extent of saxaul vegetation in this area. The saxaul vegetation located at the eastern extent of the bore field has been assessed as exemplary habitat by the Rapid Biodiversity Assessment Team<sup>33</sup> although it does not qualify as Critical Habitat as defined by the IFC Performance Standard 6 / EBRD Performance Requirement 6.

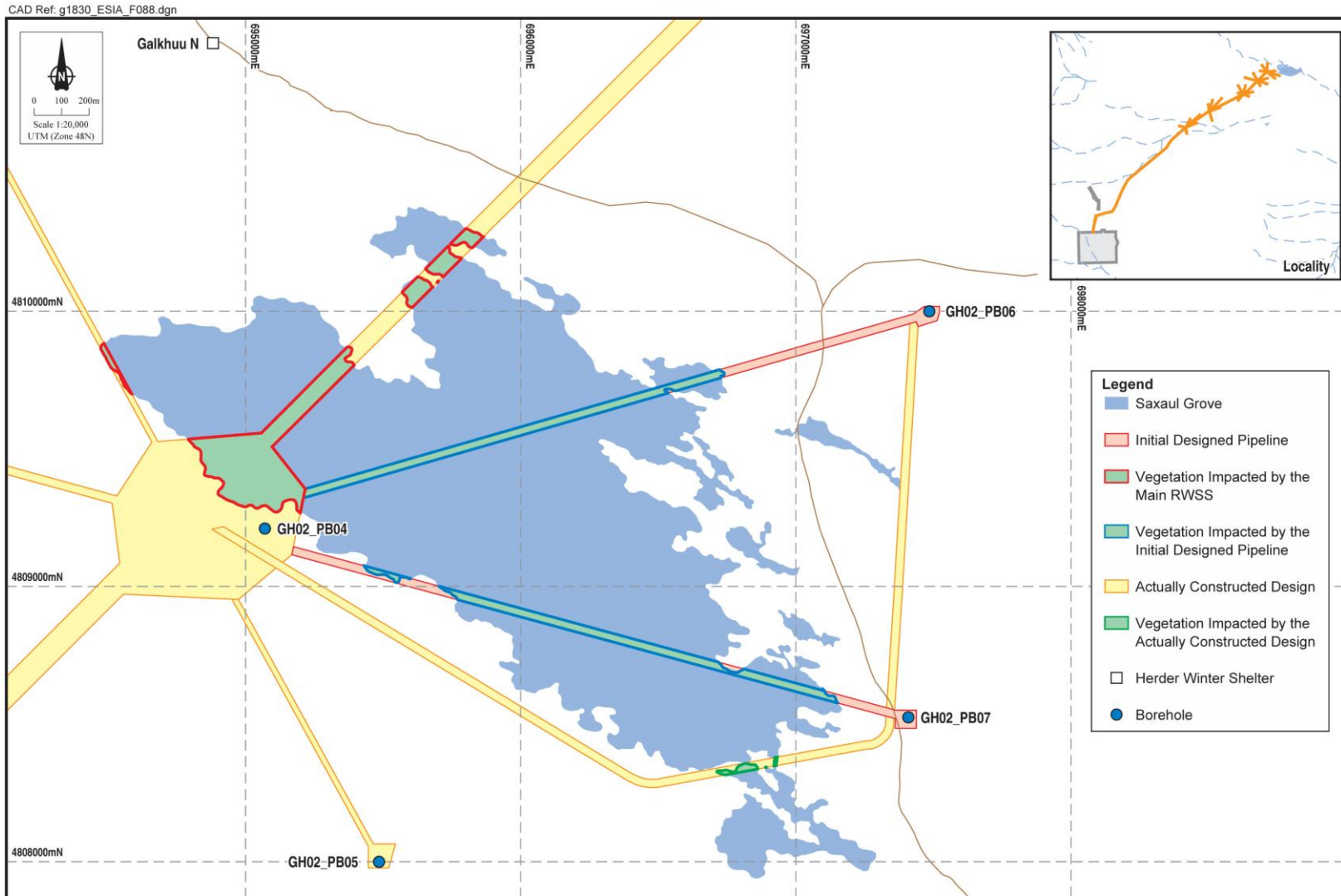
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<sup>31</sup> Report of the Environmental Review within the proposed Pipeline Corridor from Oyu Tolgoi to Gunii Hooloi Borefield; EcoTrade; 2005.

<sup>32</sup> Report of the Archaeological Survey of Oyu Tolgoi; Khanbogd *Soum*, Omnogovi *Aimag*; Mongolian Academy of Science Institute of Archaeology; 2005.

<sup>33</sup> Oyu Tolgoi Project Draft Biodiversity Management Plan borefield/Pipeline Corridor; the Biodiversity Consultancy Ltd and Flora and Fauna International, July 2011.

**Figure 5.8: Gunii Hooloi Pipeline Re-routing to Avoid Saxaul Grove near CTPS#2.**



The alternative route in the vicinity of CTPS#2 for the bore delivery infrastructure requires 31% longer delivery pipeline and 21% longer power supply (see Table 5.11), minimal change in volume of trenching or power cable and significant reduction in area of saxaul vegetation impacted (96% reduction of the area impact by the bore lines and 43% reduction in total area impacted).

**Table 5.11: Comparison of Areas and Volumes of current design versus alternative Route for delivery lines near CTPS#2**

Item	Location	Current	Amended	Change
Pipeline length	PB06	2784m	4372m	31% increase
	PB07	2696m	2850m	
	Total	5480m	7222m	
Access road	PB06	2784m	1522m	21% reduction
	PB07	2696m	2850m	
	Total	5480m	4372m	
Pipe Trench	PB06	2784x6.6=18370m <sup>3</sup>	1522x6.6=10045m <sup>3</sup>	3.4% increase
	PB07	2696x6.6=17790m <sup>3</sup>	2850x9.6=27360m <sup>3</sup>	
	Total	36160m <sup>3</sup>	37404m <sup>3</sup>	
Power Cable	PB06	1441m	1522m	5.7% increase
	PB07	2696m	2850m	
	Total	4137m	4372m	
Land Area Requirement	PB06 delivery	2784x30=8.35Ha	1522x30=4.57Ha	30.6% reduction
	PB06 Power	1441x20=2.88Ha		
	PB07	2696x30=8.09Ha	2850x31=8.84Ha	
	Total	19.32Ha	13.41Ha	
Saxaul area at risk (PB only)		9.42Ha	0.34Ha	96.4% reduction
Saxaul area at risk on main RWSS		11.87Ha		
Saxaul area at risk (total)		21.29Ha	12.21Ha	42.6% reduction

As pipelines will be buried and the surface cover will be revegetated, disturbance to summer pasture areas will be limited to the short period of pipeline installation. The pipeline does not interfere with any herder winter camps and will not restrict access to shallow herder wells. Cultural heritage surveys were undertaken as part of the permitting for the approved pipeline alignment. Further details on the pipeline alignment are included in the relevant baseline and impact assessment chapters of this ESIA.

#### **Medium voltage transmission lines**

The borefield pumps will be powered by a 110 kV transmission line from the Oyu Tolgoi electrical substation within the Mine Licence Area. The medium voltage transmission line is routed along the borefield pipeline and consists of steel or concrete poles between 8-9m high and containing three conductor wires. The medium voltage above ground power lines have been identified, by the Biodiversity Rapid Assessment, as a potential high risk due to the potential for Houbara Bustard collision with transmission line wires and the risk posed by electrocution of larger birds, including Saker Falcon, which may span the distance between conductors or may ground energised hardware. The rapid assessment also identified the risk of avoidance by Houbara Bustard due to the presence of overhead power lines and the vehicle use of the access road; and potential increased predation from birds of prey which may be attracted by the carcasses of animals killed by transmission line collision or electrocution.

The recommended mitigation measures from the Biodiversity Rapid Assessment was to consider the feasibility of burial, or partial burial, of the medium voltage transmission line along the borefield pipeline route. The burial of the transmission line will result in removal of an identified significant risk posed to biodiversity values. Partial burial of the medium voltage transmission line has already occurred or is

planned for some section of the borefield infrastructure where the transmission line passes near the airport flight approach routes and near major roads and other infrastructure where overhead power lines pose a significant safety risk.

The consideration of further burial of the medium voltage transmission line for the borefield has raised the following potential negative aspects:

- Burial of the transmission line parallel and in close proximity to the water pipeline may increase the risk of electric induced corrosion of the pipeline, and therefore a greater risk of pipeline failure;
- The transmission line would require a second trench to be excavated parallel to the water pipeline trench, with increased disruption of access and increased vegetation disturbance associated with additional excavations;
- Potential for increased risk to public safety from accidental contact with buried transmission lines due to lack of awareness of underground line presence, lack of “right of way” controls for such infrastructure in Mongolia and the lack of existing controls over excavating and digging activity in isolated areas of Gunii Hooloi; and
- Substantial increase in cost for line burial considering that the borefield medium voltage transmission line had commenced construction of overhead poles along the route at the time of this assessment. The line route had been approved by the Government of Mongolia and significant design changes would require further approvals and likely project delays. The burial of the transmission line from Oyu Tolgoi to the Gunni Hooloi borefield is estimated to cost USD \$685,000 per kilometer as opposed to USD\$233,000 per kilometre for overhead transmission lines.

Further burial of the medium voltage borefield transmission line has therefore not been considered as feasible at this stage of the project. This option may be further considered during operations if a specific and significant impact to biodiversity could not be avoided or mitigated through other means and could not be successfully offset in order to achieve the Project’s commitment to Net Positive Impact (NPI) to biodiversity.

Design options that will be included in the construction of the medium voltage transmission line to the borefield include:

- Protection of conductors, poles, jump wires and dead ends to minimise the risk of electrocution to roosting birds; and
- Installation of bird flight diverters on the overhead wires to reduce the risk of collisions.

## **5.10 EXPORT OF CONCENTRATE**

### **5.10.1 Export Options**

The market for the concentrate from Oyu Tolgoi is the smelters in China or the markets beyond China. There is limited demand in Russia for copper concentrate. Therefore the concentrate will be transported to China. The point of sale of concentrate will be the Mongolian/Chinese border and the area of influence considered by the Project with regard to the transport of concentrate therefore extends to the Mongolian/Chinese border only.

The export of concentrate by both road and rail has been investigated. A proposal for a Chinese gauge railway link connecting Tavan Tolgoi, Oyu Tolgoi and Gashuun Sukhait (at the Mongolian/Chinese border) to the Chinese rail network was rejected by the Government of Mongolia in 2009. The Project would be required to transport concentrate by road to the rail head (in China or Mongolia). For customs purposes, the concentrate will need to be trans-shipped at the border from Mongolian to Chinese vehicles.

As the concentrate will be transported to China, it is not considered feasible to transport the concentrate to the Trans-Mongolian Railway and then require it to be trans-shipped at the border to the Chinese gauge railway. Given the Government of Mongolia’s current reluctance to permit a rail spur into Mongolia from China with a Chinese gauge railway, the construction of a railway to the Project is not considered feasible in the short-term.

Given the lack of a realistic rail option in Mongolia in the short term, the concentrate will need to be transported by road to China. The Project road transport options considered during early feasibility studies<sup>34 35</sup> were as follows:

- **Route 1:** Oyu Tolgoi to Hangi (Mandal on the Chinese side), which is approximately 295 km in length with an additional 100 km to the rail head at Bayan Obo in China;
- **Route 2:** Oyu Tolgoi to Zamin Uud (Erenhot on the Chinese side), which is approximately 460 km in length with a rail head at the border with access both on the Mongolian and Chinese gauge railways; and
- **Route 3:** Oyu Tolgoi to Gashuun Sukhait (Ganqimaodu on the Chinese side) which is approximately 100 km in length with an additional 230 km to the nearest rail head in China.

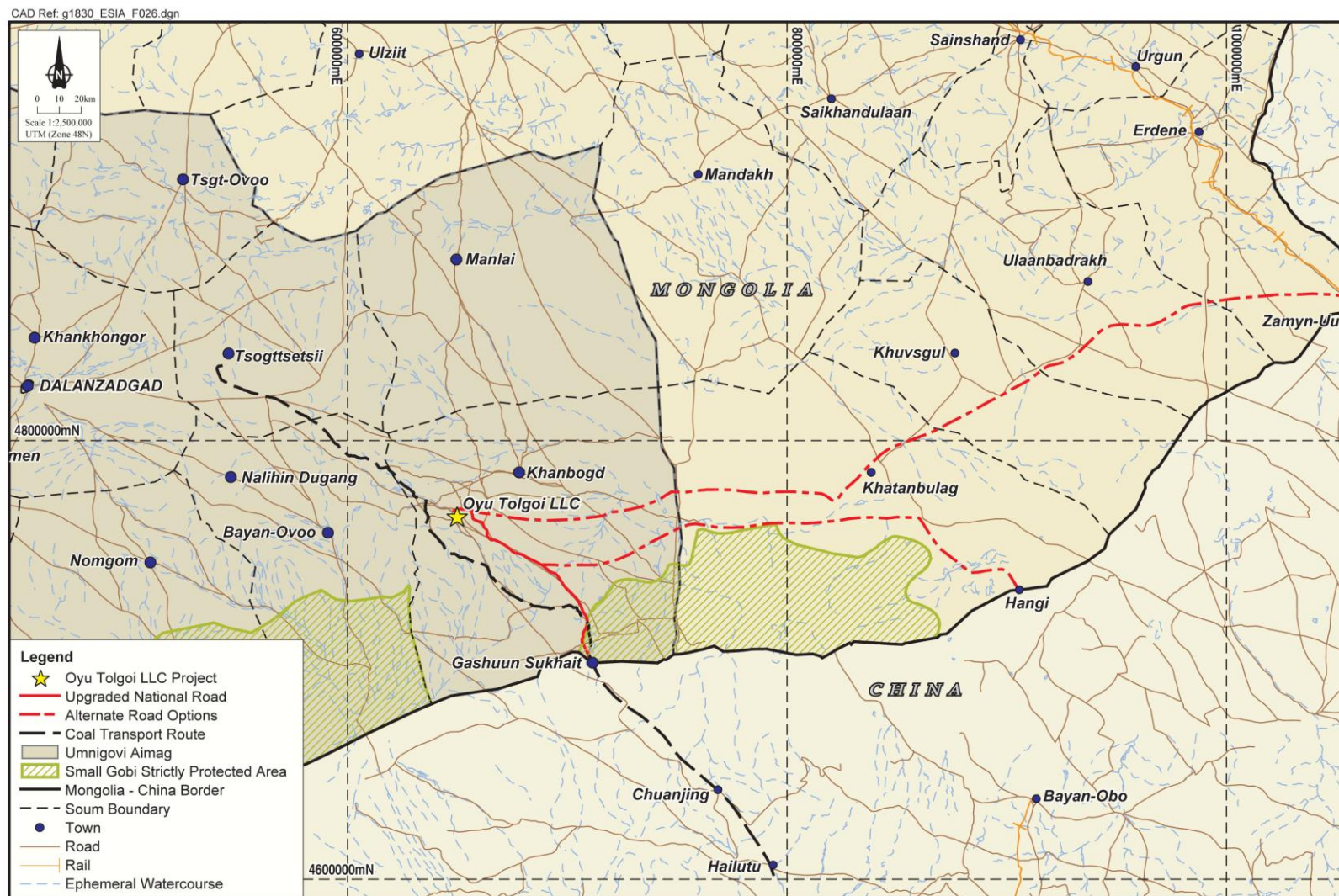
These routes are illustrated in *Figure 5.9*.

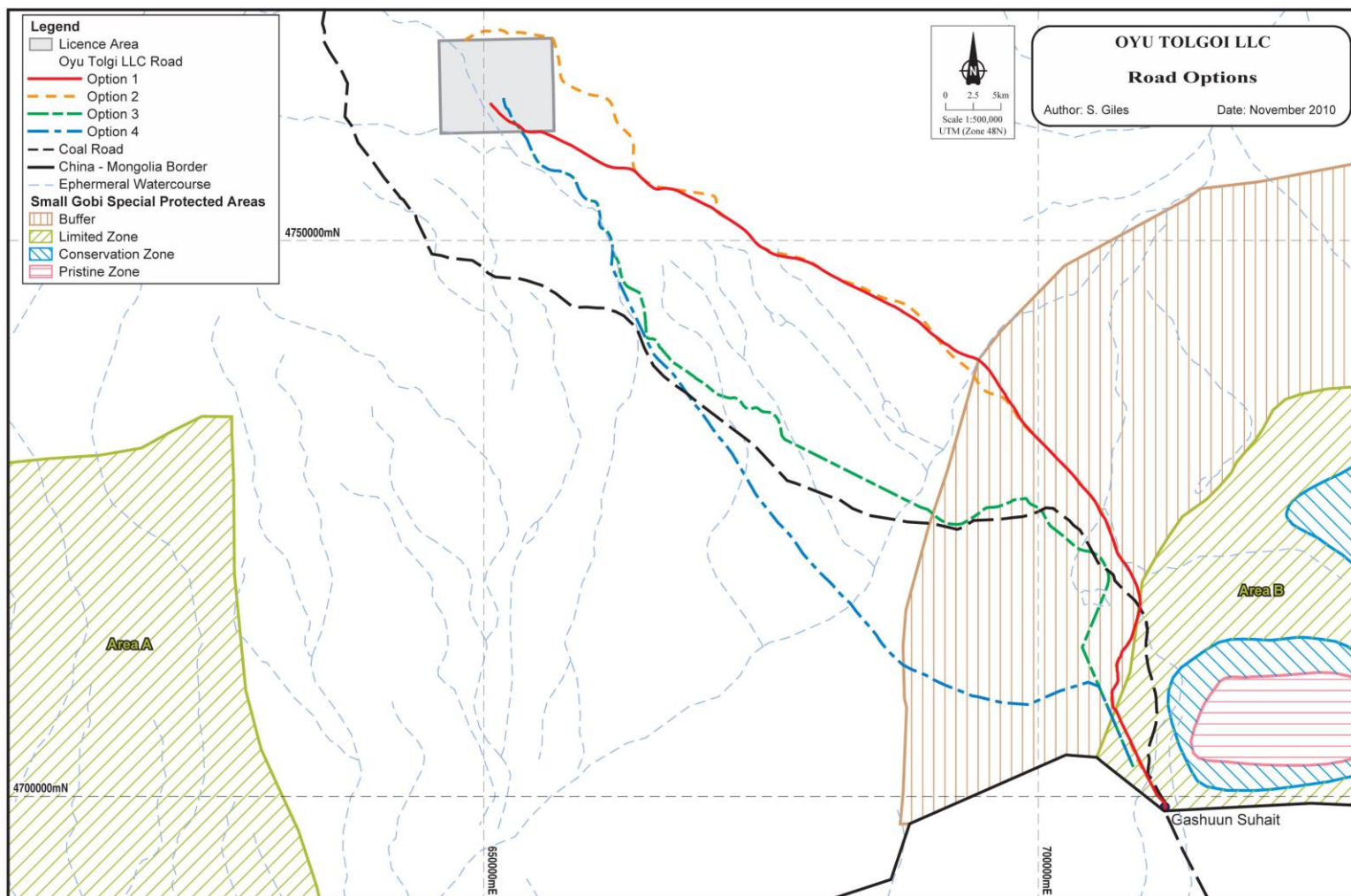
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<sup>34</sup> Knight Piésold Pty Limited (2003); Oyu Tolgoi Project Route Reconnaissance on Eastern Routes to Hangi and Zamiin Uud, Ref. PE601-00001/5, November 2003

<sup>35</sup> Ivanhoe Mines Mongolia Inc (2003). Southern Road Route Options Report, October 2003

Figure 5.9: Route Options to the Chinese Border from Oyu Tolgoi





Both the eastern alternative routes evaluated require a significant length of road construction in Mongolia to upgrade the current tracks which make up the access route, in addition the eastern-most route via Zamin-Uud also requires road upgrades in IMAR to enable trucks to reach Bayan Obo. The key observations in relation to the alternative routes evaluated can be summarized as follows:

- It is feasible and practical to build either of the eastern routes, but poor quality road building soils do occur in many areas along the roads and suitable borrow pits would be widely spaced;
- Water supply for construction and maintenance will be an issue as it will require the development of a substantial groundwater network;
- There are some substantial sand dunes along the route and the area around Zamiin-Uud is known to be problematic for windblown sand. This route may disturb these dunes and there is an increased risk of dust storms impacting traffic and safe driving conditions;
- Both routes pass through the buffer zone to the SPA and would result in substantial risk of increased fragmentation of habitat for the endangered Asiatic Wild Ass and the Goitered Gazelle, which is listed as vulnerable; and
- Due to the significantly longer length of both eastern routes, both routes would lead to greater potential disruption of summer pastureland for herders as well as increase the potential for disrupted access to herder wells.

For the primary route under evaluation (to Gashuun Sukhait) these key observations can be summarized as follows:

- The route would make use of existing tracks south and passes through the western section of the SGSPA, which is recognised as one of the most sensitive environmental receptors present on all three options;
- The route may contribute to east-west fragmentation of habitat for endangered and vulnerable migratory species which are already impacted by coal transportation between coal producers in the Tavan Tolgoi basin and the Gashuun Sukhait border crossing;
- Water wells installed by Oyu Tolgoi are available for the construction of sections through the Galbyn Gobi with additional infill boreholes required between these and the mining licence wells; and
- The route interacts with the coal transport route and will require careful consideration of the interaction between these.

Following consideration of the alternatives, the route to Gashuun Sukhait was chosen for the following reasons:

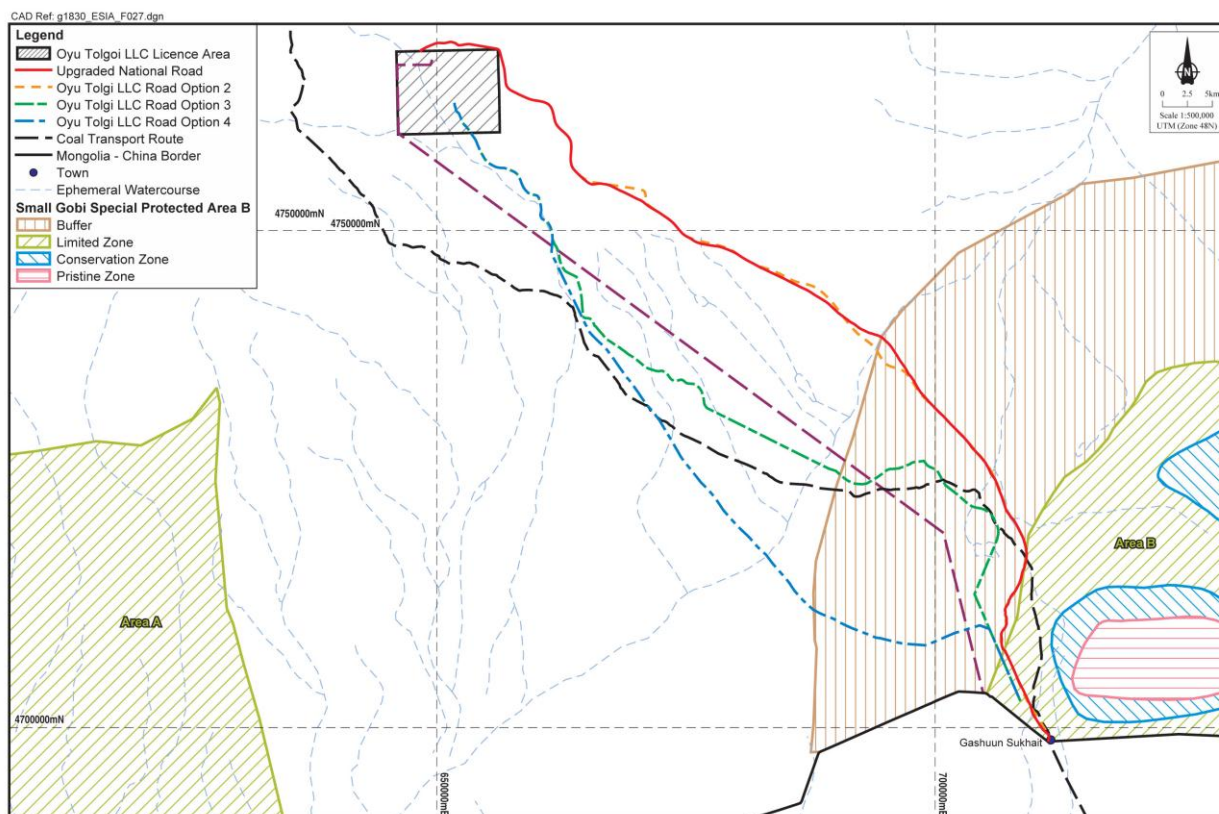
- There is a lack of water resources and suitable rock for construction along the eastern routes;
- The eastern routes would require 300 km of additional new road construction compared with the 100 km of road reconstruction for the route to Gashuun Sukhait;
- The eastern routes would require three times the amount of land disturbance from road construction and borrow pits compared with the route to Gashuun Sukhait;
- The route to Gashuun Sukhait is the shortest distance and keeps the trucks in the same corridor as the coal transport route near the border rather than adding truck impacts to the relatively undisturbed areas eastwards along the eastern routes; and
- The shorter distance of the route compared to the eastern routes would reduce the potential impact to herders.

The potential impacts and management of vehicle traffic to Gashuun Sukhait are discussed in *D11: Transport Management Plan*

## 5.10.2 Oyu Tolgoi to Gashuun-Sukhait Options

The detail of the route of the preferred export option, i.e. Oyu Tolgoi to Gashuun Sukhait has been subject to more detailed alternative route studies. These were first considered in 2003<sup>36</sup> where an eastern and western route alignment were considered and further assessed as part of the EIA for the infrastructure corridor<sup>37</sup>. These route options are shown in *Figure 5.10* below.

**Figure 5.10: Route Options from Oyu Tolgoi to Gashuun Sukhait**



Both road options initially assessed (shown as Option 3 and 4 above) share a common route for the first 36 km from the Mine Licence Area. The first 12 km of the route south of Oyu Tolgoi, traverses relatively flat desert and semi desert steppe prior to entering the Undai River valley where rocky outcrops and river crossings are common for a 14 km section south to Javkhlant. The key features of the two routes were:

### **Road Option 3**

This follows the existing access road from Oyu Tolgoi south to Gashuun Sukhait, via the Javkhlant Bag centre and the Border Protection Authority (BPA) check point. The road is 102.57 km in length from Oyu Tolgoi to Gashuun Sukhait. This road option avoids a major drainage basin to the west and has potentially better access to water and road building materials than options to the west of the drainage basin. Numerous water supplies have been identified along the route from Oyu Tolgoi to Javkhlant Bag.

Approximately 13 km of this road route passes through the Small Gobi B Strictly Protected Area (SGSPA) from the BPA checkpoint to the border crossing. The road route proposed through the SGSPA follows and upgrades the existing access road. Approximately 12 km of road also traverses the SGSPA Buffer Zone.

<sup>36</sup> Report on Southern Road Route option from Oyu Tolgoi to the Gashuun Sukhait Border Crossing in China. Prepared by Don Best (IMMI). Dated 4th October 2003

<sup>37</sup> Ecotrade (2004), Oyu Tolgoi Project Environmental Impact Assessment, Volume 1, Report of Oyu Tolgoi to Gashuun Sukhait Road and Infrastructure Corridor, prepared by Ecotrade LLC

Road Option 1 follows generally flat terrain with only 6km of road passing through the hilly section near the Tsagaan Khad temporary settlement adjacent to coal export stockpiles.

#### **Road Option 4**

This route is 97.4 km long and is a more direct route from Oyu Tolgoi to Gashuun Sukhait and traverses relatively flat land. The entry point to the SPA is south of the existing checkpoint and would therefore require the relocation of this checkpoint. Preliminary discussions with the Mongolian authorities indicate some concerns with regard to the proposed route in relation to the border and border protection zone.

The main disadvantage of this route is that it traverses approximately 20 km of alluvial filled valley which has sandy surface soils that are not suitable for road construction. It is unlikely that road construction material will be found within this alluvial plain so road base materials will need to be transported substantial distances. Approximately 20 km of the road also runs along a large north/south tending drainage basin that could be a problem during any potential short duration flood event.

Based on this, Road Option 3 was selected and the 2004 DEIA was approved by the Ministry of Nature and Environment. These route selections were undertaken prior to the commencement of any significant coal export from the region to the border and the temporary border settlement of Tsagaan Khad was only used quarterly when the border was opened for Chinese traders to come through to sell wares and buy cashmere and other product from Mongolian traders. Following the approval of the DEIA Oyu Tolgoi started earthworks for the first 30 km upgrade of the road from Oyu Tolgoi.

#### **Selection of Final Route Option**

Following the initial route selection coal transported from the Tavan Tolgoi coal mine and other smaller coal mines to the Gashuun Sukhait border point started in May 2004. This was undertaken by the Chinese Pushin company using high volume trucks. These trucks adopted the same road route as selected by Oyu Tolgoi from the Undai River crossing to Gashuun Sukhait border point, which represented 80% of the route approved for use by Oyu Tolgoi. In addition the temporary settlement of Tsagaan Khad had become established as a temporary coal stockpiling depot.

The intensive and uncontrolled coal truck transport from Tavan Tolgoi to the border point has resulted in environmental disturbances and erosion of the road and road corridor land, soil and vegetation covering an estimated 309 hectare (ha) plus 20 ha from the excavation of road building materials. As a result, it was impossible for Oyu Tolgoi to continue the road upgrade on this originally approved route. Therefore Oyu Tolgoi proposed a change in the road option to a much shorter more easterly alignment (indicated as Option 1, with some variations used during the construction phase shown as Option 2). This route is also the designated national road within Mongolia to the Gashuun Sukhait border point and utilises a previously-existing desert road through the SGSPA within the lowest level protection area and a zone where road use is permitted<sup>38</sup>. Use of this alignment minimises impacts to the SGSPA as it uses an existing road alignment<sup>39</sup> (rather than creating a new road) and meets the requirements of the Government of Mongolia for the road approach to the Chinese border, crossing both through the SGSPA and a military border security zone along the border. The Government of Mongolia has provided substantial direction to Oyu Tolgoi on the route of the upgraded National road through the Small Gobi Strictly Protected Area "B" and at Gashuun Sukhait, as this road is within a border security zone and is subject to national planning for border crossing infrastructure. The location of the border crossing was determined by the Government of Mongolia and Oyu Tolgoi therefore was using already established infrastructure locations during its route selection processes – making it impossible to avoid crossing through a small section of the Small Gobi Strictly Protected Area "B". The Government direction on the road route options in the Protected Area and associated buffer zone, and also the need to comply with the government Master Plan for the Gashuun Sukhait border crossing related to the approach to the border crossing has limited the avoidance options available to Oyu Tolgoi in its planning processes.

The options of sharing a common road for the Oyu Tolgoi concentrate and the Tavan Tolgoi coal transport to Gashuun Sukhait is not considered a viable option for two key reasons:

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<sup>38</sup> The protection levels (lowest to highest) are limited zone, conservation zone, pristine zone.

<sup>39</sup> The road to Gashuun Sukhait to be used by Oyu Tolgoi is the A-0203 as designated by the Government of Mongolia.

- The coal transport road volumes in 2009 were in excess of 390 coal trucks per day from 11 different coal mining companies<sup>40</sup>. This volume has significantly increased since that time and a recent traffic census (in 2011) indicated that there are approximately 800 heavy vehicle movements on the road.<sup>41</sup> Currently, the Oyu Tolgoi to Gashuun Sukhait road has approximately 150 heavy vehicle movements per day related to construction activities. While this number will actually decline during operations, because the road is a public highway, traffic levels are forecast to increase and are expected to peak with total traffic volumes of approximately 1600 vehicles per day by 2030, although current total traffic volumes are well below 400 vehicles per day. As a result, the high existing volumes of traffic relate to coal transportation, if combined with the mixed Oyu Tolgoi and public traffic from the Oyu Tolgoi – Gashuun Sukhait road would lead to very high traffic volumes and the mixing of heavy vehicles and small cars and trucks on the same road. Not only would this create congestion problems, it would also lead to significant risks of frequent traffic accidents. The Oyu Tolgoi road design and alignment are fixed (as a national highway), agreed with the Mongolian government, and not possible to change.
- The Government<sup>42</sup> does not wish Tavan Tolgoi coal traffic to use the national highway (according to L. Gansukh, Minister for Environment and Tourism; meeting minutes of 12 March 2010). As a result, even if Oyu Tolgoi wished to have a combined road, this option has been ruled out by the Government.

To support this third road option a supplementary DEIA was prepared detailing the changes in road route, road design and environmental baseline<sup>43</sup>. Social and cultural impacts of the road options were evaluated by the DEIA consultants in the social baseline studies.

The proposed final road route is located between 6 and 20 km east of the original planned route and is a more direct route, traverses an area with more suitable road building materials and does not require substantial river crossings, and therefore avoids potential impacts to shallow herder wells and springs that are common along the northern section of Options 3 and 4. Baseline, impact assessment and management and mitigation plans for the selected road alignment are included within this ESIA. The final road alignment is set out in *Chapter A4: Project Description*. The social, water and biodiversity aspects considered by the road route alternatives analysis are described below.

### **Social Aspect Considerations for Third Route Option Design**

The social baseline study identified six nomadic herder families as using the proposed third route option from Oyu Tolgoi to Gashuun Sukhait for seasonal camp sites and grazing pasture. These activities are generally focused around well sites. The low population density of the area (approximately 1-2 families per 100 km<sup>2</sup>) will limit the potential for impacts associated with increased traffic movement. However, there is potential for some risk and disruption to the livelihood of these families by:

- Increased dust and noise from vehicle traffic for camps located adjacent to the road;
- Impacts on shallow herder wells from water resources used for road construction;
- Loss of stock from road kill and the potential for road accidents associated with increased traffic; and
- Risks associated with the transport of hazardous materials.

The implementation of the following mitigation measures is proposed:

- Maintain a minimum separation distance of 500 m between the road alignment and herder camps or community facilities;
- Oyu Tolgoi will apply appropriate safety standards for all vehicles and transport operations, with freight vehicles to comply with applicable Mongolian standards for noise emissions and freight drivers provided with appropriate training and competency tests;

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<sup>40</sup> Energy Resources LLC; Ukhua Khudag Phase II ESIA, 2009, ERM and Sustainability Pty Ltd.

<sup>41</sup> See *Chapter B11: Transport and Infrastructure*.

<sup>42</sup> L. Gansukh, Minister for Environment and Tourism; meeting minutes of 12 March 2010

<sup>43</sup> Ecotrade (2006), Supplementary Environmental Impact Assessment Report For Oyu Tolgoi – Gashuun Sukhait altered road alignment prepared by Ecotrade LLC

- The design of the fully constructed road will be suitable for predicted traffic volumes and the unsealed road will have appropriate dust suppression applied during operations, prior to the progressive sealing of the road which will eventually resolve the dust issue;
- Water resources used for road construction, maintenance and dust control will be resourced from dedicated bores or wells in a manner that maintains local water supplies;
- Implementation of appropriate procedures for the transport of hazardous materials and incident response;
- Employment and training initiatives for construction and maintenance of the road alignment will target and give preference to local residents; and
- Oyu Tolgoi will liaise and consult with local families using pastures within the road alignment to minimise the risk of stock loss from vehicle accidents through an assessment of well locations and grazing patterns.

A survey completed in 2006 along the proposed road corridor identified no significant archaeological sites. Oyu Tolgoi propose to manage the protection of cultural heritage sites by avoiding the disturbance of any identified sites wherever possible and where a site is identified, the site will be reported to the appropriate authorities.

#### ***Water Resource Aspect Considerations for Third Route Option Design***

The environmental baseline identified several dry river beds and ravines crossing the proposed third route option that are activated temporarily by rain. Water from these watercourses percolates into the shallow groundwater which supplies shallow wells used by herders for watering of livestock. It is proposed to mitigate impacts on water resources by avoiding stream crossings at significant ephemeral dry riverbeds, surface springs, elm trees which are phreatophytes that signify the presence of groundwater, and herder wells. Additionally, to mitigate the potential for contamination of the shallow groundwater and surface water, the transport of hazardous chemicals will comply with all legal permits and approvals and hazardous chemical transport procedures and emergency response procedures will be developed to meet appropriate international standards.

#### ***Biodiversity Considerations for Third Route Option Design***

Similar to the biodiversity issues surrounding the high voltage transmission lines discussed earlier, the preliminary route assessments of the road upgrade from Oyu Tolgoi to Gashuun Sukhait did not fully identify the significance of the road on the biodiversity values of the region. The development of the coal road from Tavan Tolgoi to Gashuun Sukhait as a major transport corridor from 2004 onwards provided the focus on migratory ungulates and bird species of conservation significance. The 2010 Birdlife International report<sup>44</sup>, which identified an Important Bird Area over a substantial part of the preferred road route, triggered the need for Oyu Tolgoi to undertake more extensive biodiversity field surveys, culminating in a Rapid Biodiversity Assessment in May 2011. The primary risk posed by use of the upgraded road as a national highway is indirect habitat loss of the populations of Asiatic Wild Ass and Goitered Gazelle.

The field study team, consisting of internationally recognised subject area specialists, made recommendations<sup>45</sup> on road design aspects that may mitigate the biodiversity impacts associated with the preferred road option which was substantially under early construction phase at the time of the Rapid Biodiversity Assessment.

The Rapid Biodiversity Assessment noted that mitigation of impacts from the road upgrade to Gashuun Sukhait, while essential, will be of considerably lower value without concurrent mitigation of impacts from the Tavan Tolgoi export road which already appears to constitute a functional barrier to ungulate movements. Likewise, it will be important to consider other road/rail infrastructure and potential associated future settlement patterns. A regional approach to the mitigation of road impacts is therefore highly encouraged in order to achieve appropriate mitigation of Critical Habitat and achievement of Net Positive Impact

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<sup>44</sup> Houbara Bustard and Saker Falcon Surveys in the Galba Gobi IBA, Southern Mongolia, Birdlife International,

<sup>45</sup> The Biodiversity Consultancy Ltd and Flora and Fauna International; Biodiversity Management Plan, Road Upgrade to Gashuun Sukhait, July 2011

While complete avoidance of roads creates a barrier effect and fragmentation, fully mitigated roads are not expected to act as full functional barriers to any species in the Oyu Tolgoi Area of Influence. The Rapid Biodiversity Assessment advised the Project that the only known way to substantially mitigate these risks is through construction of appropriate and sufficient viaducts ('wildlife crossings'). Overpasses may also have potential mitigation value, but are untested in open environments. It is here assumed that burying sections of the road in tunnels is both too expensive in terms of time and cost to be seriously considered. It is estimated that one appropriate viaduct (minimum 4.5 m high x 12 m wide) would be needed approximately every 6 km along the road to ensure appropriate ecological permeability for gazelles and wild ass. The Project has committed to incorporating these, and other biodiversity recommendations into the road design as discussed in *Chapter C6: Biological Resources and Ecosystem Services* and *Chapter D6: Flora and Fauna Management Plan*. Based on this approach, the fragmentation effect of roads to be upgraded or constructed by Oyu Tolgoi is categorized as a Moderate Risk impact for Asiatic wild ass and goitered gazelle and a Low Risk impact for argali and Houbara bustard.

## 5.11 UNDAI RIVER DIVERSION

The Undai is one of the most significant ephemeral watercourses within the Project Area of Influence, of equal importance are the subsurface flows in the sediments of the Undai and the occasional surface flows which recharge the Undai sediments along the course of the watercourse where they flow. The Southern Oyu Pit excavation will extend into the Undai flood plain and the waste rock dumps (WRDs) will lie across the course of the Undai. Given the size of the Undai and the operational (flooding) risks it poses, Oyu Tolgoi will divert the watercourse to the south of the project's surface features to prevent the flooding of the open pit and the ensure continuity of flows within the Undai downstream of Oyu Tolgoi.

The Southern Oyu open pit will extend into the ephemeral Undai River flood plain and WRDs will be located directly across the Undai river channel. The section of the Undai River covered by the WRD will also include the Bor Owoo Spring, a permanent freshwater spring. The loss of Bor Owoo Spring may have significant impacts on priority biodiversity features which use the spring as a source of drinking water.

### 5.11.1 Significance of the Undai

Surface flows of the Undai are short-lived and unpredictable, hence the surface flows are of limited use to the local population. Depending on the local topography, flash floods (locally called "Gobi wild floods") often have a heavy sediment load, and can travel at relatively high speeds down the valleys from the area of rainfall into downstream areas which have not experienced any rain. In the absence of other water features, flood events provide temporary standing water features which can be vital at times for herders and their livestock. Drinking water is provided through annual flooding of the Undai River which recharges shallow alluvial aquifers. In turn, the shallow alluvial aquifers may recharge deeper aquifers and maintain semi-permanent surface water sources such as the Bor Owoo Spring.

Rivers and springs are living heritage sites that play a vital part in functioning of the landscape and in maintaining local people's livelihoods in the area. The Undai represents one of the important water supply sources for Khanbogd *soum* herders and their livestock. Most sacred natural sites are regarded as "key environmental points for herder survival" (Sampildondov & Purevjav 2011).

The Bor Owoo spring provides a supply of fresh water, an essential ecosystem function in the dry environment of the Southern Gobi. A series of other, smaller springs follow the course of the Undai down through the southern end of the Project Area of Influence and ephemeral channels south of Khanbogd.

Qualitative evidence of the value of surface water to animals may be seen in the clustering of wildlife observations along the Undai River. Loss of vegetation through water diversions and groundwater withdrawals can also contribute to erosion and airborne dust.

### 5.11.2 Use of the Mitigation Hierarchy to Consider Alternatives

Due to the physical proximity of the ore body (and hence the open pit) and the course of the Undai there was no option for Oyu Tolgoi activities to avoid interacting with the Undai and the Bor Owoo spring. Given the impossibility of avoidance, the key issues relate to minimisation of impacts. Oyu Tolgoi is committed to the continuity of water supply for downstream water users (both wildlife and herders). As a result, the issues facing Oyu Tolgoi related to:

- Ensuring continuity of water flows in the Undai downstream of the Oyu Tolgoi Mine Licence Area;
- Replacing the Bor Ovoo spring.

Successful implementation of these two objectives would meet Oyu Tolgoi's own commitments, regulatory requirements (as set out in a range of Oyu Tolgoi DEIAs) and ensure that any disruption of impacts to herders and wildlife were minimised.

### **5.11.3 Ensuring Continuity of Water Flows in the Undai**

The location of the Southern Oyu pit and the WRDs requires a diversion system to be put in place that will capture Undai flows above the open pit and WRDs and return flows into the Undai channel downstream of areas impacts by Oyu Tolgoi operations.

The potential impacts that could arise downstream from the Undai diversion are associated with interruptions or restriction to the groundwater flow in the Undai alluvial sediments. This groundwater flow in the Undai sediments is considered to be an essential component of the groundwater flows which sustain the springs downstream of the Mine Licence Area and the herders, fauna and flora which depend on them.

#### ***Alternatives Considered***

The simplest engineering option would be to construct a "cut off wall" to block surface and subsurface flows and to capture all flows in a concrete lined diversion channel to accommodate all of the flow as surface water. However, this would result amongst other impacts, with the evaporation of all, if not the majority, of the base flow as it was brought to the surface, with associated impacts on the downstream aquifers and springs, loss of the Bor Ovoo spring, and also increased velocities of flood events; all of which are considered to be unacceptable.

As a result of the unacceptability of this option, Oyu Tolgoi is planning a more complex and expensive option of the engineered diversion, and subsurface pipeline for subsurface flow and creation of an artificial spring in order to avoid all these possible impacts. Oyu Tolgoi has undertaken consultation on this issue with local herders and other stakeholders, most recently in late 2011 following the completion of the River Diversion Detailed Engineering Report and the development of a DEIA for the diversion scheme and associated public consultation. The "River Diversion Detailed Design Report" and the associated River Diversion DEIA have been presented to the Mongolian Water Authority for independent professional assessment. A "Conclusion Report" has been received from the Water Authority confirming the design approach proposed.

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### ***Design Selected***

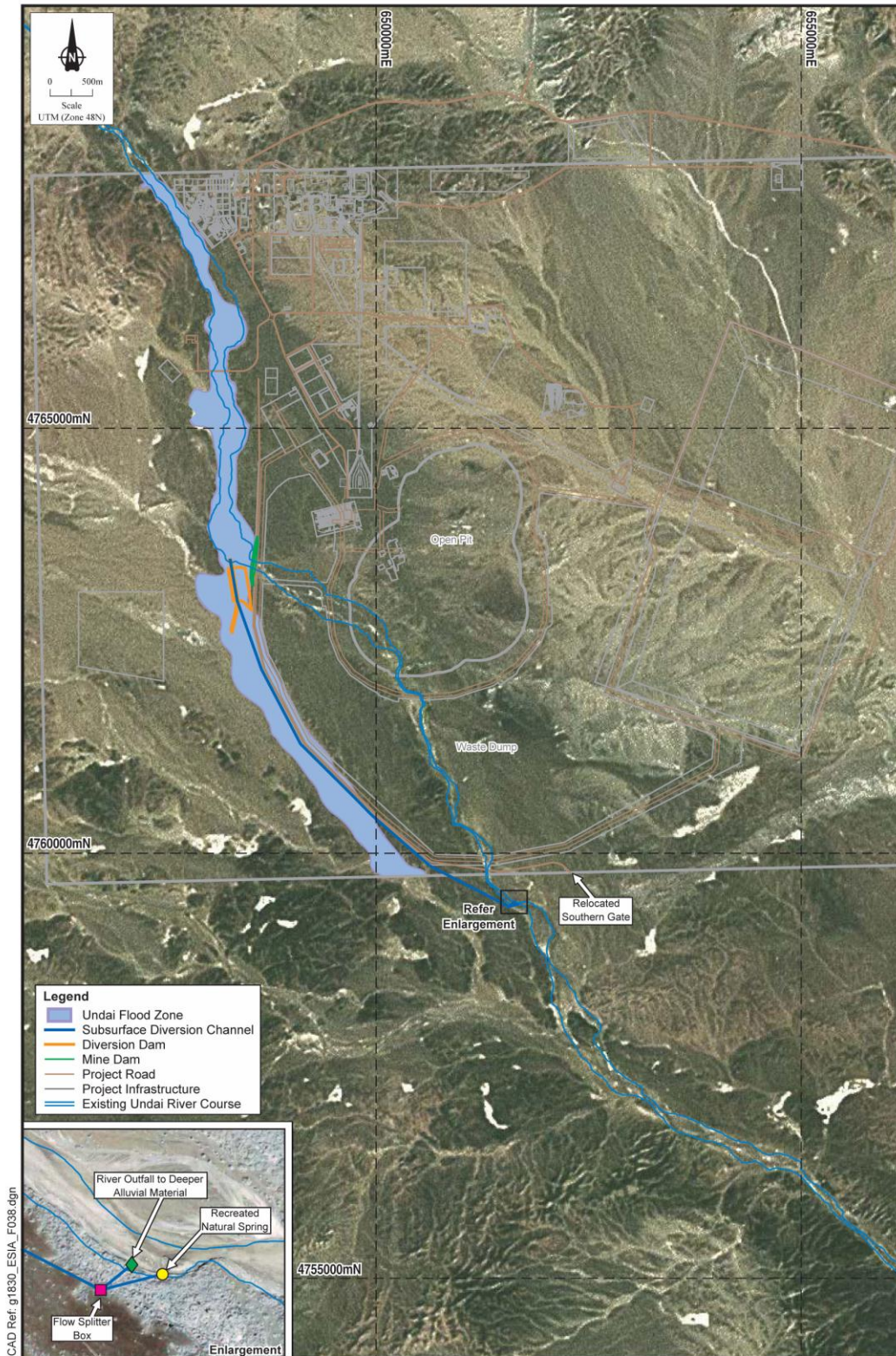
The overall objective of the design of the diversion is to minimise and manage the impact of the diversion by ensuring that the diverted flows are returned efficiently to the river bed downstream so as to maintain surface and subsurface water flows within the local ephemeral watercourse network. In particular the design of the subsurface flow ensures that there are no groundwater losses through evaporation caused by the diversion between the inlet and replacement spring.

Based on an evaluation of available options, Oyu Tolgoi has determined that the best solution will be to divert the watercourse to the south of the operations into an adjacent watercourse (termed the “Western Channel” or Nuur Tsangi) which flows into the Khuren Tolgoi (or “Red River”) which is one of the Undai’s tributaries, The Western Channel is an minor ephemeral water course which, during significant flood events in the Undai, acts as an overflow for excess flows in the Undai.

This diversion will allow flood water in the Undai to pass safely around the mine operations area and to re-join the course of the Undai approximately 1,800 m south of the Mine Licence Area.

This diversion will allow flood water in the Undai to pass safely around the mining operational area and to re-join the course of the Undai approximately 1,800 m south of the Mine Licence Area. The current flood plain of the Undai, the diversion dam, low flow channel and diversion channel are illustrated in *Figure 5.11* below.

**Figure 5.11 Undai River Diversion**



Detailed engineering design for the diversion has been undertaken in 2011<sup>46</sup> and construction work will start on the diversion in 2012, following Mongolian permitting approvals.

Further details of the design for the diversion may be found in *Chapter C5: Water Resources*.

Impacts on water resources as a result of the Undai diversion, and how Oyu Tolgoi will monitor hydrological flows and implement any adaptive management necessary if the design does not perform as expected are set out in *Chapter C5: Water Resources*. The impacts on fauna and flora as a consequence of the diversion, and more significantly the development of the pit, waste rock dumps and associated haul roads, are addressed in *Chapter C6: Biological Resources and Ecosystem Services*.

#### 5.11.4 Replacing the Bor Ovoo Spring

The diversion of the Undai will result in a 6.8 km section of the Undai through the Mine Licence Area becoming dry. This dry section includes the location of the Bor Ovoo Spring, which will also be covered by the waste rock dump.

As outlined above, it is not feasible to avoid the destruction of the Bor Ovoo spring. As a result, the key mitigation is to replace the Bor Ovoo spring and ensure that the replacement spring mimics the ecological function of Bor Ovoo spring in terms of maintaining similar surface and subsurface flow patterns and seasonal variations throughout the year.

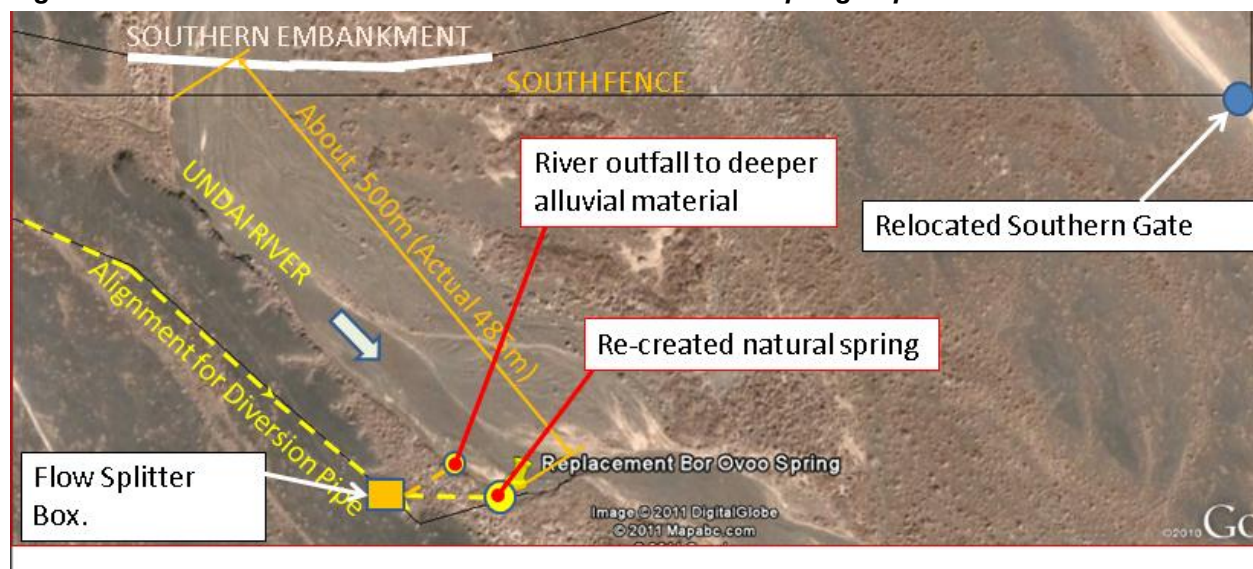
The Bor Ovoo spring will be recreated south of the Mine Licence Area at the location where the subsurface flow diversion pipeline terminates.

##### **Alternatives Considered**

Initially, the location of the replacement spring was proposed to be in close proximity to the southern fence of the Mine Licence Area. The reason for this was to minimise the length of the Undai that would become dry due to the diversion scheme.

In consultation with biodiversity experts, Oyu Tolgoi subsequently moved the location of the replacement spring approximately 500 m to the south of the Mine Licence Area fence. The reason for this was to take account of the likely avoidance behavior away from human activity by animals that may use the spring as a water source.

**Figure 5.12: Alternative Location Selected for the Bor Ovoo Spring Replacement**



<sup>46</sup> SMEC, 2011. Oyu Tolgoi Project: River Diversion Detailed Engineering. Detailed Design Report – Final. A2MW-90-K. 5 September 2011.

### **Design Selected**

The spring is designed such that it is available for use by a range of different fauna groups, including but not limited to large herbivores, and will be available for use by livestock as well as wildlife. In addition the spring is designed such that any water not consumed by wildlife or livestock will infiltrate the alluvium of the river bed and contribute to downstream alluvial groundwater resources.

The location of the replacement spring represents a compromise between minimising disruption to the Undai channel by minimising the length of the diversion, retaining the replacement spring as close as possible to location of the original spring and ensuring sufficient separation distance to minimise avoidance behavior by animals. Despite the balanced compromise location finally selected, the replacement spring is likely to be positioned too close to the fenced mine site for it to be fully used by large ungulates given their likely avoidance of human activity and associated infrastructure.

The detailed design of the Bor Ovoo spring replacement is presented in *Chapter C5: Water Resources* and issues related to wildlife are discussed in *Chapter C6: Biological Resources and Ecosystem Services*.

## **5.12 CONCENTRATE TRANSPORT**

The transportation of concentrate from the Project into China will be through the Gashuun Sukhait-Ganqimaodu border crossing. As Oyu Tolgoi does not have a registered entity in China the concentrate will be taken across the border to a bonded area where the containers will be unloaded. Once it has cleared customs the container will be loaded to the purchaser truck and transported by road to the nearest rail head for shipment to the end smelter or if the smelter is close directly by road. The bonded area will be attached to the current JIL yard through which construction materials are imported.

Oyu Tolgoi has considered the form of shipping container for the concentrate, and reviewed options for bulk, bagged and containerised. The conclusion of this assessment was that containerised transport was the most efficient and safest with the following advantages:

- Avoids risk of spillage and loss of product; and
- Allows multimodal transport options for customers, with container being able to be transported in China by rail or road.

If, in the future, there is a bilateral agreement between China and Mongolia which makes this an International Border, then concentrate could travel from Mongolia under bond to a Mongolian bonded warehouse at the port and then be exported.

As Oyu Tolgoi will be selling the concentrate at the border and has no control on the destination of this, no alternatives assessment on transport routes through China has been undertaken.

### **Railway Option**

Direct rail transport is considered a long-term transportation solution, particularly considering the strategic location of Oyu Tolgoi between regional coal supplies and the Chinese border. However, as this will require a change of the current Government of Mongolia rail strategy, rail transport to and from the mine is only considered as a potential future development and this train option is outside the scope of this ESIA.

## **5.13 WORKFORCE RECRUITMENT AND ACCOMMODATION**

Local employment is the main socio-economic benefit that the Project can directly bring to people living in the *soums* nearest to the Oyu Tolgoi Mine. The wider Omnogovi and Mongolian workforce are also likely to be able to access considerable employment opportunities. A number of Mongolian national content targets and other commitments have been made between Oyu Tolgoi, Rio Tinto and the Government of Mongolia, in particular that there will be 60% Mongolian national employees during construction and that by Year 5 of operations, 90% of the Oyu Tolgoi workforce will be Mongolian nationals.

Manpower estimates for the construction phase currently indicate that within the 2-3 year construction period, Oyu Tolgoi staff and contractors could peak at 14,800 people. Estimates for the production phase, indicate a total workforce in the order of 3,500 employees for underground and aboveground mining operations.

There is a high expectation of employment in the local *soums*, the Omnogovi *aimag* and within Mongolia, particularly because the Oyu Tolgoi Project is the largest mining venture in Mongolian history.

### 5.13.1 Workforce Recruitment

Oyu Tolgoi, in partnership with all applicable Mongolian Government and non-government agencies, intends to ensure that there is a suitably qualified workforce available to meet the requirements of the Project. The options open to Oyu Tolgoi to achieve this included:

- Open Recruitment from global workforce;
- Focus on recruitment from across Mongolia; and
- Focus on recruitment from Southern Gobi Area.

The assessment of these recruitment options has been framed in the context of the objectives of Oyu Tolgoi to recruit as locally as possible from the Mongolian workforce, legally-binding requirements set out in the Investment Agreement on the composition of the workforce, and tempered by the available skill sets in the local and national workforce.

The central goal of Oyu Tolgoi is to ensure that preference is given to hiring from southern Gobi region communities and that 90% of the workforce will be Mongolian within five (5) years of the commencement of production phase.

Oyu Tolgoi has made the following commitments to human resources:

- Oyu Tolgoi will use best efforts to work with contractors who maintain a) a greater than 60% Mongolian workforce for construction work; and b) a greater than 75% Mongolian workforce for direct mining operations. For the remainder of the operating workforce, from the commencement of production, the figure is 90%;
- Within 5 years of the commencement of production, Oyu Tolgoi will use its best endeavours to ensure that no fewer than 50% of its employed engineers shall be Mongolian nationals; and
- Within 10 years of the commencement of production, no fewer than 70% of its employed engineers shall be Mongolian nationals.

Based on the requirements of the Investment Agreement, Oyu Tolgoi has recently developed a 5-year training strategy which has been submitted to the Government of Mongolia for approval. Adopting this strategy will ensure that the workforce recruitment meets national expectations and the requirements of the Investment Agreement.

### 5.13.2 Workforce Accommodation

Oyu Tolgoi has undertaken and participated in, a range of studies to evaluate the options for employee housing<sup>47,48</sup>. *Table 5.12* characterises typical approaches to mine employee housing and sets out the benefits and implications of each approach. It concludes that the overall best approach in terms of delivering benefits to both the mining company and host community is the “**Integrated Community**” approach.

The Taktics4 Oyu Tolgoi Housing Location Strategy study evaluated a more focused set of options: (i) the On-site Option; (ii) the Khanbogd Option and (iii) the Khanbogd/South Gobi option. Evaluation of the options was made in terms of their likely ability to meet expectations of Government (national, *aimag* and *soum*), the host community, Oyu Tolgoi and potential investors. The evaluation concluded that the “**Khanbogd/South Gobi**” option best meets the expectations of all stakeholders, although the likely total cost to Oyu Tolgoi of executing this option is estimated at US\$20 million more than the second-ranked “**Khanbogd-centric**” option.

<sup>47</sup> Taktics4: Housing Location Strategy for Oyu Tolgoi November 2007

<sup>48</sup> Castalia: South Gobi region Urban Infrastructure Background Study for World Bank; September 2008

**Table 5.12: Oyu Tolgoi Construction Workforce and Revised Influx Estimates**

Impact of Four Development Models:		Company Town	Fly-in fly-out	Gated Community	Integrated Community
<b>Influx</b>	<b>Level</b> <b>Growth Rate</b>	High >10%	Low <0%	Moderate to High 2-3%	Low to High 1-26%
<b>Financial</b>	<b>Cost</b> <b>Explanation</b>	High High CAPEX and operational expenditure	Low to Moderate Low CAPEX but high cost of transport and operations	Moderate Moderate CAPEX and operational costs	Low to Moderate CAPEX depends on Infra. Available, low OPEX
<b>Economic</b>		Lower mining royalties because of higher upfront investment in infrastructure	Overall welfare gains if money saved by mining company transfers into royalty payments for government	Government royalties depend on how much infrastructure expenditures the mining company must make	Higher royalties if mining company saves money it would otherwise spend on infrastructure costs
<b>Social</b>		Improved quality because of family-centered housing, but more impact on surroundings	Residential living flexibility for workers, but increased risk of family dysfunction and parenting problems	Health benefits for workers and their families, but possible social tensions between mining population and existing population	Health benefits as workers live with families, but risk of social tension from cultural differences or income disparities between mine workers and existing populations
<b>Sustainability</b>		High dependence on mine leads to few alternative employment opportunities when mine closes	Limited local cultural, environmental and economic impact; No direct jobs or benefits from infrastructure and services for local community around the mine.	Limited cultural, environmental, and economic impact on local areas	Infrastructure and job benefits for local community Opportunity to develop sustainable local service delivery institutions and thus reduce CAPEX requirements

Oyu Tolgoi’s approach to accommodating its personnel represents a combination of the following:

- Camp-type residential facilities for construction workforce; and
- investigation into the balance between an integrated community model which also meets the business needs of Oyu Tolgoi.

During the Project construction phase, workers will live in either purpose-built camp accommodation on site or in Khanbogd at dedicated camps and travel to work on a bus-in/bus-out (BIBO) basis. Workers who are locally resident in Khanbogd will be transported to the mine on a daily basis to their work locations on a rotational shift basis in common with all other workers.

- All construction workers hired from locations other than Khanbogd will be housed within dedicated construction camps.<sup>49</sup>

During the construction phase, workers (both Oyu Tolgoi workers and construction contractors) will live in on-site camps and will not be permitted to leave their camps for recreational purposes. All the camps are autonomous and operated on a self-contained basis, therefore minimising workers’ interaction with the neighbouring communities and the need for the workforce to use community infrastructure<sup>50,51</sup>. Family-type accommodation is not provided at the site, but available in Khanbogd for eligible workers who meet the specific accommodation criteria.

<sup>49</sup> Ref. Section 13.8 of IDOP.

<sup>50</sup> There are two small camps operated by contractors located adjacent to Khanbogd and housing cleaning, catering and other support staff. These camps are open and workers can visit Khanbogd.

<sup>51</sup> See Oyu Tolgoi *Camp Conduct and Code of Behaviour*.

### **Housing for Operations Personnel**

Starting in April 2012, a scoping study for the Oyu Tolgoi town and business park was commenced. The scoping stage will identify a range of potential options for all facets of the town and business park development, including consideration of location; integration; cost; level of services; governance etc. Through the scoping stage a preferred option for each of these considerations will be identified and submitted for consideration in advance of a feasibility study.

### **Development of the Worker Housing Model**

The Oyu Tolgoi Project commissioned a construction-phase Influx Risk Assessment that was conducted by Barclay & Associates in 2007, to identify the likely magnitude and nature of construction-phase influx.<sup>52,53</sup> According to this study, population influx associated with the Oyu Tolgoi project would have both adverse and beneficial impacts on host communities.

Subsequent to that assessment, the Oyu Tolgoi Regional Development Team has produced population projection estimates at *soum* level, as shown in *Table 5.13*. These calculations used the same methodology as adopted by the Asian Development Bank (ADB) in its population projections for the South East Gobi<sup>54</sup> but draw on slightly different assumptions based on the more recent data. The latter included the higher rates of influx observed for Dalanzadgad (exceeding ADB's initial estimates). These assessments will be updated based on the preferred options identified through the Scoping Stage.

The figures presented in the table below highlight the predicted substantial increase in the size of Khanbogd *soum* population.

**Table 5.13: Soum Level Population Projections, Years 2010 to 2020**

Soum Centre	Likely Future Function (and distance from Oyu Tolgoi)	Official Population, Census 2010	Population Projections	
			2015	2020
Dalanzadgad	Regional Mining Centre (250 km)	18,746	22,600	30,000
Khanbogd	Key Urban Service Centre for Oyu Tolgoi (45 km)	3,522	14,000	20,000
Manlai	Satellite Urban Centre (120 km)	2,441	2,400	3,000
Bayan Ovoo	Satellite Urban Centre (80 km)	1,600	1,800	2,200

Source: Oyu Tolgoi Regional Development Team 2010, and Khanbogd Government Office 2010.

Khanbogd *soum* has already demonstrated the highest growth rate as compared with the neighbouring *soums* (with the exception of Tsogttetsii).<sup>55</sup> Between 2000 and 2009, Khanbogd experienced a population growth rate of about 4.2% per year which was higher than the national average and was to an extent attributable to the Oyu Tolgoi's earlier construction activities. In 2010, the annual rate of population growth exceeded 11% which testifies to the fact that Khanbogd *soum* progressively becomes a locus of

<sup>52</sup> Oyu Tolgoi: Influx Risk Assessment, Ivanhoe Mines and Rio Tinto, Barclay & Associates, October 2007.

<sup>53</sup> The construction-phase risk assessment focused mainly on the fairly limited influx that had occurred in the vicinity of Oyu Tolgoi at the time of the work (2007), and used those figures to extrapolate possible future scenarios.

<sup>54</sup> Asian Development Bank. *Southeast Gobi Urban and Border Town Development Project*. Source URL: <http://www.adb.org/projects/project.asp?id=42184>

<sup>55</sup> Oyu Tolgoi Project Social, Economic and Environmental Subset, Centre for Policy Research, Population Training and Research Centre, 2009.

increasing migration, primarily as a result of the burgeoning mining industry (see *Chapter B8: Population and Demographics* for more data on the demography of Khangbogd *soum*).

According to the ADB projections, population of Khanbogd *soum* is expected to increase significantly by year 2020 (from 3,522 in 2010, 14,000 in 2015 to 20,000 in 2020)<sup>56</sup>.

The Oyu Tolgoi strategy and programmes for influx management (see *Chapter C8: Population and Influx*) are based on recommendations made in the 2007 Influx Risk Assessment. Additional information used to develop the Oyu Tolgoi influx management approach includes an updated Project design, the revised housing model, results from the ongoing consultation with local communities and government, and the requirements set out in the Oyu Tolgoi Investment Agreement.

Although Oyu Tolgoi does not have the authority to exert direct control over population movements and migration paths, the Project can influence the movements of workers and suppliers through a regulated and planned process of hiring/employment, procurement, and workforce residential arrangements. In particular, the Project can exercise substantial control over matters such as:

- Where workers are recruited, thereby preventing the spread of informal and counterfeit/unauthorised hiring venues beyond the designated points of hire;
- Where workers are housed, helping to avoid/minimise an unregulated settlement sprawl;
- The availability and quality of energy and water supply, sanitation, as well as other provisions to the Project workforce and wider community and the elements of infrastructure where these services are impacted;
- How and where workers are mobilised from and demobilised to, thereby maximising the local content of Project manpower and optimising workforce movements and flows;
- Worker conduct and a level of interaction with the communities in the Project Area of Influence, through operating dedicated camps and enforcing codes of appropriate behaviour for Project's and contractor personnel;
- Investment in training and professional development of the local workforce, thereby reducing the need for outsourcing personnel from outside the Project Area of Influence; and
- Procurement activities and supplier development support aimed at prioritising local and regional suppliers and service providers, helping to establish the local business base and strengthen its capacity.

## 5.14 CONCLUSIONS

The Oyu Tolgoi Project has evaluated a wide range of options to develop the Project as currently defined. This section has outlined a number of the key issues that have been subject to options analysis to derive the most effective solutions while taking account of environmental and community concerns and constraints.

The alternatives set out in this section represent strategic or macro-level alternatives. Alternatives selection for more detailed operational issues related to the implementation and operation of the Project are described throughout the ESIA.

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<sup>56</sup> Southeast Gobi Urban and Border Town Development Project; PPTA Project Report; Supplementary Appendix A; Asian Development Bank, November 2009.