



ECOLOGICAL FIELD SURVEY FOR THE PERU LNG NATURAL GAS PIPELINE PROJECT

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May, 2007

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EXECUTIVE SUMMARY

This Ecological Field Survey (EFS) is based on the ecological evaluation carried out within the Right of Way (ROW) which has been conceded to Peru LNG for the construction of the natural gas pipeline that will extend from near the town of Chiquintirca (Ayacucho Department) to the Gas Liquefaction Plant at Pampa Melchorita (Lima Department).

The information included herein is not only based on the fieldwork information gathered and analyzed by the EFS team, but also on the data from the Peru LNG Environmental and Social Impact Assessment (ESIA). Moreover, for the purposes of the present document, the ESIA was considered as a regional overview and the EFS as a more specific, local approach, considering that the ESIA had a 3 to 7 km wide study corridor and the EFS was restricted to a 50m-wide area. That is, the EFS focused on potential impacts within and along and immediately adjacent to the ROW and used the ESIA as a macro perspective of the ROW surroundings. The survey was based on the project footprint area (the ROW) as defined at the time the EFS was commissioned. It does not include additional work areas (beyond those provisionally identified in the ESIA) where the project footprint may be widened resulting from future proposals by Peru LNG's construction contractor for pipeline construction support facilities such as camps, storage yards, pipe yards, access roads, and shooflies and extra work space along the ROW.

Also, using biogeographical information and ecological criteria, the EFS team defined 14 Ecological Landscape Units (ELUs) within the 402-km pipeline ROW route (Table 1). In order to describe every ELU, the type of vegetation was used as the primary criterion for the definition of habitat types within each ELU.

Table 1 Ecological Landscape Units (ELUs)

No.	Ecological Landscape Units	KPs	Elevation (m)		Wet Season Precipitation Range (mm)
			Min.	Max.	
1	Apurimac River Valley Montane Forest Ecotone	0+000 – 20+511	2,966	4,066	600 - 2000
2	Campana Watershed	20+511 – 25+115	3,414	4,066	500 - 700
3	Torobamba River Valley	25+115 – 44+300	2,400	3,674	300 - 600
4	Sillaccasa Sierra	44+300 – 56+783	3,566	4,222	500 - 700
5	Yucay River Valley	56+783 – 74+199	2,850	3,864	500 - 700
6	Huamanga-Vischongo Watershed Divide	74+199 – 103+970	3,864	4,250	600 - 700
7	Vinchos River Valley	103+970 – 117+388	3,200	4,000	600 - 800
8	Apacheta High Sierras	117+388 – 162+137	3,841	4,900	700 - 1000

9	Pampas-Palmitos River Basins	162+137 – 195+050	4,000	4,700	700 - 1000
10	Huaytará High Plains and Ridges	195+050 – 249+538	4,000	4,650	400 - 800
11	Pisco-Ica Watershed Divide	249+538 – 272+181	2,850	4,000	300 - 500
12	Coastal Bat Hills	272+181 – 308+000	750	3,100	10 - 400
13	Pisco Sand Plains	308+000 – 332+940	256	750	0 - 50
14	Ica-Lima Coastal Plain	332+940 – 402+000	125	368	0 - 10

Source: Domus.

Species Sensitivity

A key objective of the EFS was to identify the most sensitive elements and sectors of the RoW, building upon and validating the ESIA findings, in order to permit the development of the Pipeline Ecological Management Plan and the Pipeline Restoration Plan. The EFS was not intended to develop a new baseline study, thus the species lists are focused on sensitive elements and are not intended to be complete lists of species present in any given habitat type or landscape unit. For example, common, widespread, abundant species were not specifically addressed by the EFS. Also, the ESIA reports species observed at sampling points located within 3 to 7 km wide corridor, while the EFS focused on the ROW itself. Thus, the EFS findings are not intended to replace the ESIA baseline species data and they cannot be directly compared with the ESIA species data given the differences in the aims and methods of the EFS and ESIA.

Species sensitivity was determined for each species documented by the EFS on the basis of four characteristics: 1) protected status; 2) geographic distribution; 3) use by local communities, and 4) mobility (ability to flee from a disturbance). Species were scored on these characteristics with a potential range of scores from 0 to 14.

High Sensitivity:

- Any species listed as either EN or CR by IUCN¹ or INRENA **and** that is Immobile.
- Any other species with a score of 11 or higher.

Medium Sensitivity:

- Any species listed as either EN or CR by IUCN or INRENA **and** that is Mobile.
- Any species listed as either NT or VU by IUCN or INRENA **and** that is Immobile.
- Any other species with a score of from 6 to 10.

Low Sensitivity:

- Any species with a score less than or equal to 5.

¹ CR = Critically Endangered; EN = Endangered; VN = Vulnerable; NT = Near Threatened

The sensitivity of the species analyzed is summarized in Table 2 by taxonomic group.

Table 2. Sensitivity of Species Analyzed

Group	Low	Medium	High	Total
Plants	83	25	4	112
Crustaceans	0	0	1	1
Fish	2	5	0	7
Amphibians	2	5	0	7
Reptiles	4	17	0	21
Birds	218	4	0	222
Mammals	32	3	0	35
All	341	59	5	405

Sensitive Habitats

According to the ESIA, Vol. II-B, p. 6-51,

"...the most sensitive RoW segments are:

- Kp 0+000 to Kp 10+000. This corresponds to the eastern watershed.*
- Kp 55+000 to Kp 75+000: This corresponds to the two end points of the study area (high sensitivity) as well as the two intermediate segments with medium sensitivity. This is mostly in the Acocros cultivated area.*
- Kp 115+000 to Kp 120+000: Corresponds to the Vinchos River cultivated area.*
- Kp 120+000 to Kp 200+000: Corresponds to high-Andean zone 4, between the Vinchos River and Taccracocha Lake. This includes grass formations, grazing lands, sedge swamps, and lakes.*
- Kp 245+000 to Kp 250+000: Corresponds to the last segment of the puna before descending towards the Western watersheds near Huaytará.*

Therefore, the most sensitive ecosystems are the eastern watersheds, cultivated areas, and the puna area (particularly high-Andean zone 4)."

The total length of the "most sensitive ecosystems" as identified by the ESIA is 120 km, which is equivalent to 29.8% of the RoW length.

A comparison of the ESIA findings against the EFS follows:

- Kp 0+000 to Kp 10+000. Corresponds to the portions of Apurimac Valley Upper Montane Forest Ecotone and the Campana Sierra. Considered to be of Medium Sensitivity by the EFS.
- Kp 55+000 to Kp 75+000: Corresponds almost entirely to the Yucay River Valley (KP 56+800 to Kp 74+000). The EFS considers the Resinous Scrub habitat in this sector to be of High Sensitivity.
- Kp 115+000 to Kp 120+000: Corresponds to the western portion of the Vinchos River Valley and a small portion of the easternmost Apacheta High Sierras. Considered to be of Medium Sensitivity by the EFS.
- Kp 120+000 to Kp 200+000: Corresponds to Apacheta High Sierras, Pampas-Palmitos River Basins, and a portion of the easternmost Huaytará High Plains and Ridges. It does not include the Vinchos River Valley. It does include the Taccracocha Lake area; however, the lake itself is located well beyond the direct area of influence of the RoW. This includes tussock and sward-forming grasslands and peat bogs. Considered to be of Medium Sensitivity by the EFS. Does not include habitat known to be inhabited by the white-bellied cinclodes.
- Kp 245+000 to Kp 250+000: Corresponds to the last segment of the high Andean grasslands (Huaytará High Plains and Ridges) and the first 500 m of the mixed scrublands of the Pisco-Ica Watershed Divide southwest of the town of Huaytará. The grasslands are not considered to be sensitive by the EFS; however, the mixed scrubland from KP 245+000 and westward are considered to be of High Sensitivity.

Based on the EFS findings, the most sensitive ecosystems are, in general terms, the dry forest river valleys of the Apurimac and Mantaro basins, the western Andean scrublands and cactus formations, the hydromorphic habitat islands of the Pisco sand plains, and the riverine ecosystems of the coastal plain.

The three major differences between the ESIA and EFS findings on sensitive ecosystems or habitats are that 1) the ESIA considers the sector from KP 120+000 to KP 200+000 to be highly sensitive while the EFS find this zone to be largely of medium sensitivity, 2) The ESIA considers the sector from KP 249+500 to KP 300+000 to be of medium sensitivity and the sector for KP+300+000 to 308+000 to be of low sensitivity, while the EFS finds the sector from KP 249+500 to 308+000 to be of high sensitivity, and 3) the ESIA considers the sector from KP 325+000 to KP 335+000 to be of low sensitivity, while the EFS finds the sector from 326+000 to 332+000 to be largely of high sensitivity.

Table ES 3.1 HIGH AND MEDIUM SENSITIVITY SPECIES BY ECOLOGICAL LANDSCAPE UNIT (ELU)

Species	Description	Level of Sensitivity
1. Apurimac River Valley Montane Forest Ecotone, KP 0+000 – 20+511		

<i>Phrynosoma</i> sp	Frog	HIGH
<i>Polylepis pauti</i>	Quenual Tree	Medium
<i>Eleutherodactylus discoidalis</i>	Frog	Medium
<i>Proctoporus</i>	Lizard	Medium
<i>Tremarctos ornatus</i>	Spectacled Bear	Medium
<i>Agriornis ardicola</i>	Bird (Tyrant)	Medium
<i>Theristicus melanotis</i>	Bird (Ibis)	Medium
2. Campana Watershed, KP 20+511 – 25+115		
<i>Escallonia resinosa</i>	Shrub	Medium
<i>Myrosmodes</i> sp.	Bog Orchid	Medium
<i>Tecoma sambuxifolia</i>	Shrub	Medium
<i>Proctoporus</i> sp.	Lizard	Medium
<i>Theristicus melanotis</i>	Bird (Ibis)	Medium
3. Torobamba River Valley, KP 25+115 – 44+350		
<i>Corryocactus quadrangularis</i>	Cactus	HIGH
<i>Kageneckia lanceolata</i>	Shrub	HIGH
<i>Acacia macracantha</i>	Tree	Medium
<i>Ariestiguieta discolor</i>	Shrub	Medium
<i>Berberis flexuosa</i>	Shrub	Medium
<i>Echinopsos peruviana puquiensis</i>	Cactus	Medium
<i>Eriotheca vargasii</i>	Shrub	Medium
<i>Escallonia myrtilloides</i>	Shrub	Medium
<i>Escallonia resinosa</i>	Shrub	Medium
<i>Tecoma arequipensis</i>	Shrub	Medium
<i>Tecoma sumbuicifolia</i>	Shrub	Medium
<i>Chanus spinulosus</i>	Toad	Medium
<i>Stenocercus aff. apurimacus</i>	Lizard	Medium

<i>Agriornis andicola</i>	Bird (Tyrant)	Medium
<i>Vultur gryphus</i>	Condor	Medium
4. Siliccasa Sierra, KP 44+350 – 56+738		
<i>Aaa Sp.</i>	Orchid	Medium
<i>Distichia muscoides</i>	Bog Moss	Medium
<i>Escallonia myrtilloides</i>	Shrub	Medium
<i>Myrosmodes sp.</i>	Bog Orchid	Medium
<i>Perezia coerulescens</i>	Herb	Medium
<i>Vultur gryphus</i>	Condor	Medium
5. Yucay River Valley, KP 56+783 – 74+199		
<i>Corryocactus quadrangularis</i>	Cactus	HIGH
<i>Berberis flexuosa</i>	Shrub	Medium
<i>Chaunus spinulosus</i>	Toad	Medium
<i>Cleistocactus morawetzianus</i>	Cactus	Medium
<i>Echinopsis peruviana spp. Puquiensis</i>	Cactus	Medium
<i>Escallonia myrtilloides</i>	Shrub	Medium
<i>Orestias sp.</i>	Killifish	Medium
<i>Trichomycterus rivulatus</i>	Andean catfish	Medium
<i>Liolaemus sp.</i>	Lizard	Medium
<i>Stenocercus fritti</i>	Lizard	Medium
<i>Telmatobius sp.</i>	Frog	Medium
<i>Vultur gryphus</i>	Condor	Medium
6. Huamanga-Viscongo Watershed Divide, KP 74+199 – 103+970		
<i>Escallonia myrtilloides</i>	Shrub	Medium
<i>Parastrephia quadrangularis</i>	Shrub	Medium
<i>Orestias sp.</i>	Killifish	Medium
<i>Liolaemus sp.</i>	Lizard	Medium

<i>Telmatobius sp.</i>	Frog	Medium
<i>Leopardus (oreailurus) jacobitus</i>	Mountain Cat	Medium
<i>Vicugna vicugna</i>	Vicuna	Medium
7. Vinchos River Valley, KP 103+970 – 117+388		
<i>Echinopsis peruviana ssp. Puquiensis</i>	Cactus	Medium
<i>Escallonia myrtilloides</i>	Shrub	Medium
<i>Oroya peruviana</i>	Cactus	Medium
<i>Trichomycterus rivulatus</i>	Andean catfish	Medium
8. Apacheta High Sierras, KP 117+388 – 162+137		
<i>Berberis sp.</i>	Bush	Medium
<i>Ephedra Americana</i>	Bush	Medium
<i>Escallonia myrtilloides</i>	Shrub	Medium
<i>Oroya peruviana</i>	Cactus	Medium
<i>Perezia coerulensis</i>	Herb	Medium
<i>Perezia pinnatifida</i>	Herb	Medium
<i>Ribes sp.</i>	Plant	Medium
<i>Liolaemus cf. melanogaster</i>	Lizard	Medium
<i>Liolaemus melanogaster</i>	Lizard	Medium
<i>Leopardus (oreailurus) jacobitus</i>	Mountain Cat	Medium
<i>Vicugna vicugna</i>	Vicuna	Medium
<i>Asthenes dorbignyi (huancavelica)</i>	Bird (Canastero)	Medium
<i>Theristicus melanopis</i>	Bird (Ibis)	Medium
<i>Vultur gryphus</i>	Condor	Medium
9. Pampas-Palmitos River Basins, KP 162+137 – 195+050		
<i>Perezia coerulescens</i>	Herb	Medium
<i>Distachia muscoides</i>	Bog Moss	Medium
<i>Liolaemus sp.</i>	Lizard	Medium

<i>Leopardus (oreailurus) jacobitus</i>	Mountain Cat	Medium
<i>Vicugna vicugna</i>	Vicuna	Medium
<i>Asthenes dorbignyi (huancavelica)</i>	Bird (Canastero)	Medium
10. Huaytara High Plains and Ridges, KP 195+050 – 249+538		
<i>Perezia coerulescens</i>	Herb	Medium
<i>Liolaemus sp. (ramirez)</i>	Lizard	Medium
<i>Liolaemus cf. polystictus</i>	Lizard	Medium
<i>Vicuna vicugna</i>	Vicuna	Medium
<i>Asthenes dorbignyi (huancavelica)</i>	Bird (Canastero)	Medium
11. Pisco-Ica Watershed Divide, KP 249+538 – 272+181		
<i>Chersodoma arequipensis</i>	Shrub	HIGH
<i>Senecio tovari</i>	Cactus	Medium
<i>Liolaemus sp.</i>	Lizard	Medium
<i>Microlophus affitigris</i>	Lizard	Medium
12. Coastal Bat Hills, KP 272+181 – 308+000		
<i>Cleistocactus acanthurus</i>	Cactus	HIGH
<i>Browningia candelaris</i>	Cactus	Medium
<i>Cridoscolus basiacanthus</i>	Herb	Medium
<i>Ephedra Americana</i>	Shrub	Medium
<i>Loasa incana</i>	Shrub	Medium
<i>Neoraimondia arequipensis</i>	Cactus	Medium
<i>Orthopterygium huacui</i>	Tree	Medium
<i>Microlophus tigris</i>	Lizard	Medium
<i>Phyllodactylus lepidopygus</i>	Gecko Lizard	Medium
13. Pisco Sand Plains, KP 308+000 – 332+940		
<i>Dicrodoa heterolepis</i>	Lizard	Medium
<i>Microlophus thoracicusicae</i>	Lizard	Medium

<i>Phyllodactylus lepidopygus</i>	Gecko Lizard	Medium
<i>Xenospingus concolor</i>	Bird (Finch)	Medium
14. Ica-Lima Coastal Plain, KP 332+940 – 408+000		
<i>Cryphiops caementarius</i>	Shrimp	HIGH
<i>Acacia macracantha</i>	Tree	Medium
<i>Trichomycterus rivulatus</i>	Andean catfish	Medium
<i>Alsopphis sp.</i>	Snake	Medium
<i>Chaunus limensis</i>	Toad	Medium
<i>Ctenblepharys adspersa</i>	Lizard	Medium
<i>Dicrodon heterolepis</i>	Lizard	Medium
<i>Microlophus tigris</i>	Lizard	Medium

Source: Ecological Field Survey

Table ES.3.2 EFS Medium and High Sensitivity Habitats by Ecological Landscape Unit

ELU	HABITAT TYPES	HABITAT SENSITIVITY	RoW Length (m)
1. Apurimac River Valley Montane Forest Ecotone	Upper Montane Forest	Medium	4,495
	Tussock Grassland	Medium	3,321
2. Campana Watershed	Peat Bog	Medium	1,834
	Sward-forming Grassland	Medium	6,318
3. Torobamba River Valley	Cultivated Areas	High	7,902
	Dry Deciduous Forest	Medium	651
	Thorny Scrub	High	6,238
4. Sillaccasa Sierra	Tussock Grassland	Medium	10,333
5. Yucay River Valley	Thorny Scrub	Medium	171
	Resinous Scrub	High	1,630
	Yucay River	Medium	26

6. Huamanga Vischongo Watershed Divide	Tussock Grassland	Medium	27,246
7. Vinchos River Valley	Cultivated Areas	Medium	12,074
8. Apacheta High Sierras	Scarcely Vegetated High Andean Areas	Medium	21,083
	Sward-forming Grassland	Medium	17,481
	Tussock Grassland	Medium	6,900
9. Pampas Palmitos River Basins	Tussock Grassland	Medium	11,741
10. Huaytará High Plains and Ridges	Scarcely Vegetated High Andean Areas	Medium	3,599
	Sward-forming Grassland	Medium	16,127
	Tussock Grassland	Medium	33,616
11. Pisco Ica Watershed Divide	Mixed Scrub	High	17,910
	Thorny Scrub	High	4,590
12. Coastal Bat Hills	Desert Scrub	High	15,924
	Columnar Cacti and Scrub	High	20,076
13. Pisco Sand Plains	Hydromorphic Islands and Lagoons	High	4,800*
14. Ica-Lima Costal Plain	Cultivated Areas	Medium	18,197
	Desert Barrens	Medium	46,430
	Riverine Corridors	High	875

*Distance of sector where RoW passes near or crosses hydromorphic island and lagoon habitats. Actual length of such habitats traversed by RoW is approximately 274 m.

In summary, the distribution of habitat sensitivity categories over the length of the RoW is as follows:

Sensitivity	Length (m)	Percent
Low	80,412	20.0
Medium	241,643	60.1

High	79,945	19.9
Total	402,000	100.0

The EFS categorizes 19.9% of the RoW within the most sensitive category, versus 29.8% in the “most sensitive” category in the ESIA.

Low and Medium Sensitivity Habitats require good practice ecological management procedures that comply with all applicable ESIA commitments, the Ecological Management Plan (ECOMP) and Pipeline Restoration Plan (RP). In addition, site-specific measures apply to High Sensitivity Habitats as described by the ECOMP and RP.

The designation of High Sensitivity Habitat Type means that the specified area is a habitat type within which the EFS has verified the presence of either at least one High Sensitivity Species or at least two medium sensitivity animal species or at least three medium sensitivity plant species. Applying the precautionary principal, this designation requires that the Project take special care to identify the location of sensitive elements within the habitat type and develop appropriate mitigation measures for these specific locations prior to the start of construction.

In accordance with IFC Performance Standard 1, in areas of High Sensitivity Habitat, no project activities will be implemented unless the following requirements are met:

- There are no measurable adverse impacts on the ability of the critical habitat to support the established population of species or the functions of the critical habitat
- There is no reduction in the population of any recognized critically endangered or endangered species
- Mitigation measures are implemented to achieve no net loss of biodiversity where feasible, which may include but are not limited to actions such as post-operation restoration of habitats, offset of losses through the creation of ecologically comparable area(s) that is managed for biodiversity, and compensation to direct users of biodiversity.

The EFS High Sensitivity Habitats are summarized briefly below:

1. Torobamba River Valley Cultivated Areas. Despite extensive land clearing for intensive cultivation, there are patches and corridors of native vegetation between the fields that contain listed and endemic species typical of dry forests and scrublands of the Apurimac Dry Forest System. Among these species are the endangered cactus *Corryocactus quadrangularis* and the critically endangered rosaceous shrub *Kageneckia lanceolata*.
2. Torobamba River Valley Thorny Scrub. Higher up the valley slopes, patches of thorny scrub harbor the critically endangered rosaceous shrub *Kageneckia lanceolata* and other sensitive dry forest and scrub plants, as well as the endangered white-tailed shrike tyrant, a bird of the flycatcher family.
3. Yucay River Valley Resinous Scrub. The dry Yucay River Valley contains patches of native vegetation belonging to the Mantaro Dry Forest System, including populations of the endangered cactus *Corryocactus quadrangularis* and the vulnerable cactus *Echinopsis peruviana puquiensis*.

4. **Pisco-Ica Watershed Divide Mixed and Thorny Scrub.** The upper slopes of the western Andes which drain to the Pacific Ocean support highly adapted plant species such as the critically endangered composite shrub *Chersodoma arequipensis* and the regional endemic *Aequatorium tovarii*. A possible new lizard species of the genus *Microlophus* was found by the EFS in high elevation mixed scrub. Also, these habitats may support populations of the endangered rufous-breasted warbling finch, as documented by the ESIA.
5. **Coastal Bat Hills Desert Scrub and Columnar Cacti.** The lower desert slopes of the Andean foothills support sparse yet diverse vegetation with various threatened and endemic species of cacti and shrubs, including the endangered *Cleistocactus acanthurus*. This habitat supports populations of the critically endangered long-snouted bat (*Platalina genovensium*), a species that feeds exclusively on the pollen and nectar of night-blooming cacti.
6. **Pisco Sand Plains Hydromorphic Islands and Lagoons.** Among the sand dunes south of the lower Pisco River, there are small oases of wetland vegetation, often surrounding small permanent water bodies such as the Bernal and Morón lagoons. These unusual habitat islands support fauna that could not otherwise survive in the surrounding desert environment. For example, the vulnerable slender-billed finch, an endemic coastal desert bird that nests only in hydromorphic thickets and riparian areas, was observed in these habitats. While not containing any highly sensitive species, these habitats are considered to be highly sensitive due to their uniqueness, limited geographic distribution, presence of various medium sensitivity species, and loss of similar habitats in the region to agricultural conversion.
7. **Ica-Lima Coastal Plain Riverine Corridors.** The coastal plain of south-central Peru is traversed by various highly seasonal rivers and streams. The natural vegetation along these streams was formerly a dense riparian woodland and thicket, but these have largely been lost with the development of irrigated agriculture in the narrow river valleys. Only small fragments of these habitats remain. The rivers themselves have been affected by agriculture and urbanization. Nevertheless, the Pisco River supports a critical species from a socioeconomic perspective, the freshwater river shrimp *Cryphiops caementarius*, an important fishery species with an important contribution to the local economy.

Highly Unstable Sectors (HUS)

HUSs were obtained from the ESIA's *Map of Stability Physical Risk* (Vol. V) and complemented with EFS fieldwork observations. This concept includes soils with erosion vulnerability and geotechnical instability, as well as zones with generation of Acid Rock Drainage (medium and high risk) defined in the ESIA, each of which could pose a risk to ecologically sensitive resources, such as water bodies. For the purposes of the EFS, three categories of instability are utilized: low, medium, and high. Low instability includes the "stable" and "slightly unstable" categories of the ESIA (Vol IIA, Section 5.4). Medium instability is equivalent to the "moderately unstable" category of the ESIA. High instability includes the "unstable" and "highly unstable" categories of the ESIA. Thus, the HUSs presented in the EFS include the areas mapped as either "unstable" and "highly unstable" by the ESIA. The purpose of including HUSs in the EFS is to identify and highlight areas where physical instability of the ROW could present risks to the integrity of water bodies and wetlands if measures are not implemented to protect these sensitive receptors.

The EFS field team was unable to survey the zone between KP 270+000 and KP 285+000 due to security risks and logistical complexity. To analyze this stretch, existing information from the ESIA was used. However, based on the available information, there are no unique ELUs or habitat types present in this stretch that were not studied in the remainder of the ROW during the EFS, nor any specific concerns or constraints that will pose a unique problem during construction and reinstatement.

The EFS is intended, above all, to be the main source of information to inform the development of the Ecological Management Plan and the Restoration Plan, especially with regards to translocation of species from the RoW prior to construction and the development of techniques and measures to revegetate the RoW during restatement. It also provides a baseline level of information that may be useful reference material for Peru LNG and its pipeline contractor during construction and also for long-term monitoring during the operation phase of the pipeline.

1.0 INTRODUCTION

The Ecological Field Survey (EFS) is an extension of the Environmental and Social Impact Assessment (ESIA) prepared for Peru LNG, expanding on the ecological information obtained at that phase of the Project. It is also a precursor document for the development of the Project's Ecological Management Plan (ECOMP) and the Restoration Plan (RP), whose objectives are to manage and protect ecological resources during the construction phase of the Project and facilitate reinstatement and restoration of the project footprint area after installation of the pipeline. The EFS includes a database that will offer consistent and useful information for the characterization and management of the ecological conditions of the pipeline right of way (ROW) and to ensure that the impacts that may occur can be controlled and managed during the construction activities. The EFS field survey covers a 50-m wide swath centered on the proposed ROW alignment from the town of Chiquintirca (Ayacucho) to Pampa Melchorita (Lima).

The database includes two main categories of information. The first category is biological, based on information from the biological components previously identified in the ESIA and revisited and enhanced in the EFS fieldwork. The second category is physical, which covers information on environmental components which due to its natural conditions or potential to undergo some change or impact during the construction can become a risk for the project. The database also includes information on the use of natural resources by the local population and the characterization of special sites, such as the crossings of water bodies and roads.

The database verifies and enhances the information provided by the ESIA of the project. For the construction of the database, the team of specialists has undertaken the scoping of the ROW environment. The scoping helped prepare a detailed fieldwork plan and directing the efforts of data collection during this phase. The fieldwork collected new information that will allow for an improved characterization of the habitats and landscapes through simple but meaningful parameters. These parameters also help identify monitoring indicators throughout the project's lifetime.

Likewise, the specialists have defined the information criteria that have been used in the GIS database. The outcome of the criteria analysis was the definition of 14 Ecological Landscape Units (ELUs), which are shown as maps to facilitate a spatial understanding of their distribution and other attributes. This final information is then used to define the needs of the ECOMP for the construction of the pipeline and the RP for the post-construction reinstatement stage.

In order to facilitate the understanding of this document, Appendix 23.4 (Glossary) identifies key concepts and acronyms supported by a brief description.

2.0 OBJECTIVES

The general objective of the Ecological Field Survey is to contribute to the Project's environmental and social sustainability, especially in the areas of conservation and management of local biodiversity by identifying the existing ecological conditions and defining the impacts which could result from the construction and operation of the Peru LNG natural gas pipeline.

The specific objectives of the EFS are to:

- Validate and build upon the ESIA data baseline information, creating an updated and ROW-focused data bank that will serve as an input for the development of the Ecological Management Plan and the Restoration Plan that serve to minimize impacts during construction and facilitate the return of the disturbed area to its original pre-construction condition.
- Identify critical habitats (as defined by IFC Performance Standard 6)².
- Identify plants requiring relocation or re-generation elsewhere to maintain critical habitats.
- Identify zones of steep slopes that may require hydro seeding to facilitate the re-establishment of vegetative cover for erosion control during post-construction reinstatement.
- Identify natural sources of seed and other propagules for revegetation activities.
- Follow-up on the near-threatened, vulnerable, endangered, and critically endangered species suspected to be present or identified in the ESIA, identifying their areas of occurrence within and adjacent to the ROW and other areas affected by the construction of the Project, with special emphasis on potential nesting, roosting, or refuge sites (such as caves, rock shelters, tree cavities, etc.).
- Follow-up on the Chagallo shrimp (*Cryphiops caementarius*) populations in the Pisco River and other rivers to be crossed by the pipeline.
- Identify areas with medium or high sensitivity species that will require identification, capture, and relocation immediately prior to clearing activities. This shall include the reasons and alternatives for such actions.
- Identify spreads requiring minimization of the ROW width or other mitigation measures.
- Confirm existing data obtained to date and identify any additional water body or wetland crossings and other zones requiring special construction procedures.

² Defined by the IFC as "areas with high biodiversity value, including habitat required for the survival of critically endangered or endangered species; areas having special significance for endemic or restricted-range species; sites that are critical for the survival of migratory species; areas supporting globally significant concentrations or numbers of individuals of congregatory species; areas with unique assemblages of species or which are associated with key evolutionary processes or provide key ecosystem services; and areas having biodiversity of significant social, economic or cultural importance to local communities."

- Provide site specific data that will allow for the determination of restoration and mitigation requirements, including species mixes, density targets, drainage conditions, soil properties, and streambed characteristics.

3.0 LEGAL AND INSTITUTIONAL FRAMEWORK

The Peruvian environmental legal framework is a preventive element intended to avoid environmental damage from taking place. The regulations that are encompassed in it are distributed among those that regulate the protection and conservation of the environment in a general way setting forth environmental policies and general principles and those developed at sector level, which regulate the conditions so that the economic activities are environmentally sustainable. Table 3.1 summarizes the key regulations, international standards, and environmental institutions in the areas of ecological management and biodiversity conservation.

Table 3.1 Legal and Institutional Framework

NATIONAL ENVIRONMENTAL POLICY					INTERNATIONAL AGREEMENTS	ENVIRONMENTAL INSTITUTIONS
Political Constitution of Peru					Rio Declaration on Environment and Development	Ministry Council Presidency - PCM
General Law of the Environment					Convention on Biological Diversity	National Environment Council - CONAM
National Agreement					Millennium Objectives	National Institute for the Development of Andean, Amazonian and Afroperuvian Peoples -INDEPA
General Environmental Policy					World Charter for Nature	Energy and Mining Ministry: - General Office of Environmental Issues - General Office of Oil and Gas
Natural Resources and Conservation: -Law of Natural Protected Areas -Forestry and Wildlife Law - Organic Law for the Sustainable Use of Natural Resources - Law for Conservation and sustainable Use of Biological Diversity	Species Protection: - Forestry and Wildlife Law - Supreme Decree N° 034-2004-AG	Soil and Land: - General Law of the Environment - Law for Public Investment in Development of Economic Activities in National Lands and Native and Peasant Farmer Community Lands.	Waters: - General Law of the Environment - Organic Law for the Sustainable Use of Natural Resources - General Law of Water Resources.	Civic Participation: - Political Constitution of Peru - Organic Law for the Sustainable Use of Natural Resources - Law for Conservation and sustainable Use of Biological Diversity - Participation	International Finance Corporation Standards (IFC) Performance Standards on Social & Environmental Sustainability. April, 2006	Supervision Office of Energy and Mines Investment - OSINERGMIN
					Inter-American Development Bank (IDB): Environment and Safeguards Compliance Policy, January 2006. - IDB Guidelines for ESIA. Private Sector - Involuntary Resettlement Policy. IDB (Op-710; 1998) - Private Sector Guide for Public Participation in ESIA's. IDB (2001)	Health Ministry: -General Office of Environmental Health
						Ministry of Agriculture: -National Institute of Natural Resources - INRENA - Special Project for Land Titling -PETT - National Program for Watershed Management and Soil Conservation - PRONAMACHS Ministry of Education: -National Culture Institute - INC

NATIONAL ENVIRONMENTAL POLICY					INTERNATIONAL AGREEMENTS	ENVIRONMENTAL INSTITUTIONS
				Rights Law and Civilian Control	Proposed International Standards for Oil and Gas Industry: - Energy and Biodiversity Initiative (The EBI) - International Petroleum Industry Environmental Conservation Association (IPIECA)	Ombudsman
				- General Law of the Environment		Ministry of Transport and Communications: - Provías Rural
						Regional and Local Instances: - Regional Governments - Regional Offices of Agriculture - Local Governments - Universities - Water Use Commissions - Peasant Farmer Communities

Source: Domus.

3.1 ESIA COMMITMENTS

The principal commitments of the ESIA specifically related to biodiversity and restoration are embodied in the following sections of the ESIA, its Environmental and Social Management Plan (ESMP), and Responses to Comments:

- Construction Procedures on River Crossings, Ravines and Irrigation Infrastructure (ESIA Vol. I - 5.7.3.4).
- Construction Procedures in Andean Wetland Areas (ESIA Vol. I -5.7.3.3).
- Surface Water (ESMP Section 2.4.2.3).
- Vegetation (ESMP Section 2.4.2.6).
- Wildlife (ESMP Section 2.4.2.7).
- Hydro-biological Resources (ESMP Section 2.4.2.8).
- Trenching (ESMP Section 2.5.8).
- Hydrostatic Testing (ESMP Section 2.5.10).
- Major River Crossings (ESMP Section 2.5.11.1).
- Small River Crossings (Streams and Drains) (ESMP Section 2.5.11.2).
- Borrow Areas and Quarries (ESMP Section 2.5.14).
- Surface Water Quality Monitoring (ESMP Section 3.7.2.3).
- Ecological Emergencies (ESMP Section 5.8.13).
- Pipeline Crossing Bodies of Water (ESMP Section 6.6.9).
- Pipeline Crossing Wetlands (ESMP Section 6.6.10).
- Restoration and Revegetation Plan and Revegetation Monitoring components (ESMP Sections 7.0 and 3.8.2.5, respectively).
- Biological Monitoring Plan (Appendix 5.2 of Peru LNG's June 2006 responses to comments on the ESIA).

ESIA commitments are mandatory and must be complied with as appropriate by Peru LNG and its construction contractors.

The ECOMP and RP documents will reference the ESIA-ESMP commitments as necessary to provide for an auditable link between the two. The ECOMP and RP are implementation documents that are a follow-up to the approved ESIA-ESMP, the Responses to Comments, and the ESMP Framework Plan and complement the other Contractor Management Plans (CMPs) developed by PERU LNG. CONTRACTOR will prepare its own Environmental and Social Implementation Plans (ESIPs) in response to these plans.

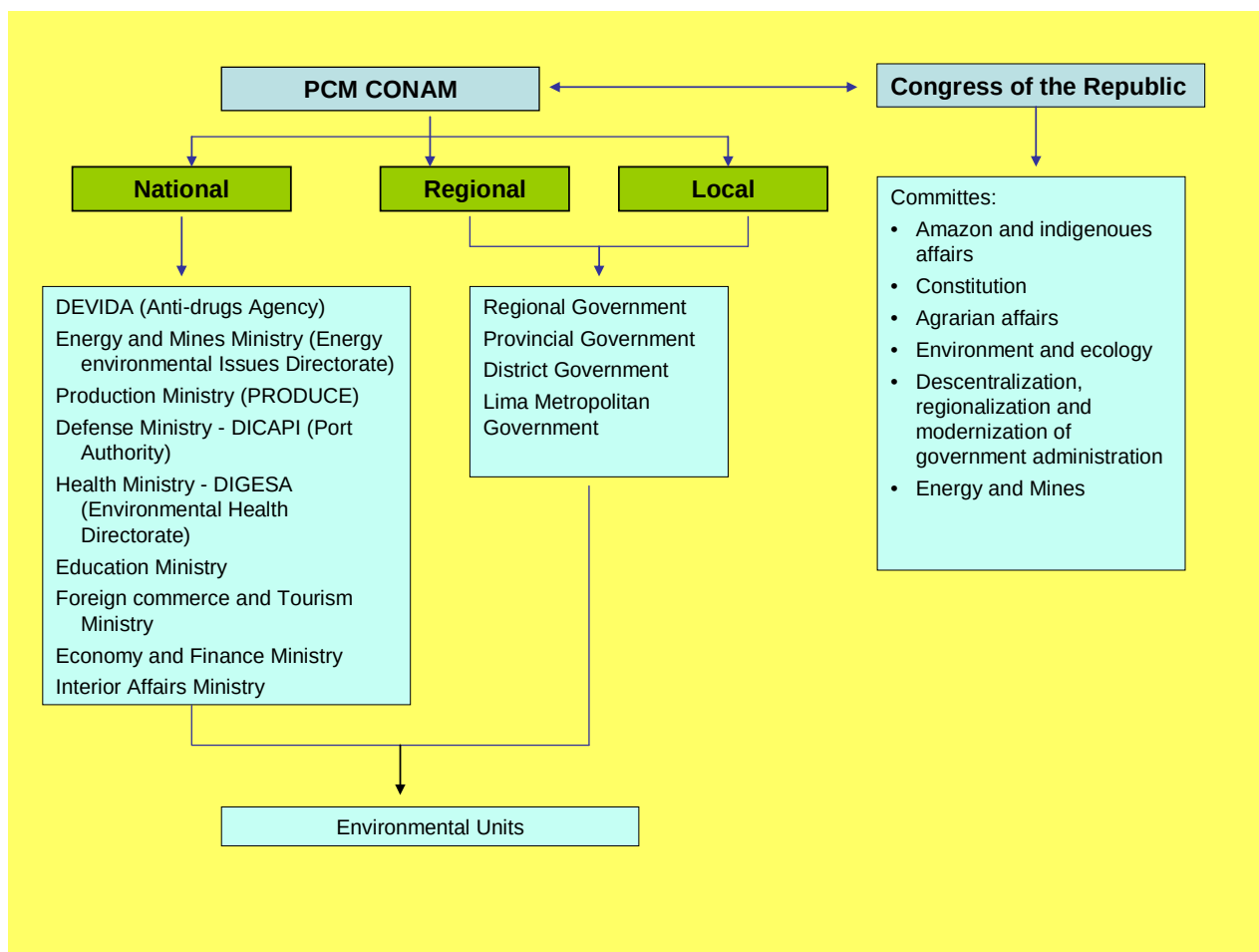
3.2 STAKEHOLDERS

The EFS analyzes the Peruvian environmental institutions that have a stake in the Plan and the effective management of ecological resources in the Project footprint area. In this context, it has been important to identify the competencies in environmental matters at the level of each sector as well as its linkages with the regional governments and involved municipalities.

National institutions, such as the National Environmental Council (*Consejo Nacional del Ambiente*, CONAM), and their coordination levels with the Regional Governments through the Regional Environmental Committees and with the Municipalities deserve special attention.

The rural communities, the local NGOs, and the academic institutions also play an important role for the project execution. Figure 3.1 shows the organization of environmental institutions.

Figure 3.1. Organization of Environmental Institutions



Source: Domus.

4.0 EFS FIELD METHODOLOGY

Detailed information about EFS field methodologies is provided in Appendix 23.2.

4.1 BIOLOGY

For the biological component, field surveys were conducted along the entire ROW route in order to document the key aspects of the natural environments, with the exception of the stretch between KP 270+000 and KP due 285+000 due to security constraints and logistics issues. The presence of ecologically sensitive species and environments was observed in detail along the route. This screening procedure was done on the ground by a team of specialists, selected for their detailed knowledge of the study area; 4 botanists, 4 ornithologists, 2 herpetologists (reptile and amphibian specialists), 3 mammalogists, and 2 experts in hydrobiology took part in the field survey. The group was supervised by a senior ecologist from the planning and assessment phases of the work.

The acquired information was organized into a database that included, among other data, the records of geographical positioning, living organisms and environments presence and status, sensitivity ranking, photographic records and other interpretative attributes. The information allows for the definition and location of sensitive species and habitats, providing the framework for the development of mitigation, management and restoration procedures for each specific case of potentially significant biological impact.

4.2 PHYSICAL ENVIRONMENT

The soils sampling plan was designed based on lateral transects on the ROW alignment and carrying out samplings using two trial pits, the first on the ROW and the second at approximately 30 to 50 m away. The pit descriptions were carried out in the most sensitive areas. In addition to the analysis of soil samples, a field data form was completed with complementary information as slopes, geology, altitude, and degree of sensitivity due to the pipeline construction activities. In the areas not visited by soils specialists, samples of organic soils were collected by the vegetation team for the corresponding chemical analyses.

4.3 SURVEY GAPS

The field survey was able to cover the entire length of the ROW, with the exception of the zone between KP 270+000 and 285+000. It was not possible to continue in this sector due to the high security risks presented by the illicit activities carried out in this zone and the logistical complexity due to the lack of water sources and inaccessibility to vehicles. The scoping and gap analysis did not indicate any areas of high biological priority to be present in this zone. The EFS used the ESIA information in order to complete this gap of the information.

5.0 ECOLOGICAL LANDSCAPE UNITS

5.1 INTRODUCTION

Based upon the findings of the field surveys, an analysis of the project footprint area has been developed, proposing a classification of ecological units that is more suitable for the development of the activities of the project.

This study has developed two classification scales: 1) the major ecological landscapes that exist on and characterize the ROW that will be named subsequently as Ecological Landscape Units (ELUs) and 2) the habitat types based on the local characteristics of soil moisture regimes and the physiognomy of the vegetation at a more detailed level within each ELU.

The delimitation of these Ecological Landscape Units (ELUs) along the ROW provides the overall template for the stratification of zones within which the sensitive elements and areas are identified. Additionally this subdivisional framework of the Project's region of influence facilitates the conceptualization, unification, and organization of the mitigation, management, restoration and environmental preservation activities into discrete and workable geographic zones that represent areas with unique characteristics and management requirements.

An ELU classification system has been defined that is intended to be understandable even for non-ecological specialists, while not diminishing its scientific and technical integrity. It is based primarily on the recognition of the macro-scale units with existing ecological similarity along the ROW, as for example valleys, mountains, plains, plateaus, or deserts in relatively wide tracts.

Fourteen major units of this type have been identified, which in order from east to west are: the Apurimac River Valley Montane Forest Ecotone, the Campana Watershed, the Torobamba River Valley, the Sillaccasa Sierra, the Yucay River Valley, the Huamanga-Vischongo Watershed Divide, the Vinchos River Valley, the Apacheta High Sierras, the Pampas-Palmitos River Basins, the Huaytará High Plains and Ridges, the Pisco-Ica Watershed Divide, the Coastal Bat Hills, the Pisco Sand Plains and the Ica-Lima Coastal Plain.

The spans and kilometers corresponding to these major ecological landscape units in relation to the pipeline and the minimum and maximum elevations for each unit are shown in Table 5.1.

Table 5.1. Level 1 - Ecological Landscape Units (ELUs)

No.	Ecological Landscape Units	KPs	Elevation (m)		Wet Season Precipitation Range (mm)
			Min.	Max.	
1	Apurimac River Valley Montane Forest Ecotone	0+000 – 20+511	2,966	4,066	600 - 2000
2	Campana Watershed	20+511 – 25+115	3,414	4,066	500 - 700
3	Torobamba River Valley	25+115 – 44+300	2,400	3,674	300 - 600
4	Sillaccasa Sierra	44+300 – 56+783	3,566	4,222	500 - 700
5	Yucay River Valley	56+783 – 74+199	2,850	3,864	500 - 700
6	Huamanga-Vischongo Watershed Divide	74+199 – 103+970	3,864	4,250	600 - 700
7	Vinchos River Valley	103+970 – 117+388	3,200	4,000	600 - 800
8	Apacheta High Sierras	117+388 – 162+137	3,841	4,900	700 - 1000
9	Pampas-Palmitos River Basins	162+137 – 195+050	4,000	4,700	700 - 1000
10	Huaytará High Plains and Ridges	195+050 – 249+538	4,000	4,650	400 - 800
11	Pisco-Ica Watershed Divide	249+538 – 272+181	2,850	4,000	300 - 500
12	Coastal Bat Hills	272+181 – 308+000	750	3,100	10 - 400
13	Pisco Sand Plains	308+000 – 332+940	256	750	0 - 50
14	Ica-Lima Coastal Plain	332+940 – 402+000	125	368	0 - 10

Source: Domus.

Appendix 23.6 presents a Photographic Gallery that shows images of representative landscapes and key findings taken during fieldwork, arranged by KPs and ELUs.

1. Apurimac River Valley Montane Forest Ecotone (KP 00+000 - 20+511)

The easternmost zone of the ROW begins near the upper limits of the montane forests of the Apurimac River Valley area of influence. This landscape is dominated by high elevation montane forest (23.50% of the length of the ROW within the ELU), much of which has been subjected to shifting agricultural practices historically, resulting in patches of degraded forests in various stages of recovery. The other natural habitats

are tussock (30.62%) and sward-forming (27.67%) grasslands and peat bog wetlands (8.92%). Actively cultivated areas occupy 9.29% of the ROW. The climate is cool and wet, as this zone is closest to the source of the moist Amazonian air masses and starts at an elevation of approximately 2,966 m at the lowest point near the Alfarpampa River and rising to just over 4,066 m. This unit includes the small settlements of Chiquintirca and Anchiguay. This area is known to harbor spectacled bears (*Tremarctos ornatus*), a wide-ranging Andean species that is listed as vulnerable by the International Union for the Conservation of Nature's (IUCN) *Red List of Threatened Species* and as endangered by Peru's National Institute of Natural Resources (INRENA). However, no bears were directly observed during either the ESIA or EFS field surveys.

2. Campana Watershed (KP 20+511 – 25+115)

From KP 20+511, the ROW rises rapidly into the highlands of the Campana area, with elevations from 3,414 to 4,066 m, which is also cool to cold and wet, dominated by sward-forming grassland (42.79%) and tall tussock grassland (30.23%), with minor areas of peat bog wetlands (20.76%). Cultivated areas occupy the remaining 6.21% of the ROW in the ELU. Large mammals reported here include white-tailed deer (*Odocoileus virginianus*) reported by ESIA and pumas or mountain lions (*Puma concolor*), a species listed as near-threatened by the IUCN and the INRENA. This area is home to an undescribed species of the lizard genus *Proctoporus* that was first collected by the EFS survey.

3. Torobamba River Valley (KP 25+115 – 44+300)

This ELU includes the Torobamba Valley and the Uras Valley, starting near the settlement of Cochas and progressing westwards to near Pampachacra and constitutes a landscape dominated by cultivated areas (41.18%) and thorny scrub (33.02%), with minor areas of the native resinous scrub (15.61%) deciduous dry forests (3.39%), and evergreen woodlands (2.67%). The Torobamba River crossing at approximately 2,400 m is the lowest point of the ROW in the Ayacucho Department and this is reflected by the warmer and drier climate, with seasonal rainfall during the summer months, producing subtropical tree crops such as avocados, pacay, and tangerines. The unique climate and the predominance of scrublands and dry forest are a result of a local rain shadow effect.³ The dry valley belongs to the Apurimac Dry Forest System defined by Linares-Palomino (2004). A characteristic element of the dry forest remnants is the pati tree

³ The rain shadow effect is created by the drying of moist air from the Amazon as it passes over the Andes from east to west. The east-facing slopes force the air to rise creating fog and rainfall in ELUS 1 and 2. As the air descends into the Torobamba Valley, it is warmed and becomes lower in relative humidity, creating drier conditions.

(*Eriothea vargasii*), a species endemic⁴ to the Apurimac system. The Torobamba Valley is also home to an endemic dry forest lizard, *Stenocercus* aff. *apurimacus*.

4. Sillaccasa Sierra (KP 44+300 - 56+783)

This mountain range separates the Mantaro (Yucay River to west) and Apurimac (Torobamba River to east) watersheds. The Cerro Sillaccasa is the highest point of this high mountain landscape, ranging from approximately 3,566 m to 4,222 m, which is nearly entirely dominated by tussock grasslands (82.64%), with small areas of sward-forming grassland (12.45%), peat bog wetlands (3.52%), resinous scrub (1.39%), and lagoons such as Laguna Yanacocha. The tussock grasslands contain an uncommon orchid of the genus *Aa*, which is usually found in localized damp conditions near small streams. A unique floristic element of the wetlands is *Myrmosodes* orchids, which are considered to be near-threatened by the INRENA. Listed animals include the puma (near-threatened under IUCN and INRENA) and Andean condor (*Vultur gryphus*), which is near-threatened in the IUCN list and endangered under the INRENA. Also, the silvery grebe (*Podiceps occipitalis*), listed as near-threatened by the INRENA, frequents the lagoons.

5. Yucay River Valley (KP 56+783 – 74+199)

Extensive cultivated areas around the villages of Chunucancha, Huaychao, Acocro, Tambo, Cuchucancha, and others occupy 81.76% of the ROW in this dry valley landscape of the upper Yucay River Basin, which, at 2,850 m, is the second lowest river crossing of ROW in the Ayacucho Department. Among the cultivated areas and villages, there are plantations of *Eucalyptus* (6.24%), used largely by local communities for firewood and timber. The patches of relict native vegetation are comprised of resinous (10.48%) and thorny (0.98%) scrublands. One peat bog was found along ELU 5 (0.26%). The natural vegetation is part of the Mantaro Dry Forest System (Linares-Palomino, 2004), which is recognized as biogeographically distinct from the dry forests of the Torobamba Valley. This difference is also reflected in the fauna, where each valley has a unique species of the *Stenocercus* Andean dry forest lizard, the Mantaro Basin endemic *Stenocercus frittsi* in the case of the Yucay Valley. The dry scrub vegetation includes various cacti, among which the more notable include the INRENA-endangered *Corryocactus quadrangularis* and the INRENA-vulnerable *Echinopsis peruviana puquiensis*. The shrub *Escallonia myrtilloides* was also found in this ELU and is listed as vulnerable by the INRENA. In the stream and riparian environments, an aquatic *Telmatobius* frog was observed as well as the widespread INRENA-near-threatened toad *Chaunus spinulosus*. *Telmatobius* frogs are generally considered threatened by the IUCN.

⁴ Endemic species are those that are restricted to a certain geographic area, i.e. not widespread.

6. Huamanga-Vischongo Watershed Divide (KP 74+199 - 103+970)

The ROW rises up and follows the watershed divide between the Huamanga Valley (Mantaro Basin) to the north and the Vischongo River Basin (Apurimac Basin) to the south, passing almost entirely through tall tussock grassland (91.31%), with occasional narrow stretches of sward-forming grassland (2.53%), and peat bog wetlands (5.62%), and cultivated areas (0.54%). Elevations range from 3,864 to 4,250. Floristically, this ELU contains populations of the INRENA-vulnerable shrubs *Parastrephia quadrangularis* and *Escallonia myrtilloides*. The rarely observed Andean cat *Leopardus jacobitus* (IUCN/INRENA endangered) was sighted in this ELU by the EFS field team. The area has some importance for the production of the vicuña (*Vicugna vicugna*), a semi-wild relative of the llama with highly-valued wool. *Telmatobius* frogs are found in some of the small streams within the ELU, indicating high-quality habitat.

7. Vinchos River Valley (KP 103+970 - 117+388)

The ROW descends abruptly from the Huamanga-Vischongo watershed ridge top into a largely cultivated valley landscape (89.89%), with relict patches of resinous scrubland (8.63%) and tussock grassland (1.48%). The Vinchos River flows northward into the Mantaro basin, with an elevation of approximately 3,200 at the ROW crossing. To the west, the valley is limited by the Apacheta Mountains starting at about 4,000 m elevation. The Vinchos River Valley harbors various species of cacti, including the INRENA-vulnerable *Echinopsis peruviana puquiensis* and the regional endemic *Oroya peruviana*. The Vinchos River Valley is noted as the most important ELU for birds along the ROW route due the presence of numerous uncommon species observed during the EFS field survey; however, the only species considered sensitive is the bearded mountaineer hummingbird.

8. Apacheta High Sierras (KP 117+388 - 162+137)

West of the Vinchos River Valley, the ROW runs essentially from east to west over a series of ridges (3,841 to 4,900 m) in this high Andean landscape dominated by scarcely vegetated zones (39.26% of the ROW length), sward-forming grasslands (33.34%), tussock grasslands (14.34%), and peat bog wetlands (11.65%), with minor areas of cultivated areas (1.07%) and resinous scrublands (0.34%). This high area is subject to seasonal snow, primarily in June to July, but occasionally in all other months. While largely very sparsely vegetated, this ELU contains sensitive plant species such as *Ephedra americana* (INRENA near-threatened), *Escallonia myrtilloides* (INRENA vulnerable), *Oroya peruana* (regional endemic), *Perezia coerulescens* (INRENA vulnerable), and *Perezia pinnatifida* (INRENA vulnerable). Of particular note, a potentially new species of *Ribes* (currant or gooseberry) was collected by the EFS field team. This sparsely populated area harbors populations of sensitive mammals such as pumas or mountain lions and Andean cats (*Leopardus jacobitus*). While not observed by the EFS team, the ESIA reported sightings of the IUCN-endangered/INRENA-critically-endangered white-bellied cinclodes (*Cinclodes palliatus*), a bird endemic to high-Andean wetlands of central Peru.

9. Pampas-Palmitos River Basins (KP 162+137 - 195+050)

This is another high-Andean landscape with elevations ranging from 4,000 to 4,700 m and dominated by tussock grasslands (46.96%), sward-forming grasslands (31.82%) and scarcely vegetated areas (17.96%), with minor areas of peat bog wetlands (3.25%) in the valleys and drainages of the Pampas and Palmitos rivers, both of which are crossed by the ROW and drain into the Apurimac Basin. A potentially new species of *Liolaemus* lizard was collected by the field team in this ELU. Among the birds observed in the Pampas-Palmitos basins during the survey, the pale-tailed canastero (*Asthenes dorbignyi huanacavelicae*) is listed by INRENA as vulnerable and was sighted in sward-forming grasslands.

10. Huaytará High Plains and Ridges (KP 195+050 - 249+538)

To the west of the steeper and more rugged mountain ranges, of ELUs 8 and 9, this landscape unit is comprised of relatively flat broad ridge tops, plains and rolling topography from 4,000 to 4,650 m in elevation, dominated by increasingly drier and lower-statured tussock grassland (61.69%) and sward-forming grassland (29.60%), with minor areas of scarcely vegetated areas (6.51%) and peat bog wetlands (2.13%). *Perezia coerulescens* (INRENA vulnerable) are relatively common elements of the sward-forming grasslands. Vicuñas are common in the grasslands of this ELU managed by the communities of the Ayaví district. The ESIA identified the Chaupi area (KP 202 to KP 205) as an Ecologically Sensitive Area due to the presence of numerous northern vizcachas (*Lagidium peruanum*); large rock-dwelling rodents that are of value to local communities as food item and are endemic to Peru.

11. Pisco-Ica Watershed Divide (KP 249+538 - 272+181)

To the west of the town of Huaytará, the mountain ridges narrow and descend from 4,000 to 2,850 m towards the Pacific coast. The vegetation changes abruptly from grasslands to mixed scrublands (78.93%) and spiny scrublands (20.27%), and desert scrub (0.80%). Of botanical interest, the INRENA-listed critically endangered *Chersodoma arequipensis* is a sensitive composite shrub that was encountered in this ELU by the EFS field team. A possibly undescribed species of *Microlophus* lizard was discovered by the field team in the high scrubland along the ROW alignment, well above 3,000 m in the eastern portion of this landscape and may represent the highest elevation locality for the genus (Appendix 23.5).

12. Coastal Bat Hills (KP 272+181 - 308+000)

In this high coastal desert landscape, the ROW runs largely along the ridges of local watershed divides (elevations from 750 to 3,100 m) through desert scrub (43.95%) before descending into the valley of the Seco River (elevations from 750 to 1,100 m) with columnar cacti and scrub (56.05%). This arid and rocky landscape is home to threatened species such as long-snouted bats (*Platalina genovensium*, IUCN-

vulnerable/INRENA-endangered) and the lizard *Microlophus tigris* (INRENA-NT). This unit corresponds to the Seco River Basin and is named after the presence of the *Platalina* bats as well as the Quebrada Murciélagos, which translates to "Bat Stream".

13. Pisco Sand Plains (KP 308+000 - 332+940)

This sandy desert landscape extends westward from the edge of the "Bat Hills" in the alluvial plains of the Seco River at about 750 m above sea level, running to parallel to east-west trending hills to the north, and entering the plains to the south of the Pisco River, descending gradually to an elevation near 256 m northwest of the Morón Lagoon. The land cover of this ELU is dominated by desert barrens (75.09%) without any substantial vegetative cover. Other zones (22.91%) are dominated by mat-forming bromeliads (*Tillandsia latifolia* and *Tillandsia palacea*) that lie upon the sandy substrates and obtain moisture directly from the fogs (*garua*) typical of the coastal deserts. There are isolated pockets of hydromorphic vegetation in depressional areas (0.23%), sometimes associated with open water, such the Morón and Bernal lagoons. These lagoons contain fish native to coastal Peru such as the green terror (*Aequidens rivulatus*), a species consumed occasionally by local communities. The INRENA-listed vulnerable lizard *Dicrodon heterolepis* was observed along the ROW during the EFS survey. The survey also documented that patches of hydromorphic vegetation in this ELU support populations of the slender-billed finch (*Xenospingus concolor*), a species listed as near threatened by the IUCN and vulnerable by INRENA.

14. Ica-Lima Coastal Plain (KP 332+940 – 402+000)

The final stretch of the ROW runs through the dry coastal plain of western Ica into the southern Lima department, at elevations of between just under 125 m (the Topará Stream crossing is the lowest point along the entire pipeline route) and 368 m. The dominant natural land cover is unvegetated desert (67.23%). Scattered patches of *Tillandsia* bromeliads are locally important (5.79%). Various seasonal streams and perennial rivers cross the plains and the ROW, some of which are lined by narrow belts of riparian vegetation (1.27% or 874 total linear meters). Despite its desert setting with annual precipitation of generally less than 10 mm, there are extensive cultivated areas under irrigation (25.71%). *Ctenoblepharys adspersa* and *Dicrodon heterolepis*, INRENA-listed vulnerable lizards, have been found along the ROW alignment in this landscape.

6.0 HABITATS

The second level of ecological classification is Habitats. These EFS identified 19 distinctive and differing habitats types which exist within the ELUs (first level of ecological classification, equivalent to a regional landscape). The habitats are largely determined by local physical characteristics (slope, relief, soil drainage, soil fertility, microclimate, etc.) and the land use history of the area, which is reflected by the characteristics of the general vegetation types (e.g., grasslands, wetlands, scrublands, and forests) and finer variations of these general categories (e.g., tussock grasslands versus sward-forming grasslands).

These habitat categories are described in the following paragraphs and summarized in Table 6.1.

Table 6.1. Habitat types identified along the Peru LNG Natural Gas Pipeline Right of Way.

Habitat Type	ELUs where present	Length along ROW (km)	Length along ROW (%)
Wetland and Riparian Areas			
Riparian vegetation	14	875	0.22%
Hydromorphic islands	13	58	0.01%
Peat bogs	1, 2, 4, 6, 8, 9, 10	13434	3.34%
Grasslands			
Sward-forming grassland	1, 2, 4, 6, 8, 9, 10	51517	12.82%
Tussock grassland	1, 2, 4, 6, 7, 8, 9, 10	98466	24.49%
Other Herbaceous Formations			
<i>Tillandsia</i> mats	13, 14	9712	2.42%
Scrublands			
Resinous scrub	3, 4, 5, 6, 7, 8, 11	6273	1.56%
Thorny scrub	2, 3, 5	11096	2.76%
Mixed scrub	11	17910	4.46%
Desert scrub	12	15924	3.96%
Forests			
Upper montane forest	1, 2	4821	1.20%
Dry deciduous forest	3	651	0.16%
Low broadleaf evergreen forest	3	513	0.13%

Cactus-dominated Formations			
Columnar cacti and scrub	12	20076	4.99%
Anthropogenic Areas			
Eucalyptus plantations	5	1088	0.27%
Cultivated areas	1, 2, 3, 5, 6, 7, 8, 14	55256	13.75%
Natural Unvegetated Areas			
Scarcely vegetated high-Andean areas	8, 9, 10	29173	7.26%
Coastal desert barrens	13, 14	65157	16.21%

The habitat types defined in these EFS correspond generally to Vegetation Units described in the ESIA. Notable improvements of the EFS classification include 1) the clarification of the nature of what the ESIA described as "Puna Scrubland", which in reality corresponds to Tussock Grassland with only scattered, if any woody plants and 2) the recognition of what was categorized as "Montane Shrubland" as a degraded phase of Upper Montane Forest.

Wetland and Riparian Areas

These are areas in which there is a distinctive presence of water, including those areas that are flooded permanently or seasonally inundated with water for a period of the year. Within this category, the following formations occur in the Project area:

Riparian vegetation

This type of formation is found along the banks of watercourses in the Ica-Lima Coastal Plain ELU. The composition of the flora is varied, including as common elements species of composites (*Tessaria*, *Baccharis*), grasses, and legumes, among others. The riverside areas usually have high ecological importance because they constitute habitats corridors, refuges, nesting areas, and places where fauna congregates, as well as for their roles in the stabilization of soils and flood control. Riparian thickets and forests in the coast of southern Peru are a key habitat of the slender-billed finch (*Xenospingus concolor*),

Hydromorphic islands

These are islands of distinctive vegetation found within isolated patches of seasonally or permanently waterlogged soil, and they are also of great importance as a habitat for the native fauna. In the coastal areas, they are characterized by the predominance of plants of the genera *Tessaria*, *Pluchea*, and *Typha*. These islands are also important for populations of the slender-billed finch in the Pisco Sand Plains ELU.

Peat Bogs

Peat bogs, known locally in Peru as *bofedales*, are high-Andean wetland formations, frequently dominated by the cushion-forming rush *Distichia muscoides*, which forms a

very dense peat, usually with a depth of several centimeters. The peat bogs are hydrologically critical for their high water retention and storage capacity, serving as sources and regulators of water for the lower reaches of the basins. Also, they are of biodiversity significance due to the presence uniquely adapted species; for example, some peat bog wetlands contain small orchids of the genus *Myrosmodes*. Mineral-rich peat bogs are the sole habitat of the white-bellied cinclodes (*Cinclodes palliatus*), an IUCN-endangered, INRENA-critically endangered bird endemic to the central Peruvian Andes. Peat Bogs are observed in seven of the fourteen ELU's, east of KP 250 which forms the edge of the Andean high plains and ridges.

Grasslands

Sward-forming grassland

These are herbaceous formations with a prevalence of diverse low-statured grasses and sedges, forming a more or less continuous sward or sod, without a dominance of tussock-forming species (i.e., bunchgrasses). Within these habitats, there may be many broadleaved herbaceous (forbs) or semi-woody plants, including small shrubs and cushion plants.

The term "cushion" means that these plants grow in a low, tight clump and have the appearance of a cushion. Cushion plants are more common in the higher elevations where their growth habit helps protect them from the dry air and cold. One of the representative species of cushion plants in the project area is *Plantago rigida*.

Tussock grasslands

These are herbaceous formations dominated by tussock-forming grasses (bunch grasses) of the genera *Stipa*, *Festuca*, *Jarava*, and *Calamagrostis*, collectively known locally as "ichu". The tussock grasslands are characterized by having a usually greater height than the sward-forming grasslands. These grasslands may also have scattered low forbs, shrubs, or cushion plants.

Both types of grasslands are important as natural grazing lands (rangelands) for both native and introduced livestock of the local communities.

Other Herbaceous Formations

Tillandsia mats

Tillandsias are small bromeliads (members of the pineapple family) which form extensive carpets or mats in coastal desert areas of Peru. These plants obtain moisture directly from fog, rather than from soil through roots. While these habitats are characterized by low diversity in species, they harbor endemic reptiles of conservation concern such as *Ctenoblepharys adspersa* sand lizards and *Phyllodactylus* geckoes.

Scrublands

The scrublands include habitats dominated by woody bushes and shrubs, often with grasses scattered between the shrubs. Scrublands are often associated with semi-arid environments, growing in areas too dry for larger trees and or dense grasslands, but with enough moisture to support low-growing drought-tolerant woody plants, often armed with spines, thorns, or chemical defenses (aromatic substances and resins in their leaves) to prevent animals from browsing upon them.

Resinous scrub

This is a formation with prevalence of shrubs, and with a peculiar dominance of species impregnated with resinous, aromatic substances. These species are commonly known as "tolas", and within them, there are several genera of the Asteraceae family (i.e., the composite or sunflower family), especially *Baccharis* and *Parastrephia*. This formation is characteristic of the flanks of the mountain range of the Andes.

Thorny scrub

This formation is dominated by thorny shrubs, primarily of the Solanaceae (*Dunalia*), Berberidaceae (*Berberis*), Fabaceae (*Acacia*) and Verbenaceae (*Duranta*) families, among others. These scrublands are locally important in biodiversity, often serving as habitat for rare bird species.

Mixed scrub

This category includes scrublands with a prevalence of non-resinous and non-thorny plants, belonging to varied plant families. These scrublands may be locally important in biodiversity, often serving as habitat for rare bird species such as the rufous-breasted warbling finch (*Poospiza rubecula*), an IUCN/INRENA endangered species endemic to western Peru. It is only observed in the Pisco-Ica Watershed Divide ELU.

Desert scrub

This formation is characteristic of the coastal foothill desert areas and has a preponderance of species of the Asteraceae and the Solanaceae, and scattered cacti, usually of low diversity. It is only observed in the Coastal Bat Hills ELU.

Forests

Upper montane forest

This formation corresponds to the high-elevation forests near the treeline in the eastern Andes and it is characterized by a high diversity of tall trees. The presence of endemic or threatened elements of flora or fauna is frequent in this formation, for example the Quenual tree (*Polylepis pauta*) and range-restricted species of orchids and frogs. It is observed in the Apurimac River Valley montane Forest Ecotone ELU and Campana Watershed ELU.

Dry deciduous Forest

This formation is characterized by the dominance of trees that lose their leaves during the dry season, typically of the Bombacaceae, Caricaceae, Anacardiaceae and Fabaceae families, among others, often with rare or endemic species. It is only observed in the Torobamba River Valley ELU.

Low broadleaf evergreen forest

This formation has a prevalence of broadleaf evergreen trees and shrubs of varied and composition (the term “evergreen” should not be interpreted to mean pine trees and their kin, but rather plants that do not lose their leaves during any specific period of the year). Although the presence of leaves is observed throughout the year, the canopy of the forest is not dense, but rather sparse. In some cases, unique or endemic species are usually found in this formation type.

Cactus-dominated Formations

Columnar Cacti and Scrub

This formation is characterized by the prevalence of isolated taller tree-like or “organ-pipe” cacti, usually over a meter in height, within which there are species of the genera *Armatocereus*, *Echinopsis* and others. Among the cacti are scattered shrubs. Some of the cacti and associated organisms in this formation are of conservation interest such as the long-snouted bat (*Platalina genovensium*), a species that feeds on the nectar of night-blooming cacti and which is categorized as vulnerable by the IUCN and as critically endangered by the INRENA. This is also a habitat favored by the INRENA near-threatened lizard *Microlophus tigris*. It is only observed in the Coastal Bat Hills ELU.

Anthropogenic Areas

In these areas, there is prevalence of human activity that has significantly altered the natural components of the landscape, resulting in their replacement with anthropogenic habitats.

Eucalyptus plantations

Eucalyptus are hardy fast-growing trees of Australian origin that thrive in the Andes, even at elevations over 3,000 m and are found in the Yucay River Valley ELU. They are widely planted by local communities for firewood, timber, windbreaks, and other uses, and they are highly visible in the landscape due to their heights reaching over 20 m and dark evergreen foliage.

Cultivated areas

Native Peruvian communities have cultivated much of their landscape for various millennia, with a diversity of native crops, under both irrigated and dry land systems. Cultivated areas may still harbor considerable wild biodiversity in areas along canals and

field or terraces boundaries. Areas of intensively managed artificial pastures are included under this habitat category. This habitat is common along the RoW, occurring in eight different ELUs

Naturally unvegetated areas

There are many zones along the ROW alignment with a prevalence of bare exposed soil or rocks. In these areas the levels of diversity and plant biomass are extremely low.

Scarcely vegetated high-Andean areas

They are areas that include rocky areas and areas of exposed soil, characteristic of high-Andean areas and stretching from Apacheta High Sierras (KP 117) to the end of the Huaytara High Plains and Ridges ELU (KP 250).

Coastal Desert barrens

They are coastal areas where there is prevalence of exposed sandy substrate and without a significant macroscopic plant cover. They are observed only in the western segment of the RoW in the Pisco Sand Plains ELU and Ica – Lima Coastal Plain ELU between approximately KP 308 and KP 402.

7.0 SPECIES AND HABITAT SENSITIVITY

7.1 SPECIES SENSITIVITY

7.1.1 SPECIES SENSITIVITY CRITERIA

Each ELU contains species that, in accordance with their importance, can be identified as of either no, low, medium, or high sensitivity. To identify the category to which each species belongs, a scheme was developed that utilizes four criteria to evaluate the importance of the species. These criteria are: 1) protection status, 2) spatial distribution, 3) local use, and 4) mobility.

1. Protection Status

There are six different levels of protection that are defined by a species' categorization in the international IUCN⁵ and national INRENA^{6,7} lists of threatened species. In order to qualify the importance of each level an evaluation scale has been developed. The most protected status level is linked with the higher value of the scale and the lowest value for the species without protection status. Table 7.1 shows the description for each level and its respective quantification as applied by this study.

Currently, the IUCN uses a range of quantitative criteria for listing any taxon as Critically Endangered, Endangered, Vulnerable, Near Threatened, Least Concern, or Data Deficient. Meeting any one of these criteria qualifies a taxon for listing at that level of threat. The relevant factor is whether any one criterion is met, not whether all are appropriate or all are met. The criteria to be met are set in four categories: (1) reduction of population size, (2) geographic range, (3) population size by itself, and (4) quantitative analysis.

⁵ IUCN. 2006. IUCN Red List of Threatened Species. Prepared by the IUCN Species Survival Commission. IUCN, Gland, Switzerland.

⁶ Supreme Decree N° 043-2006-AG. Categorization of Threatened Wild Flora.

⁷ Supreme Decree N° 034-2004-AG. Categorization of Threatened Wild Fauna Species.

Table 7.1. Species Sensitivity Criteria: Protection Status

Criteria: Protection Status			Quantification
Level	Critically endangered (CR)	A taxon is Critically Endangered when the best available evidence indicates that it is considered to be facing an extremely high risk of extinction in the wild.	6
	Endangered (EN)	A taxon is Endangered when the best available evidence indicates that it is considered to be facing a very high risk of extinction in the wild.	5
	Vulnerable (VU)	A taxon is Vulnerable when the best available evidence indicates that it is considered to be facing a high risk of extinction in the wild.	4
	Near Threatened (NT)	A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify. However, it is close to qualifying for or is likely to qualify for a threatened category in the near future.	3
	Low (L)	Species categorized as Least Concern or Data Deficient by the IUCN. (These categories are not used by the INRENA.)	2
	Not Listed (N)	Widespread and abundant taxa which do not qualify for a threatened category	0

Source: Adapted from IUCN (2006).

2. Spatial Distribution

The spatial distribution criterion has defined three levels that describe how widely distributed a particular species is, that is whether is locally endemic, regionally endemic, or widespread. Table 7.2 describes each level and their quantification values. Locally endemic species receive a numerical score of 3 to reflect their higher inherent sensitivity due to their restricted geographic ranges. Regional endemics receive a score of 2 as they are more widespread, but still restricted to a particular geographic region, for example, the Central Andes Mountains of Peru. Widespread species are those found over a wide range of habitats, regions, countries, and even continents and are not scored because of their abundance and commonality.

Table 7.2. Species Sensitivity Criteria: Distribution

Criteria: Spatial Distribution			Quantification
Level	Local Endemic	Only found in a specific biogeographic region, or only present in a small range in Peru.	3
	Regional Endemic	Found in part of the Andes or the coastal deserts.	2
	Widespread	Found widespread across major regions of South America or beyond.	0

Source: Domus.

3. Local Use

Local use of species is also defined on three levels: permanent use, seasonal use, and species without use. Table 7.3 shows their description and values on the quantification scale. Species utilized year round and frequently by local communities are assigned as score of 2, while those of only seasonal or occasional use are scored as 1. Species not used or only very rarely used are given a score of 0.

Table 7.3. Species Sensitivity Criteria: Local Use

Criteria: Local Use			Quantification
Level	Permanent	Used year round on and frequently	2
	Seasonal	Used seasonally or only occasionally	1
	Not used	Not used, or very rarely used	0

Source: Domus.

4. Mobility

The mobility criterion relates to the ability of an organism to move or flee in order to avoid a disturbance. Table 7.4 describes the two mobility categories: mobile and immobile. Small animals with limited ability to flee from their sites of refuge or perches, such as most reptiles, amphibians, and small mammals, are considered to be immobile and most susceptible to direct impacts of the clearing and grading activities associated with the open of pipeline rights of way, and are thus assigned a score of 3. Likewise, all

plants are considered to be immotile and are assigned a score of 3. Most birds and larger mammals, such as cats, sheep and camelids are readily able to flee from disturbances and are unlikely to be directly impacted by clearing and grading activities and are thus assigned a score of 0.

Table 7.4. Species Sensitivity Criteria: Mobility

Criteria: Mobility			Quantification
Level	Immobile	An organism which cannot move (i.e., plants), or which uses a very small or limited home range (e.g. small rodents, small reptiles and amphibians) and does not flee rapidly from its refuge when disturbed.	3
	Mobile	Organisms with the ability and tendency to flee or take flight upon being disturbed, such as adult birds and larger mammals.	0

Source: Domus.

7.1.2 SPECIES SENSITIVITY CATEGORIES

A species sensitivity classification scheme was developed to identify to which category a species belongs. The quantification values of each criterion described above are summed for each species. High Sensitivity species are those with 11 or more points, Medium Sensitivity species are those with from 6 to 10 points. Species with 1 to 5 points are categorized as Low Sensitivity, and those with 0 points are considered to be of No Sensitivity. Table 7.5 shows the value range of each sensitivity classification.

Table 7.5. Value Range for Species Sensitivity

Category	Range
High	11 or higher
Medium	6 - 10
Low	1 - 5
None	0

Source: Domus.

Complete listings of the species observed during the EFS field survey are presented under the description of each ELU, including the sensitivity criteria values described above.

7.2 HABITAT SENSITIVITY

According to the Inter-American Development Bank (IDB) *Environment and Safeguards Compliance Policy*, a Critical Habitat is:

“a subset of both natural and modified habitat that deserves particular attention. Critical habitat includes areas with high biodiversity value⁸, including habitat required for the survival of critically endangered or endangered species⁹, areas having special significance for endemic or restricted-range species; sites that are critical for the survival of migratory species; areas supporting globally significant concentrations or numbers of individuals of congregatory species; areas with unique assemblages of species or which are associated with key evolutionary processes or provide key ecosystem services; and areas having biodiversity of significant social, economic or cultural importance to local communities”.

Following the IDB criteria, the EFS utilizes the results of the Species Sensitivity Analysis to develop a Habitat Sensitivity Analysis that considers the presence of High and Medium sensitivity species identified in each habitat of each ELU.

The habitat sensitivity analysis for a habitat within an ELU considers the number of medium and high sensitivity species present in that unit. A High Sensitivity Habitat is defined as a discrete and defined habitat within a specific ELU, which either contains at least one High Sensitivity species or at least seven Medium Sensitivity plant species or five Medium Sensitivity animal species.

A Medium Sensitivity habitat is defined as containing at least two Medium Sensitivity animal species or at least three Medium Sensitivity plant species. Low Sensitivity habitats are those that contain no High Sensitivity species, one or no Medium Sensitivity animal species, and not more than two Medium Sensitivity plant species. Table 7.6 shows the value range for habitat sensitivity.

⁸Such as areas that meet the criteria of the World Conservation Union (IUCN) classification.

⁹As defined by the IUCN Red List of Threatened Species or as defined in any national legislation.

Table 7.6. Value Range for Habitat Sensitivity

Category	Range
High	1 or more High Sensitivity Species
	7 or more Medium Sensitivity Plant Species or 5 or more Medium Sensitivity Animal Species
Medium	3 or more Medium Sensitivity Plant Species or 2 or more Medium Sensitivity Animal Species
Low	2 or fewer Medium Sensitivity Plant Species or 1 or no Medium Sensitivity Animal Species

Source: Domus.

General ESIA commitments and ECOMP and ecological good practice procedures are applicable to all High, Medium, and Low Sensitivity Habitats. In accordance with International Finance Corporation (IFC) and IDB policies, High Sensitivity Habitats¹⁰ should be avoided by construction activities or otherwise will require more significant levels of protection, mitigation, or compensation, including site-specific mitigation measures.

The details of the results of the Habitat Sensitivity Analysis are shown in Appendix 23.7.

¹⁰ Equivalent to IFC "Critical Natural Habitats" or IDB "Critical Habitats".

8.0 ELU 1: APURIMAC RIVER VALLEY MONTANE FOREST ECOTONE (KP 00+000 - 20+511)

8.1 GENERAL DESCRIPTION

The easternmost zone of the ROW passes along the upper limits of the montane forests of the Apurimac River Valley. This landscape has remnant patches of high elevation montane forest and scrublands, but has been subject to shifting agricultural practices, resulting historically in patches of degraded forests in various stages of recovery. From KP 07+500 to 11+000 close to the Sachapampa River, colluvial soils are very sensitive to water erosion process and landslides can occur during the wet season.

The climate is cool and wet, as this zone is close to the source of the moist Amazonian air masses but has elevations between 2,966 and 4,066 m. This ELU includes the small rural communities of Chiquintirca, Jollpa, and Anchiuay.

This ELU contains Highly Unstable areas¹¹ (KP 01+000 – 2+500; 08+400 – 11+000) that are very susceptible to mass wasting processes such as landslides and erosion.

8.2 PHYSICAL CHARACTERISTICS

This section describes the precipitation, geology, soils, water bodies, infrastructure and physical risk factors within the Apurimac River Valley Montane Forest Ecotone ELU

8.2.1 PRECIPITATION

Precipitation is highly seasonal. The wet season is from January to March, and is known locally as the “winter” or rainy season, even though it actually corresponds with the climatologically-defined austral summer. The dry season extends from April to December. Table 8.1 shows precipitation values for each season.

¹¹ Highly Unstable areas are defined by the ESIA, Vol. IIA, Section 5.4.

Table 8.1. Precipitation – ELU 1

KP Range	Estimated Precipitation (mm)	
	Peak (January – March)	General (September – April)
00+000 – 02+000	500 - 800	1000 - 2000
02+000 - 03+000	400 - 500	800 - 1000
03+000 - 07+000		700 - 800
07+000 - 13+000		800 - 1000
13+000 - 17+000		700 - 800
17+000 - 20+511		600 - 700

Source: ESIA, Vol. IIA.

8.2.2 GEOLOGY

The geological units of the Apurimac River Valley Montane Forest Ecotone landscape include slates, limestones, and sandstone, to a lesser extent siltstones and marls, sometimes alternating with superficial glacial and alluvial deposits of the Quaternary geologic period. The rocks of this ELU are very hard and do not pose significant risks of instability except for very isolated sectors, where highly fissured slates and marls are present. Stocks of porphyritic andesites (around KP 2+000), are found on Atampa Hill, which flanks Jollpa Stream to the northwest of Chiquintirca.

There is no risk of acid rock drainage (ARD) in this ELU.

8.2.3 SOILS

Soils are Entisols and Inceptisols with shallow to deep organic surface horizon and soil fertility is generally low based on the low levels of phosphorus typical in most of the soils. Soils have a strongly acidic pH (typically less than 5.5). Soils typically are of medium depth along the whole ELU, despite the variable slope. Organic matter content is high at several KPs, where soil samples were analyzed.

The soils present low fertility on the basis of available levels of phosphorus as shown in Table 8.2.

Table 8.2. Surface Horizon Characteristics - ELU 1

KP	pH	Surface horizon depth	Organic matter	Fertility	Slope (%)
00+500	Strongly acid	Medium	High	Low	60%
05+000	Strongly acid	Medium	High	Low	20%
15+000	Strongly acid	Medium	High	Low	20-40%

Source: ESIA, Domus.

pH: Strongly acid = Less than 5.5; Moderately acid = 5.6 to 6.0; Slightly acid = 6.1 – 6.5; Neutral = 6.6 - 7.0; Slightly alkaline = 7.1 – 7.8; Moderately alkaline = 7.9 to 8.4; Strongly alkaline = 8.5 or greater.

Surface horizon depth: Low = Less than 5 cm; Medium = 5 cm to 15 cm; High = More than 15 cm.

Organic matter: Low = Less than 2%; Medium = 2% to 4%; High = More than 4%.

Fertility based on Available Phosphorus: Low = Less than 7.0 ppm; Medium = 7.0 to 14.0 ppm; High = More than 14.0 ppm.

8.2.4 WATER BODIES

Within ELU 1, the ROW crosses three rivers (Alfarpampa, Qollpa and Sachapampa), and the Cochas bog, at KP 14+500. The ROW runs above the Jejamachay stream between approximately KP 7+200 to 9+800 and the Sachapampa river between approximately KP 10+000 to KP 14+500. The ROW does not cross lagoons or lakes in this ELU. Details are shown in Table 8.3.

Table 8.3. Principal Waterbody Crossings - ELU 1

Waterbody Type or Name	KP Mid-channel	Elevation (m)
Arroyos		
ARROYO	19+766.58	3928.65
Quebradas		
QUEBRADA	475.71	3013.99
QUEBRADA	4+503.45	3641.3
QUEBRADA	4+800	3562
QUEBRADA	5+031.39	3562.2
QUEBRADA	5+682.76	3702.9
QUEBRADA	5+974.37	3773.1
QUEBRADA	6+313.72	3861.3
QUEBRADA	6+811.78	3759.8
QUEBRADA	7+323.23	3663.1
QUEBRADA	7+591.88	3600
QUEBRADA	7+871.28	3532.2
QUEBRADA	8+404.55	3474
QUEBRADA JEJAMACHAY	8+861.99	3409.5
QUEBRADA JEJAMACHAY	9+013.88	3373.7
QUEBRADA	10+469.67	3330.6

QUEBRADA	11+270.65	3307.9
QUEBRADA	11+302.51	3313.6
QUEBRADA	11+419.39	3315.3
QUEBRADA	11+865.27	3370.3
QUEBRADA	11+898.06	3368.6
QUEBRADA	12+524.41	3391.9
QUEBRADA	13+068.51	3403.7
QUEBRADA	13+127.96	3405.9
QUEBRADA	13+193.56	3409.6
QUEBRADA	13+572.87	3429.4
QUEBRADA	17+347.16	3989.4
QUEBRADA	18+217.95	3933.1
QUEBRADA	19+010.83	3720.63
QUEBRADA	19+900	3932
Rivers		
ALFARPAMPA	0+196.09	2976.52
QOLLPA	0+475.71	3013.99
SACHAPAMPA	9+884.19	3199.6

Source: Peru LNG Pipeline Project Alignment Sheets (Gulf Interstate Engineering, 2006).

In addition to the rivers and streams, there are 3 peat bog crossings with a total length of 957 m approximately at KP 6+000 to 8+000. The Row passes near two peat bogs between KP 14+000 and 15+000 and approximately KP 20+300 to 20+500 (see Table 8.8 for more details).

8.2.5 INSTABILITY AND PHYSICAL RISK

Highly Unstable areas occupy the greatest proportion of the ROW length at 34.9%, with the other two categories split almost evenly. Table 8.4 shows the risk evaluation data.

Table 8.4 Instability and Physical Risk Levels – ELU 1

Risk Level	Kp Start	KP Finish	Length (m)	
Low	00+000	00+647	647	6834
	04+970	05+250	280	
	05+590	05+930	340	
	06+790	06+890	100	
	06+890	07+000	110	
	07+000	07+772	772	
	07+772	07+894	122	
	08+362	08+718	356	
	10+970	11+608	638	
	12+342	13+130	788	
	13+130	13+500	370	
	13+500	13+795	295	
	13+795	13+917	122	
	13+917	14+384	467	
	14+384	14+529	145	
	14+529	15+120	591	
	18+719	19+039	320	
	19+975	20+243	268	
	20+243	20+346	103	
Medium	01+380	04+970	3590	3840
	05+250	05+500	250	
High	00+647	01+380	733	9672
	05+500	05+590	90	
	05+930	06+790	860	
	07+894	08+362	468	
	08+718	10+970	2252	
	11+608	12+342	734	
	15+120	18+719	3,599	
	19+039	19+975	936	

Source: ESIA, Environmental Baseline.

8.2.6 INFRASTRUCTURE

No roads are crossed by the ROW in ELU 1. However, the project has planned the construction of a 4.2-km access road, starting in San Miguel to KP 04+255. Also, the construction of 5 shooflies is planned at approximately KPs 8+000, 10+000, 15+000, 17+000 and 20+000. A Base Camp is proposed in KP 00+500 and two Mobile Camps in KP 05+330 and KP 12+594, located in Japes and Anchiuay respectively. Table 8.5 shows infrastructure information.

Table 8.5. Planned Project Infrastructures – ELU 1

Type of Infrastructure	KP*	Name	Action	Related to
Camps	00+500	Sector PS3	Topsoil Protection / Erosion control devices and slope revegetation	ECOMP/RP
	05+330	Movil Japes	Topsoil Protection	ECOMP/RP
	12+594	Movil Anchiuay	Topsoil Protection	ECOMP/RP
Access roads	04+255	4.237	Topsoil protection / Erosion control devices and slope revegetation	ECOMP/RP
Shooflies	08+376	V152 to V156	Topsoil protection / Erosion control devices and slope revegetation	ECOMP/RP
	10+003	V142 to V144	Topsoil protection / Erosion control devices and slope revegetation	ECOMP/RP
	15+155	V100 to V115	Topsoil protection / Erosion control devices and slope revegetation	ECOMP/RP

	17+717	V100 to V104	Topsoil protection / Erosion control devices and slope revegetation	ECOMP/RP
	20+429	Secar Putaja	Topsoil protection / Erosion control devices and slope revegetation	ECOMP/RP

*KP as indicated by the ESIA provided for reference only
Source: ESIA, Project Description.

8.3 HABITATS AND SPECIES

8.3.1 HABITAT DISTRIBUTION

The habitats of ELU 1 are listed in sequential order in Table 8.6, including the length of each habitat unit and associated start and finish ROW KPs. Table 8.7 presents habitat lengths over the ROW, including subtotals for each habitat type.

Table 8.6. Habitats Sequence – ELU 1

Habitat Type	Length (m)	KP Start	KP Finish
Cultivated areas	589	00+000	00+589
Intact Upper Montane Forest	134	00+589	00+723
Degraded Upper Montane Forest	809	00+723	01+532
Tussock grassland	2048	01+532	03+580
Degraded Upper Montane Forest	463	03+580	04+043
Cultivated areas	660	04+043	04+703
Degraded Upper Montane Forest	74	04+703	04+777
Sward-forming grassland	180	04+777	04+957
Peat bogs	26	04+957	04+983
Sward-forming grassland	1387	04+983	06+370
Tussock grassland	408	06+370	06+778
Peat bog	138	06+778	06+916
Tussock grassland	84	06+916	07+000
Sward-forming grassland	437	07+000	07+437
Peat bogs	432	07+437	07+869
Sward-forming grassland	82	07+869	07+951
Degraded Upper Montane Forest	1733	07+951	09+684

Cultivated areas	497	09+684	10+181
Intact Upper Montane Forest	61	10+181	10+242
Degraded Upper Montane Forest	1221	10+242	11+463
Tussock grassland	1273	11+463	12+736
Peat bogs	494	12+736	13+230
Cultivated areas	159	13+230	13+389
Sward-forming grassland	408	13+389	13+797
Peat bog	118	13+797	13+915
Sward-forming grassland	610	13+915	14+525
Peat bog	183	14+525	14+708
Sward-forming grassland	156	14+708	14+864
Upper montane forest	326	14+864	15+190
Sward-forming grassland	1177	15+190	16+367
Tussock grassland	2307	16+367	18+674
Sward-forming grassland	624	18+674	19+298
Peat bog	296	19+298	19+594
Sward-forming grassland	374	19+594	19+968
Peat bog	95	19+968	20+063
Sward-forming grassland	188	20+063	20+251
Peat bog	48	20+251	20+299
Sward-forming grassland	52	20+299	20+351
Tussock grassland	160	20+351	20+511

Source: ESIA Biological Baseline Map 2-1 and Domus

Table 8.7. Habitat Summary – ELU 1

Habitats		Length (m)	KP Start	KP Finish
Cultivated areas		589	00+000	00+589
		660	04+043	04+703
		497	09+684	10+181
		159	13+230	13+389
Subtotal		1,905	9.29%	
Upper Montane Forest	Intact	134	00+589	00+723
		61	10+181	10+242
	Degraded	809	00+723	01+532
		463	03+580	04+043
		74	04+703	04+777
		1733	07+951	09+684
		1221	10+242	11+463
		326	14+864	15+190

Subtotal	4,821	23.50%	
Peat bogs	26	04+957	04+983
	138	06+778	06+916
	432	07+437	07+869
	494	12+736	13+230
	118	13+797	13+915
	183	14+525	14+708
	296	19+298	19+594
	95	19+968	20+063
	48	20+251	20+299
Subtotal	1,830	8.92%	
Sward-forming grassland	180	04+777	04+957
	1387	04+983	06+370
	437	07+000	07+437
	82	07+869	07+951
	408	13+389	13+797
	610	13+915	14+525
	156	14+708	14+864
	1177	15+190	16+367
	624	18+674	19+298
	374	19+594	19+968
	188	20+063	20+251
	52	20+299	20+351
Subtotal	5,675	27.67%	
Tussock grassland	2048	01+532	03+580
	408	06+370	06+778
	84	06+916	07+000
	1273	11+463	12+736
	2307	16+367	18+674
	160	20+351	20+511
Subtotal	6,280	30.62%	
Total ELU 1:	20,511		

Source: ESIA, Domus.

8.3.2 HABITAT DESCRIPTIONS

Upper Montane Forest

The Upper Montane Forest has a local predominance of the quenual tree (*Polylepis pauta*), a species categorized as vulnerable by the IUCN and near threatened by the INRENA. In addition, this habitat can be characterized by the presence of various species of terrestrial and epiphytic orchids.

Gomphichis sp. terrestrial orchids are scarce and prefer rocky areas. *Pleurotalis* sp. was found within bushes. *Stelis* sp. and *Helianthus* sp., are epiphytic orchids, located on tree branches. These orchids are not considered to be sensitive species because they belong to widespread genera, but temporary or permanent relocation can be taken into account. Orchids constitute a very important group for Peruvian authorities because of their potential economic importance.

Less dense Upper Montane Forest was identified in the ESIA as Montane scrubland. The ESIA found *Weinmannia* spp., *Styrax andinus* and *Clusia* spp. as frequent tree species in this habitat type. The undercanopy strata includes *Morus insignis*, *Vallea stipularis* and *Hesperomeles* cf. *lanuginosa*, and *Chusquea* sp. A diversity of ferns and mosses cover the area during the humid season. Bushes in the transition, ecotone area, belong to *Hyptidendron* cf. *arboretum*, *Baccharis latifolia*, *Rhynchoteca spinosa* and *Brachyotum naudinii*. The forestry inventory done by the ESIA revealed for the Upper Montane Forest, 580 trees and 89.54 m³ per hectare.

Tussock grassland

Tussock grasslands in this ELU are likely a consequence of long-term degradation of the original Upper Montane Forest. *Festuca dolichophylla* and *Stipa obtusa* are the predominant species in tussock grassland habitat type, including almost 50% of the plant abundance.

Sward-forming grassland

In the Sward-forming grassland habitat type, the most common species are the grasses *Calamagrostis vicunarum*, and *Aciachne pulvinata*. Sward-forming grasslands are very important being used as preferred pastures and, like the tussock grassland, appear to be a result of historical human impacts in this ELU.

Peat bogs

Small peat bogs areas were found but with little ecological or economical importance. *Distichia muscoides*, *Plantago tubulosa*, and *Hypochaeris taraxacoides* are the most abundant species in this habitat type, and are common in other bogs along the ROW.

Cultivated Areas

Much of this ELU has been subjected to shifting cultivation practices and present approximately 19% of the ROW length is under recent cultivation of crops and pastures.

Key Fauna

A typical large mammal of this ELU is the spectacled bear (*Tremarctos ornatus*), that was reported by local people in the Chiquintirca area. However, none were directly

observed during either the ESIA or EFS field surveys. Other mammals registered are the northern vizcacha (*Lagidium peruanum*) and the skunk *Conepatus chinga*.

The puma or mountain lion (*Puma concolor*), listed as near-threatened by the IUCN and the INRENA, has been registered in this ELU. The White-tailed deer (*Odocoileus virginianus*) were reported by the ESIA in this area.

This ELU has high bird diversity, including the creamy-crested spinetail (*Cranioleuca albicapilla*), an endemic range-restricted species of the southern Andes of Peru. In addition, the black-faced Ibis (*Theristicus melanopis*) was found associated with wetlands, the white-tailed shrike tyrant (*Agriornis ardicola*) and the bearded Mountainer (*Oreotrochilus melanogaster*) was also recorded in this ELU.

EFS reptile and amphibian specialists found two potentially new species in this ELU: a lizard of the genus *Proctoporus* and a frog of the genus *Phrynopus*. The IUCN has categorized most species of *Phrynopus* as threatened due to the highly localized distributions and the threats to their habitats.

Rainbow trout (*Oncorhynchus mykiss*) have been recorded in the area, an introduced species that is a predator of native aquatic fauna, but which is considered an important resource by local communities. This species was reported near Anchiuay, 150 m away from the ROW in the Sachapampa River (KP 10+000) and again near KP 14+500 (Cochas peat bog).

Hydrobiology

Along each ELU, water bodies were sampled in order to determine any salient characteristic, including notable or dominant species. Table 8.8 presents all water bodies sampled in ELU 1 along with their locations and important species found. For ELU 1, samples of the trout, *Oncorhynchus mykiss*, which is a species of high economic importance for the surrounding communities, was found in two of the stations.

Table 8.8. Water bodies Sampled– ELU 1

Station	Habitat	Waterbody	Name	Height (m)	KP	Species
Hi-40	Altoandino	Laguna	Yanapaccha	3930	17+000	
Hi-41	Altoandino	Bofedal	Cochas	3404	14+500	<i>Oncorhynchus mykiss</i>
Hi-42	Interandino	Río	Sachapampa	3171	10+000	<i>Oncorhynchus mykiss</i>
Hi-43	Interandino	Quebrada	Qollpa	3033	0+500	
Hi-44	Interandino	Río	Alfarpampa	2971	0+000	

8.3.3 SPECIES SENSITIVITY ANALYSIS

Table 8.9 shows the high and medium sensitivity species found during the EFS fieldwork, based on the species sensitivity criteria presented in Section 7.1 of these EFS.

Table 8.9. Species Sensitivity Criteria – ELU 1

No	Species	Protection Status						Spatial Distribution			Local Use			Mobility		Σ
		CR	EN	VU	NT	L	N	Local	Regional	Widespread	Permanent	Seasonal	None	Immobile	Mobile	
	Plants															
	<i>Aciachne pulvinata</i>						0		2				0	3		5
	<i>Calamagrostis vicunarium</i>						0				2			3		5
	<i>Distichia muscoides</i>						0					1		3		4
	<i>Festuca dolichophylla</i>						0				2			3		5
1	<i>Gomphichis</i> sp.						0		2				0	3		5
	<i>Hypochaeris taraxacoides</i>						0		2					3		5
2	<i>Oncidium</i> sp.						0		2				0	3		5
	<i>Plantago tubulosa</i>						0									0
3	<i>Pleurothallis</i> sp.						0		2					3		5
4	<i>Polylepis pauta</i>				3					0	2			3		8
5	<i>Stelis</i> sp.						0		2					3		5
	<i>Stipa obtusa</i>						0			0			0	3		3
	Fish															
6	<i>Oncorhynchus mykiss</i>						0				2			3		5
	Reptiles and amphibians															
12	<i>Gastrotheca marsupiata</i>								2				0	3		5
7	<i>Eleutherodactylus discoidalis (sensus latus)</i>							3		0			0	3		6
8	<i>Phrynosoma</i> sp.		5					3					0	3		11
9	<i>Proctoporus</i> sp.						0	3					0	3		6
10	<i>Tachymenis peruviana</i>						0			0			0	3	0	3
	Mammals															
11	<i>Akodon</i> cf. <i>torques</i>								2				0		0	2
12	<i>Odocoileus virginianus</i>									0			0		0	0
13	<i>Tremarctos ornatus</i>		5						2		2				0	9
19	<i>Conepatus chinga</i>						0			0			0		0	0
20	<i>Lagidium peruanum</i>						0	3			2				0	5
21	<i>Oligoryzomys</i> cf. <i>destructor</i>									0			0		0	0
22	<i>Phyllotis</i> cf. <i>xanthopygus posticalis</i>							3		0	2		0		0	5
23	<i>Puma concolor</i>				3					0			0		0	3
	Birds															
24	<i>Agriornis andicola</i>			4					2				0		0	6

14	<i>Ampelion rubrocristatus</i>								0			0		0	0
15	<i>Anisognathus igniventris</i>								0			0		0	0
16	<i>Anairetes parulus</i>								0			0		0	0
17	<i>Aratinga mitrata</i>							2				0		0	2
18	<i>Asthenes sp.</i>							2				0		0	2
19	<i>Basileuterus luteoviridis</i>								0			0		0	0
20	<i>Bolborhynchus orbygnesius</i>								0			0		0	0
21	<i>Buthraupis montana</i>								0			0		0	0
22	<i>Coeligena violifer</i>								0			0		0	0
23	<i>Contopus cinereus</i>								0			0		0	0
24	<i>Cranioleuca albicapilla</i>						3					0		0	3
25	<i>Crotophaga ani</i>								0			0		0	0
26	<i>Diglossa cyanea</i>								0			0		0	0
27	<i>Eriocnemis sapphiropygia</i>							2				0		0	2
28	<i>Euphonia lanirostris</i>								0			0		0	0
30	<i>Hemispingus superciliosus</i>								0			0		0	0
29	<i>Iridosornis analis</i>							2				0		0	2
30	<i>Margarornis squamiger</i>								0			0		0	0
31	<i>Metallura aeneocauda</i>						3					0		0	3
32	<i>Myiarchus tuberculifer</i>								0			0		0	0
33	<i>Myioborus miniatus</i>								0			0		0	0
32	<i>Myioborus ornatus</i>							2				0		0	2
33	<i>Notiochelidon flavipes</i>							2				0		0	2
34	<i>Oreotrochilus melanogaster</i>						3					0		0	3
34	<i>Ochthoeca rufipectoralis</i>							2				0		0	2
35	<i>Patagioenas fasciata</i>								0			0		0	0
36	<i>Patagioenas plumbea</i>								0			0		0	0
37	<i>Phrygilus erythronotus</i>							2				0		0	2
37	<i>Progne tapera</i>								0			0		0	0
38	<i>Psilopsiagon aurifrons</i>								0			0		0	0
39	<i>Pygochelidon cyanoleuca</i>								0			0		0	0
40	<i>Schizoeaca sp.</i>						3					0		0	3
41	<i>Schizoeaca vilcabambae</i>						3					0		0	3
42	<i>Scytalopus parvirostris</i>							2				0		0	2
43	<i>Sporophila luctuosa</i>								0			0		0	0
44	<i>Synallaxis azarae</i>								0			0		0	0
45	<i>Synallaxis unirufa</i>							2				0		0	2

40	<i>Theristicus melanopis</i>			4				2				0		0	6
46	<i>Thlypopsis rufieps</i>							2				0		0	2
47	<i>Troglodytes solstitialis</i>								0			0		0	0
48	<i>Turdus chiguanco</i>								0			0		0	0
49	<i>Vireo leucophrys</i>								0			0		0	0
50	<i>Turdus fuscater</i>								0			0		0	0

Protection Status*:

CR= Critically endangered 6 points
 EN= Endangered 5 points
 VU= Vulnerable 4 points
 NT= Near threatened 3 points
 B= Low (Others) 2 points
 N= Not listed 0 points

Σ= Sensitivity value

1 - 5: Low

6 - 10: Medium

11 or higher: High

Species Distribution:

Local = (Endemic locally or to an EBA**) 3 points
 Regional = (Regional endemic in Andes or Coast) 2 points
 Widespread = (Across S. America or cosmopolitan) 0 points

Mobility:

Immobile = (restricted movement or in very short distance) 3 points
 Mobile = 0 points

Local Uses:

Permanent= 2 points
 Seasonal = 1 point
 None = 0 points

***Protection Status:** According IUCN (2006) or National Legislation (D.S. No. 034-2004-AG/D.S. No. 043-2005-AG)

****EBA:** Areas determined by Birdlife International, which includes at least 2 bird species with less than 50,000 km² of known distribution range.

8.3.4 HABITAT SENSITIVITY ANALYSIS

Based on the presence of high and medium sensitivity species presented in Table 8.9, the Upper Montane Forest, the Tussock Grassland and the Sward-forming Grassland habitats of the Apurimac River Valley Montane Forest Ecotone ELU are considered to be of Medium Sensitivity due to the presence of three, two and three Medium Sensitivity animal species respectively. None of the other habitats in this ELU meet the criteria for a high or medium sensitivity habitat as described in Section 7.2 of these EFS.

8.4 KEY ISSUES AND RECOMMENDATIONS

Precipitation

High precipitation values in the first two km of the ROW should be taken into consideration for the planning and execution of construction activities in relation to possible environmental impacts for all project activities, as higher and more intense precipitation on exposed soils will result in surface runoff, erosion, and sediment mobilization into adjacent water bodies.

Physical Risk

Taking into account wet season precipitation values (1,000 to 2,000 mm) in the first two KP of the ROW, the section between KP 01+000 and KP 02+700 could be a high risk area along with specific sections of the area between KPs 05+500 and KP 20+000. Approximately 37.5% of the ROW length is classified as Highly Unstable, with a high risk of mass wasting along the ROW especially during the rainy season. Erosion control during the construction phase must be focused on avoiding mass wasting and topsoil conservation practices with special focus on the implementation and maintenance of erosion control measures during the rainy season and especially on long, steep slopes and in the vicinity of water bodies.

There is a small section between KP 1+380 and 5+500 classified as a medium risk level area. Mass wasting risk in the rest of the ROW (33.6%) is quite low.

Soils

Bulk density and mechanical resistance of soils are high, creating a potential for compaction problems if soils are not properly managed. Careful attention should be placed on the handling of topsoil, particularly when wet, in the site clearance and grading and reinstatement phase.

A low to medium topsoil layer and low fertility are common characteristics of these types of soils. If these factors combine with steep slopes, erosion risk will be higher during the construction phase, where the ground loses its protective topsoil and vegetation cover. And it is a complicated zone for remediation during the restoration activities. According to this, it is important to consider fertilization in this ELU in site specific locations, especially close to water bodies and steep slopes where soil enrichment may accelerate the rate of revegetation and therefore ground stabilization. As the ELU has high levels of precipitation and steep topography, there is a need to promote vegetation quickly, in order to protect the soils. During the construction phase temporary erosion control devices such as silt fences, slope breakers and wooden barriers must be implemented and maintained and the topsoil must be protected with geojute and the establishment of vegetative cover.

Superficial topsoil in this ELU requires good practice protection during construction activities to ensure as much soil is returned to the ROW during reinstatement to facilitate ROW stabilization and habitat restoration. This will involve adequate topsoil stripping during site preparation and clearance, erosion control from the stockpile and protection from mixing and contamination by the materials such as earthworks subsoil and trench spoil.

Water bodies and Wetlands

Rivers and stream protection should be enforced, including peat bogs and other water bodies along the ROW, by designing and implementing temporary measures to prevent sedimentation of these water bodies and accelerated erosion of stream and river banks. Pollution prevention and control good practices should be adopted to control and minimize the risk of hydrocarbon contamination of wetlands and sensitive wetlands habitats.

There are also important peat bog areas (14+500) that provide important environmental services for local people and habitat for birds; these require special consideration for avoiding impacts by the construction works. Measures should be implemented where needed to protect the streams, lagoons, and bogs along the ROW. The EFS considers peat bogs as a special concern that requires particular attention as set out in the ESIA, which includes the control of the ROW width (25 m) and an accelerated construction program where practicable to minimize time disturbance in this locality. As part of the ECOMP measures, it is important to protect the topsoil and the natural vegetation during the construction phase in order to restore the habitat as close as possible to its pre-construction condition.

Habitats and Species

One High Sensitivity frog species (*Phrynopus sp*) was identified. Six medium sensitivity species have been identified in the Apurimac River Valley Montane Forest Ecotone: the quenual tree (*Polylepis pauta*) and six fauna species including the spectacled bear (*Tremarctos ornatus*), one frog (*Eleutherodactylus discoidalis*), a lizard (*Proctoporus sp.*)

and two birds, the white-tailed shrike tyrant and black faced ibis (*Agriornis andicola* and *Theristicus melanopsis*).

The quenal tree is commonly used in reforestation campaigns in the surrounding areas and material representing the local germplasm should be obtained for replanting during reinstatement of areas where these trees have been removed during ROW clearance.

Given the high mobility of the spectacled bear, there are no direct impacts from construction activities on this species and no specific actions are required for this species.

The frogs and lizards are less mobile and will require removal from the ROW and relocation to areas not affected by construction activities, if observed either during the pre-clearance survey or if observed on the ROW thereafter. The ECOMP and RP contain the criteria and procedures for the rehabilitation of the ROW habitat for each high and medium sensitivity species of fauna.

Key Issues Summary

Control of highly unstable soil conditions and the protection of topsoil and water bodies require attention during construction and reinstatement along the ROW in the Apurimac River Valley Montane Forest Ecotone. Table 8.10 shows the key ecological issues and recommendations for ELU 1.

Table 8.10. Key Issues and Recommendations - ELU 1

Issue	KP Reference	Recommendations	Reference
Risk of mass wasting in Highly Unstable terrains	01+000 – 02+000	Topsoil strip and protection Temporary erosion and sediment controls Reinstatement with special techniques (e.g. fertilization, hydro seeding, mulch) if required in the highest risk areas.	ECOMP
	02+000 -02+700		ECOMP
	05+500-05+590		ECOMP / RP
	05+930-06+790		
	08+400 – 11+000		
	15+120-18+719		
	19+039-19+975		
Peat bog habitat	07+770	Topsoil strip before construction and protection. Restoration of topsoil and plants during abandonment.	ECOMP / RP
	14+500	Restoration of topsoil and plants during abandonment.	ECOMP

Quenual tree (<i>Polylepis pautu</i>)	0 - 15	Planting of new trees during biorestoration of ROW	ECOMP
Birds – black-faced ibis and white-tailed shrike tyrant	Peat bog habitats	Identify any nests during pre-clearance survey if site clearance during the nesting season.	ECOMP
Reptiles/Amphibians – Froga and Lizards	ELU-wide	Pre-clearance survey to identify and relocate reptiles from ROW prior to site clearance activities.	ECOMP

Source: EFS Fieldwork

NOTE – The column 'KP Reference' is for indicative purposes only, suggesting where plant or fauna species or other issues were observed during the EFS or are likely to occur on the basis of other studies including the ESIA. This is not intended to be an exhaustive or exclusive list and must be verified at the time of construction with appropriate management actions taken accordingly wherever the issue is identified. This statement applies to all ELUs, 1-14.

9.0 ELU 2: CAMPANA WATERSHED (KP 20+511 – 25+115)

9.1 GENERAL DESCRIPTION

The ROW rises rapidly into the highlands of the Campana area through a landscape of irregular topography with a cool to cold climate with annual precipitation from 500 to 700 mm, depending on altitude. There are abundant sward-forming and tall tussock grasslands, and scattered peat bog wetlands. The altitude in this ELU fluctuates from approximately 3,414 to 4,066 m.

This unit includes the settlements of Putaja and Campana.

As in the Apurimac River Valley Montane Forest Ecotone, the soils of the Campana Watershed are Entisols and Inceptisols with shallow to deep organic topsoil at elevations from 3,670 to 3,725 m. Bulk density and mechanical resistance is high (meaning low total soil porosity) with the potential for compaction problems that will reduce water infiltration and increase runoff and soil erosion. In general, soil fertility ranges from low to medium level. Also low levels of phosphorus in most of the soils are very representative. There are peat bog areas with high organic carbon content from 15 to 50 cm in depth.

This ELU has four habitat types, dominated by sward-forming grassland (42.79%) and tall tussock grassland (30.23%), with areas of peat bog wetlands (20.76%) and cultivated areas occupy the remaining 6.21% of the ROW in the Campana Watershed ELU.

9.2 PHYSICAL CHARACTERISTICS

9.2.1 PRECIPITATION

Precipitation is seasonal in this ELU. The wet season is from January to March, and is known locally as the “winter” or rainy season, even though it corresponds with the austral summer. The dry season is from April to December. Table 9.1 shows precipitation values during each season.

Table 9.1. Precipitation - ELU 2

Estimated Precipitation (mm)			
Peak (January - March)		General (September - April)	
KP Range	Precipitation (mm)	KP Range	Precipitation (mm)
20+511 - 22+000	400 - 500	20+000 - 22+500	600-700
20+511 - 25+115	300 - 400	22+500 - 25+115	500-600

Source: ESIA, Environmental Baseline.

9.2.2 GEOLOGY

The geological units of the Campana watershed Ecotone landscape include slates, limestones and sandstones, to a lesser extent siltstones and marls, sometimes alternating with Quaternary glacial and alluvial deposits. The rocks of this ELU are very hard and do not pose significant risks of instability except for very isolated sectors where highly fissured slates and marls are present.

No Acid Rock Drainage (ARD) risk is present in this ELU.

9.2.3 SOILS

Soils have a neutral to strongly acidic pH with no salinization or carbonate problems. Surface horizon has a medium depth along the whole ELU, despite the variable slope. Organic matter content is low at KP 21+000. The topsoil is of medium depth at all sites evaluated.

The soils present low to medium fertility on the basis of available levels of phosphorus as shown in Table 9.2.

Table 9.2. Surface Horizon characteristics - ELU 2

KP	pH	Surface horizon depth	Organic matter	Fertility	Slope (%)
21+000	Neutral	Medium	Low	Low	20-40%

Source: ESIA, Environmental Baseline and EFS Field Work.

pH: Strongly acid = Less than 5.5; Moderately acid = 5.6 to 6.0; Slightly acid = 6.1 – 6.5; Neutral = 6.6 - 7.0; Slightly alkaline = 7.1 – 7.8; Moderately alkaline = 7.9 to 8.4; Strongly alkaline = 8.5 or greater.

Surface horizon depth: Low = Less than 5 cm; Medium = 5 cm to 15 cm; High = More than 15 cm.

Organic matter: Low = Less than 2%; Medium = 2% to 4%; High = More than 4%.

Fertility based on Available Phosphorus: Low = Less than 7.0 ppm; Medium = 7.0 to 14.0 ppm; High = More than 14.0 ppm.

Both the steep slopes and low fertility indicate potential restrictions to natural regeneration of vegetation in the area during reinstatement.

During the construction, erosion control devices such as diversion berms, silt fences, slope breakers and wooden barriers must be implemented.

9.2.4 WATER BODIES AND WETLANDS

Within ELU 2, the Uchuputara Huayco is crossed at KP 26+100. The ROW also crosses Campana Stream at KP 22+600. Table 9.3 shows details of the water bodies close to or to be crossed by the ROW.

Table 9.3. Principal Waterbody Crossings – ELU 2

Waterbody Type or Name	KP Mid-channel	Elevation (m)
Streams		
ARROYO	23+520.86	3836.31
Gullies		
QUEBRADA CAMPANA	22+600	3796
QUEBRADA	21+865.21	3835.76
QUEBRADA. PUTAJJA	23+538.51	3833.92
Rivers		
UCHUPUTARA HUAYCO	26+100	

Source: Peru LNG Pipeline Project Alignment Sheets (Gulf Interstate Engineering, 2006).

The ROW crosses one peat bog approximately at KP 22+400 to 22+700 and passes within a few meters of a peat bog near KP 22+000.

Instability and Physical Risk

Highly Unstable Sectors account for only 8.9% of the ROW length in the Campana Watershed ELU. Nevertheless, 81% of this ELU is considered to be Moderately Unstable. Table 9.4 shows risk evaluation data.

Table 9.4. Instability and Physical Risk Levels - ELU 2

Risk Level	Kp Start	KP Finish	Length (m)	
Slightly Unstable	22+230	22+286	56	564
	22+286	22+794	508	
Moderately Unstable	20+852	22+230	1,378	4,584
	22+794	26+000	3,206	
Highly Unstable	20+346	20+852	506	506

Source: ESIA, Environmental Baseline

9.2.5 INFRASTRUCTURE

No roads are crossed by the ROW in this ELU. However, the project has planned the construction of a shoofly, at approximately 24+000. A mobile camp is proposed at KP 23+173, near Campana stream. Table 9.5 shows infrastructure information.

Table 9.5. Planned Project Infrastructures – ELU 2

Type of Infrastructure	KP	Name	Action	Related to
Camps	23+173	Mobile near Campana	Topsoil Protection	ECOMP/RP
Shooflies	24+698	Putaja - Cochas	Topsoil protection / Erosion control devices and slope revegetation	ECOMP/RP

Source: ESIA, Project Description

9.3 HABITATS AND SPECIES

9.3.1 HABITAT DISTRIBUTION

The habitats of ELU 2 are listed in sequential order in Table 9.6, including the length of each habitat unit and associated start and finish ROW KPs. Table 9.7 summarizes the lengths of each habitat type within ELU 2, including subtotals for each habitat type.

Table 9.6. Habitat Sequence – ELU 2

Habitats	Length (m)	KP Start	KP Finish
Tussock grassland	743	20+511	21+254
Sward-forming grassland	667	21+254	21+921
Peat bog wetlands	32	21+921	21+953
Sward-forming grassland	10	21+953	21+963
Peat bog wetlands	84	21+963	22+047
Cultivated areas	286	22+047	22+333
Peat bog wetlands	436	22+333	22+769
Sward-forming grassland	316	22+769	23+085
Tussock grassland	253	23+085	23+338
Sward-forming grassland	381	23+338	23+719
Peat bog wetlands	404	23+719	24+123
Sward-forming grassland	596	24+123	24+719
Tussock grassland	396	24+719	25+115

Table 9.7. Habitats Summary - ELU 2

Habitats	Length (m)	KP Start	KP Finish
Peat Bog Wetlands	32	21+921	21+953
	84	21+963	22+047
	436	22+333	22+769
	404	23+719	24+123
Total	956	20.76%	
Sward-forming Grassland	667	21+254	21+921
	10	21+953	21+963
	316	22+769	23+085
	381	23+338	23+719
	596	24+123	24+719

Total	1,970	42.79%	
Cultivated areas	286	22+047	22+333
Total	286	6.21%	
Tussock Grassland	743	20+511	21+254
	253	23+085	23+338
	396	24+719	25+9115
Total	1,392	30.23%	
Total ELU 2:	4,604		

9.3.2 HABITAT DESCRIPTIONS

Peat Bog Wetlands

The ROW passes through four areas of peat bogs, occupying 20.76% of the length of the ROW in this ELU. The bogs associated with Campana Stream are very important for local communities like Putaja, Cochas Alto and Cochas, securing water supply for them. These bogs are dominated by *Plantago rigida*, known locally as "champa estrella" and *Lachemilla pinnata*, both herbs typical from bogs. Individuals of threatened terrestrial orchid *Myrosmodes sp* were also found in this habitat type.

Sward-forming grassland

This is the largest habitat type comprising 42.79% of the whole ELU, but its species richness is lower than in any other habitat types. In the Sward-forming grassland habitat type the most common species are the grasses *Calamagrostis vicunarium* and *Aciachne pulvinata*. Sward-forming grasslands are very important being used as preferred pastures by local farmers.

Sward forming grassland generally grows on flat land with moist soils and is an intermediate vegetation type between sedge swamps and grassland. This vegetation unit is fairly common in the Andean highlands, occurring in extensive areas.

Tussock grassland

Tussock grasslands are located in areas extremely cold, dry, with strong winds and occupy some 30.23% of the ROW in this ELU. The structure of the vegetation unit is very simple with only one herbaceous stratum of around 30 cm in height. The structure is dominated by tussock or bunch-forming grasses together with a few rosette-forming plants growing among the rocks.

The dominant species in the habitat type is the grass, *Stipa obtusa*. There also appear species of the Urticaceae, Geraniaceae, and Asteraceae plant families. All the grasses

and other herbs found in this habitat type are typical of degraded, overgrazed areas. The high-Andean endemic cactus *Austrocylindropuntia floccosa* appears in this habitat type. This low-growing cactus often forms dense mats or cushions.

Cultivated Areas

Cultivated areas occupy 6.21% of the ROW in the Campana Watershed ELU.

Fauna

This area is home to an undescribed species of the lizard genus *Protoporus* that was first collected by the EFS survey.

Among the mammals, the white-tailed deer (*Odocoileus virginianus*) was reported by ESIA in this area.

For birds, the black-faced Ibis (*Theristicus melanopis*) was found associated with wetlands.

Hydrobiology

Table 9.8 presents water bodies sampled along ELU 2. No salient characteristics were found in this ELU.

Table 9.8. Water bodies Sampled – ELU 2

Station	Habitat	Waterbody	Name	Height (m)	KP
Hi-39	Altoandino	Quebrada	Campana	3800	22+700

9.3.3 SPECIES SENSITIVITY ANALYSIS

Table 9.9 shows the high and medium sensitivity species observed during the EFS Field Survey, based in the species sensitivity criteria presented in Section 7.1 of the EFS.

There are 5 Medium Sensitivity species identified in this ELU; 3 plant species, 1 reptile (lizard) and 1 bird (black-faced ibis).

Table 9.9. Species Sensitivity Criteria - ELU 2

No	Species	Protection Status						Spatial Distribution			Local Use			Mobility		Σ
		CR	EN	VU	NT	L	N	Local	Regional	Widespread	Permanent	Seasonal	None	Immobile	Mobile	
	Plants															
	<i>Aciachne pulvinata</i>						0		2				0	3		5
1	<i>Austrocylindropuntia floccosa</i>						0			0			0	3		3
	<i>Calamagrostis vicunarum</i>						0				2			3		5
2	<i>Castilleja</i> sp.						0			0	2			3		5
	<i>Escallonia resinosa</i>			4					2				0	3		9
3	<i>Hypochaeris taraxacoides</i>						0		2				0	3		5
4	<i>Lachemilla diplophylla</i>						0		2				0	3		5
5	<i>Lachemilla pinnata</i>						0		2				0	3		5
6	<i>Luzula racemosa</i>						0				2			3		5
7	<i>Myosmodes</i> sp.				3			3						3		9
8	<i>Plantago rigida</i>						0		2				0	3		5
9	<i>Ranunculus flagelliformis</i>						0			0		1		3		4
	<i>Stipa obtusa</i>						0			0			0	3		3
	<i>Tecoma Sambuxifolia</i>				3				2			1		3		9
	Reptiles and amphibians															
11	<i>Liolaemus</i> cf. <i>walkeri</i>						0		2				0	3		5
12	<i>Gastrotheca marsupiata</i>						0		2				0	3		5
14	<i>Proctoporus</i> sp.						0	3					0	3		6
	Mammals															
16	<i>Abrothrix jelskii</i>						0			0			0		0	0
17	<i>Auliscomys pictus</i>						0		2				0		0	2
18	<i>Calomys sorellus</i>						0	3					0		0	3
	Birds															
25	<i>Anas flavirostris</i>						0			0			0		0	0
27	<i>Basileuterus coronatus</i>						0			0			0		0	0
28	<i>Chloephaga melanoptera</i>						0		2		2				0	4
29	<i>Cranioleuca albicapilla</i>						0	3					0		0	3
31	<i>Muscisaxicola albilora</i>						0			0			0		0	0
35	<i>Phalcoboenus megalopterus</i>						0			0			0		0	0
36	<i>Plegadis ridgwayi</i>						0			0			0		0	0
40	<i>Theristicus melanopis</i>			4					2				0		0	6
41	<i>Vanellus resplendens</i>						0		2				0		0	2

Protection Status*: CR= Critically endangered 6 points EN= Endangered 5 points VU= Vulnerable 4 points NT= Near threatened 3 points B= Low (Others) 2 points N= Not listed 0 points Σ= Sensitivity value <table border="1"> <tr><td>1 - 5: Low</td></tr> <tr><td>6 - 10: Medium</td></tr> <tr><td>11 or higher: High</td></tr> </table>	1 - 5: Low	6 - 10: Medium	11 or higher: High	Species Distribution: Local = (Endemic locally or to an EBA**) 3 points Regional = (Regional endemic in Andes or Coast) 2 points Widespread = (Across S. America or cosmopolitan) 0 points Mobility: Immobile = (restricted movement or in very short distance) 3 points Mobile = 0 points	Local Uses: Permanent= 2 points Seasonal = 1 point None = 0 points
1 - 5: Low					
6 - 10: Medium					
11 or higher: High					
*Protection Status: According IUCN (2006) or National Legislation (D.S. No. 034-2004-AG/D.S. No. 043-2005-AG) **EBA: Areas determined by Birdlife International, which includes at least 2 bird species with less than 50,000 km2 of known distribution range.					

9.3.4 HABITAT SENSITIVITY ANALYSIS

Based on the presence of medium sensitivity species presented in Table 9.9, the Peat Bog Wetlands of the Campana Watershed ELU are considered to be of Medium Sensitivity due to the presence of five Medium Sensitivity plant species. None of the other habitats in this ELU meet the criteria for a high or medium sensitivity habitat as described in Section 7.2 of these EFS.

9.4 KEY ISSUES AND RECOMMENDATIONS

Physical Risk

Approximately 9% of the ROW length in this ELU is considered to have High physical instability (Table 9.4), which require the implementation of erosion and mass wasting prevention measures. Mass wasting risk in the rest of the ROW is quite low.

Erosion control during construction phase must be focused on installing and maintaining erosion controls along the RoW, especially in areas of high erosion risk close to water bodies and peat bogs. Stripping and preservation of topsoil during construction will be critical to facilitate the revegetation of sensitive areas during reinstatement.

In the highest risk areas additional measures including hydro seeding and fertilizers application should be considered.

Water bodies and Wetlands

The Campana Stream is close to the ROW, requiring construction best practices with respect to erosion control and pollution prevention.

There are also important peat bog areas (KP 22+500) that provide important environmental services for local people and habitat for birds; these require special consideration for avoiding impacts by the construction works. Measures should be implemented where needed to protect the streams, lagoons, and bogs along the ROW.

Habitats and Species

The population of the *Escallonia resinosa* has high potential as seed source; however, this stand does form a continuous forest and the trees are mainly around cultivated lands.

Impacts on *Proctoporus* lizards should be addressed by the ECOMP and the RP, establishing measures for habitat protection and restoration, including removal from the

RoW during the site pre-clearance survey. During reinstatement the habitats should be restored as close as reasonably possible to its original form, including ground vegetation and morphology. There are 3 threatened plant species in this ELU. There are also 2 medium sensitivity animal species found in this ELU. Species are listed in Table 9.9.

The key issue for habitats is the peat bog wetlands, in particular the Campana Stream bog that provides an important water supply to locals.

Table 9.10 presents the key issues and recommendations for the Campana Watershed ELU.

Table 9.10. Key Issues and Recommendations - ELU 2

Issue	KP Reference	Recommendations	Reference
Risk of mass wasting in Highly Unstable terrains	20+346 to 20+852	Topsoil strip and protection Temporary erosion and sediment controls. Additional biorestore measures (hydroseeding, fertilizer, mulch) considered in highest risk areas	ECOMP / RP
Peat bog habitat	22+500	Topsoil strip and storage during construction. Translocation of bog orchid (<i>Myrosmodon</i> sp) and shrubs (<i>Escallonia resinosa</i> and <i>Tecoma sambucifolia</i>) at peat bog habitat crossings prior to commencement of construction	ECOMP / RP
Proctopurus lizard	20+511 – 25+115	Pre-clearance survey to identify and relocate from ROW prior to site clearance activities. Monitoring of habitat after reinstatement.	ECOMP / RP
Black-faced ibis (<i>Theristicus melanopis</i>)	Peat bog habitats	Identify any nests during pre-clearance survey if site clearance during the nesting season.	ECOMP/RP

Source: EFS Fieldwork

10.0 ELU 3: TOROBAMBA RIVER VALLEY (KP 25+115 - 44+300)

10.1 GENERAL DESCRIPTION

This unit includes the Torobamba and Uras valleys, starting near the settlement of Cochas and progressing westwards to near Pampachacra. The climate is warmer and drier than in ELUs 1-2 corresponding to its lower elevation, with rainfall concentrated during the austral summer months, allowing for the production of subtropical tree crops such as avocados, pacay (*Inga* spp.), and tangerines. This ELU covers elevations between approximately 2,400m at the Torobamba River crossing to around 3,674 m. This unit includes the rural communities of General Cordova de Soccos, Patibamba, and Uras and the ROW passes near the small settlements of Uras, Cochas, Patibamba, and Soccos.

The dry valley belongs to the Apurimac Dry Forest System defined by Linares-Palomino (2004). A characteristic element of the dry forest remnants is the pati tree (*Eriotheca vargasii*), a species endemic to the Apurimac system. The Torobamba Valley is also home to an endemic dry forest lizard, *Stenocercus* aff. *apurimacus*.

There are two zones with very high risk of erosion at KP 29+500 and the other near the Torobamba River from KP 40+500 to KP 44+250 with predominance of landslides and gully erosion. Bulk density and mechanical resistance is high (meaning lower total soil porosity) with compacting problems that will reduce water infiltration and increase runoff and soil erosion with compacting problems. Alluvial soils at the bottom of the valley are very fertile with lower bulk density and mechanical resistance while in the colluvial areas topsoils are shallow with low fertility and very sensitive to being compacted. The high mountains are very slightly unstable with predominance of granite rocks.

This ELU has 6 habitat types, dominated by cultivated areas (41.18%) and thorny scrub (33.02%), with minor areas of the native resinous scrub (15.61%), tussock grassland (4.12%), deciduous dry forests (3.39%), and low broadleaf evergreen woodlands (2.67%).

10.2 PHYSICAL CHARACTERISTICS

10.2.1 *PRECIPITATION*

Precipitation is seasonal in this ELU. The wet season is from January to March, and is known locally as the “winter” or rainy season, even though it corresponds with the austral summer. The dry season is from April to December. Table 10.1 shows precipitation values during each season.

Table 10.1. Precipitation – ELU 3

Estimated Precipitation (mm)			
Peak (January - March)		General (September - April)	
KP Range	Precipitation (mm)	KP Range	Precipitation (mm)
25+115 – 37+000	300 - 400	25+115 - 27+000	500 - 600
37+000 – 41+000	200 - 300	27+000 - 37+000	400 - 500
41+000 – 44+300	300 - 400	37+000 - 40+000	300 - 400
		40+000 - 44+300	400 - 500

Source: ESIA, Environmental Baseline

Precipitation during rainy season with typically 300 – 400 mm will be the period of greatest soil erosion risk along the RoW.

10.2.2 *GEOLOGY*

The geological units of the Torobamba River Valley landscape include slates, limestones and sandstones, to a lesser extent siltstones and marls, sometimes alternating with Quaternary glacial and alluvial deposits. The rocks of this ELU are very hard and do not pose significant risks of instability except for very isolated sectors where highly fissured slates and marls are present.

In both flanks of the Torobamba River there are volcanic agglomerates, lava, sandstones and conglomerates, interspersed in some places with lutite. These rocks are mainly very hard and do not pose significant risks to stability, except for localized sectors on hillsides where highly weathered lutite outcrops, creating areas of loose and unstable clays.

There is a formation, consisting of sand and clay conglomerates, outcrops only between the Torobamba and Uras rivers. Because it is not very compact, this formation poses a certain risk of instability resulting in small rock falls.

On the left flank of the Torobamba River, forming the Cerro Buenavista mountain, and adjacent to Llajuapampa Stream (around KP 35+000), there are several small rhyolitic acid stocks in which the rock is light grey with grey and red phenocrysts.

There is no Acid Rock Drainage (ARD) risk present in this ELU

10.2.3 *Soils*

The soils sampled in ELU 3 have a neutral to strongly acidic pH and no salinization or carbonate problems.

Near the settlement of Cochas, KP 29+000, the soils have developed on colluvial and alluvial quaternary deposits, being quite stony in the A horizon. At KP 31+000, there is a recent colluvium deposit that is stony, highly unstable, and has signs of superficial erosion.

At KP 41+000, near the Socosmayo River and the Patibamba settlement there is a recent alluvial deposit that is medium eroded, and has granite rocks. At KP 44+000, near the Socos settlement, soils have developed upon granitic rocks, with very steep slopes, and signs of superficial erosion.

Surface horizons depths are low to medium along KP 29+000 to KP 31+000 and medium from KP 41+000 to KP 44+000.

Organic matter content along the ROW is medium.

The soils are of medium to low fertility in most of the ELU as shown in Table 10.2. The A horizon and subsoils are mostly loamy sands, with lower nutrient and organic matter content in the subsoil. In general, the subsoil will not affect the movement of water because both effective horizons (A and B) presented a very good drainage. Aggregates are weakly united and therefore soil horizons have a low stability.

Table 10.2. Surface Horizon Characteristics - ELU 3

KP	pH	Surface horizon depth	Organic matter	Fertility	Slope (%)
26+000	Strongly acid	Medium	Low	Low	20-40%
28+000	Strongly acid	Medium	Medium	High	
29+000	Strongly acid	Medium	Medium	Medium	5-10%
30+000	Strongly acid	Medium	Medium	Low	
31+000	Strongly acid	Medium	Medium	Low	60-80%
32+000	Neutral	Medium	Medium	High	
35+000	Strongly acid	Medium	Medium	Medium	
41+000	Neutral	Medium	Low	Low	10-20%
44+000	Strongly acid	Medium	Medium	Low	>100%

Source: EFS Field Work.

pH: Strongly acid = Less than 5.5; Moderately acid = 5.6 to 6.0; Slightly acid = 6.1 – 6.5; Neutral = 6.6 - 7.0; Slightly alkaline = 7.1 – 7.8; Moderately alkaline = 7.9 to 8.4; Strongly alkaline = 8.5 or greater.

Surface horizon depth: Low = Less than 5 cm; Medium = 5 cm to 15 cm; High = More than 15 cm.

Organic matter: Low = Less than 2%; Medium = 2% to 4%; High = More than 4%.

Fertility based on Available Phosphorus: Low = Less than 7.0 ppm; Medium = 7.0 to 14.0 ppm; High = More than 14.0 ppm.

10.2.4 WATER BODIES

The ROW in ELU 3 passes near three streams: 500 m from the Yanaccacca at KP 29+000, 100 m from the Uras at KP 30+000. The main river crossing is at Torobamba River at KP 38+800.

The Uras Stream has greenish, fast moving water, a bed of coarse sand and boulders, and is located 100 m far from the ROW axis. There are no bogs or lagoons in ELU 3, as shown in Table 10.3.

Table 10.3. Principal Waterbody Crossings – ELU 3

Waterbody Type or Name	KP Mid-channel	Elevation (m)
Streams		
ARROYO	31+447.29	2851.26
ARROYO	33+120.48	3209.98
ARROYO	40+059.80	2471.8
ARROYO	41+952.38	2950.24
ARROYO	42+157.99	2969.14
Gullies		
QDA UCHUYPUTARA HUYJO	26+100	3688
QDA UCHUYPUTARA HUYJO	29+980	2586
QDA SECA	35+046.18	3095.06
QDA SECA	36+117.39	2883.18

QDA SECA	36+133.87	2882.57
QUEBRADA	37+365.37	2754.17
Rivers		
YANACCACCA	29+000	2590.00
URAS	30+042.43	2569.28
TOROBAMBA	38+823.90	2402.53

Source: Peru LNG Pipeline Project Alignment Sheets (Gulf Interstate Engineering, 2006).

10.2.5 *INSTABILITY AND PHYSICAL RISK*

Highly Unstable areas account for 38.6% of the ROW in the Torobamba River Valley ELU. Table 10.4 shows the distribution of the physical risk categories within ELU 3.

Table 10.4. Distribution of Physical Risk Categories - ELU 3

Risk Level	KP Start	KP Finish	Length (m)	
Low	26+000	27+253	1,253	4,279
	30+795	31+396	601	
	34+708	35+762	1,054	
	41+447	42+818	1,371	
Medium	27+253	28+268	1,015	6,918
	28+686	30+550	1,864	
	31+396	34+708	3,312	
	38+020	38+747	727	
High	28+268	28+686	418	7,053
	30+550	30+795	245	
	35+762	38+020	2,258	
	38+747	38+875	128	
	38+875	40+067	1,192	
	40+067	41+447	1,380	
	42+818	43+058	240	
	43+058	44+250	1,192	

Source: ESIA, Environmental Baseline

10.2.6 *INFRASTRUCTURE*

Two roads are crossed by the ROW in ELU 3, San Miguel Cochas and San Miguel Cochas Detour, both near KP 37+000. The project has planned the construction of 2 shooflies, in KP 35+280 and KP 40+032. A base camp is proposed to be installed in Patibamba, KP 38+928. The camp proposed to be placed in Patibamba is planned to provide lodging for 400 people.

Table 10.5 shows infrastructure information.

Table 10.5. Planned Project Infrastructures – ELU 3

Type of Infrastructure	KP	Name	Action	Related to
Camps	38+928	Patibamba	Topsoil strip prior to camp establishment. Reinstatement and revegetation after abandonment	ECOMP/RP
Shooflies	35+280	San Miguel - Cochas	Topsoil strip prior to establishment. Reinstatement and revegetation after abandonment	ECOMP/RP
	40+032	--	Topsoil strip prior to establishment. Reinstatement and revegetation after abandonment	ECOMP/RP

Source: ESIA, Project Description

10.3 HABITATS AND SPECIES

10.3.1 HABITAT DISTRIBUTION

The habitats of ELU 3 are listed in sequential order in Table 10.6, including the length of each habitat unit and associated start and finish ROW KPs. Table 10.7 summarizes the lengths of each habitat type within ELU 3, including subtotals for each habitat type.

Table 10.6. Habitat Sequence – ELU 3

Habitat Types	Length (m)	KP Start	KP Finish
Tussock grassland	790	25+115	25+905
Thorny scrub	2150	25+905	28+055
Cultivated Areas	1,938	28+055	29+993
Thorny Scrub	938	29+993	30+931
Cultivated Areas	1,249	30+931	32+180
Thorny Scrub	440	32+180	32+620
Low Broadleaf Evergreen Forest	513	32+620	33+133
Thorny Scrub	1,579	33+133	34+712
Cultivated Areas	1,811	34+712	36+523
Thorny Scrub	655	36+523	37+178

Cultivated Areas	1,100	37+178	38+278
Thorny Scrub	573	38+278	38+851
Cultivated Areas	1,202	38+851	40+053
Dry Deciduous Forest	651	40+053	40+704
Resinous Scrub	1,062	40+704	41+766
Cultivated Areas	601	41+766	42+367
Resinous Scrub	1,933	42+367	44+300

Table 10.7. Habitats Summary – ELU 3

Habitat Type	Length (m)	KP Start	KP Finish
Tussock grassland	790	25+115	25+905
Total	790	4.12%	
Low Broadleaf Evergreen Forest	513	32+620	33+133
Total	513	2.67%	
Dry Deciduous Forest	651	40+053	40+704
Total	651	3.39%	
Cultivated Areas	1,938	28+055	29+993
	1,249	30+931	32+180
	1,811	34+712	36+523
	1,100	37+178	38+278
	1,202	38+851	40+053
	601	41+766	42+367
Total	7,901	41.18%	
Thorny Scrub	938	29+993	30+931
	440	32+180	32+620
	1,579	33+133	34+712
	655	36+523	37+178
	573	38+278	38+851
	2150	25+905	28+055
Total	6,335	33.02%	
Resinous Scrub	1,062	40+704	41+766
	1,933	42+367	44+300
Total	2,995	15.61%	
Total ELU 3:	19,185		

Source: ESIA, Environmental Baseline and Domus.

10.3.2 HABITAT DESCRIPTIONS

Tussock Grassland

The high-Andean endemic cactus *Austrocylindropuntia floccosa* appears in this habitat type. This low-growing cactus often forms dense mats or cushions. This habitat type represents the 4.12% of the ELU.

Thorn Scrub

The major remaining natural habitat type in the Torobamba River Valley ELU is thorny scrub (33.02%). Mixed shrubs with *Dodonaea viscosa*, *Berberis flexuosa* and *Dasyphyllum ferox* have been registered as dominant species. Listed threatened species include *Tecoma sambuxifolia* (INRENA near threatened), *Kageneckia lanceolata* (IUCN vulnerable, INRENA critically endangered), and *Corryocactus quadrangularis* (INRENA endangered). The most important families of shrubs are Asteraceae and Berberidaceae. Thorn underbrush throughout the study area was *Baccharis tricuneata*. Also, there are some elements of the Resinous Scrub surrounding cultivated areas, dominated by *Baccharis odorata* and *Escallonia resinosa* (listed as vulnerable by the INRENA).

Resin Scrub

Resinous scrub covers 15.61% of the ROW in the Torobamba River Valley ELU. The most common species are *Dodonaea viscosa*, *Tecoma arequipensis* (INRENA vulnerable), and *Schinus molle*. In this ELU Resinous Scrubs are typically found in surrounding cultivated areas.

Low Broadleaf Evergreen Forest

Low Broadleaf Evergreen Forest (2.67%) grows in the warmer Andean valleys, with remnants often found along streams or drainage ditches in cultivated areas. The forest is characterized by trees with leaves present all year round forming shelter-belts or isolated plants. The low broadleaf evergreen forest is present around cultivated fields and associated with resinous scrub in the Torobamba and River Valley.

The ESIA include two plant communities dominated by different species in the Low Broadleaf Evergreen Forest: chachacoma (*Escallonia resinosa*) communities and alder (*Alnus acuminata*) communities. There are also small areas trees of the genera and several shrubs of the genera *Berberis*.

Dry Deciduous Forest

This ELU includes a small area (3.39%) covered by dry deciduous forests with predominance of the *Eriothea vargasii* (pati, endemic to the Apurimac dry forests) and several special elements as *Tecoma arequipensis* (INRENA-vulnerable), the cacti *Echinopsis peruviana puquiensis* (INRENA-vulnerable), *Austrocylindropuntia floccosa*, and *A. subulata* (Andean endemics). *Tecoma arequipensis* has a medium sensitivity due to its relatively high abundance in this area. Cacti have a high sensitivity because of their scarcity.

Cultivated areas

41 % of this ELU has been converted to cultivated areas. While having undergone a major alteration, the cultivated areas still contains important biodiversity elements. *Aristeguietia discolor*, an IUCN-near-threatened bush that sometimes grows in association with *Escallonia resinosa*, was identified in cultivated areas, near KP 35+000. In Allpacorral, Uras and the lower zones there are *Tecoma sambuxifolia* shrubs (listed as near-threatened by the INRENA).

Fauna

Large mammals reported in this ELU include pumas or mountain lions (*Puma concolor*). The mountain lion (*Puma concolor*, IUCN/INRENA near threatened) was registered in the Torobabamba River Valley ELU. Bats registered in this ELU were *Desmodus rotundus* (vampire bats), *Artibeus lituratus*, *Sturnira erythromos* and species of the genus *Histiotus*. Other important mammals recorded were the skunk *Conepatus chinga*, the Andean fox (*Lycalopex culpaeus*), and the white-tailed deer (*Odocoileus virginianus*).

The threatened white-tailed shrike-tyrant (*Agriornis andicola*, IUCN-VU, INRENA-EN) was observed in this zone. The creamy-crested spinetail (*Craniouca albicapilla*) and the chestnut-breasted mountain-finch (*Poospiza caesar*) are endemic and range-restricted to the southern Andes of Peru present in this ELU. The endemic lizard *Stenocercus* aff. *apurimacus* and warty toad (*Chaunus spinulosus*) was found in this ELU.

Hydrobiology

Table 10.8 presents water bodies sampled along ELU 2. No salient characteristics were found in this ELU.

Table 10.8. Water bodies Sampled – ELU 3

Station	Habitat	Waterbody	Name	Height (m)	KP
Hi-36	Interandino	Río	Torobamba	2368	39+000
Hi-37	Interandino	Quebrada	Uras	2562	30+000
Hi-38	Interandino	Quebrada	Yanaccacca	2797	29+000

10.3.3 SPECIES SENSITIVITY ANALYSIS

Table 10.9 shows the sensitive species found in the Torobamba River Valley ELU during the EFS fieldwork.

Two High Sensitivity plant species were identified; a cactus (*Corryocactus quadrangularis*) and shrub (*Kagneckia lanceolata*). Nine other plant species were defined as Medium Sensitivity, two reptile species (lizard and warty toad) and two birds, the white-tailed shrike tyrant and the Andean condor, *vulture gryphus*.

Table 10.9. Species Sensitivity Criteria - ELU 3

No	Species	Protection Status						Spatial Distribution			Local Use			Mobility		Σ
		CR	EN	VU	NT	L	N	Local	Regional	Widespread	Permanent	Seasonal	None	Immobile	Mobile	
	Plants															
1	<i>Acacia macracantha</i>				3					0	2			3		8
2	<i>Agave americana</i>						0			0	2			3		5
3	<i>Ariestiguetia discolor</i>				3				2				0	3		8
4	<i>Austrocylindropuntia floccosa</i>						0			0			0	3		3
	<i>Austrocylindropuntia subulata</i>						0		2				0	3		5
5	<i>Baccharis odorata</i>						0		2				0	3		5
	<i>Baccharis tricuneata</i>						0			0	2			3		5
6	<i>Berberis flexuosa</i>						0	3		0			0	3		6
7	<i>Corryocactus quadrangularis</i>		5					3		0			0	3		11
8	<i>Cuphea</i> sp.						0		2				0	3		5
9	<i>Dasyphyllum ferox</i>						0		2				0	3		5
10	<i>Delostoma lobbii</i>						0			0			0	3		3
11	<i>Dodonaea viscosa</i>						0			0	2			3		5
12	<i>Dunalia spinosa</i>						0		2				0	3		5
	<i>Echinopsos peruviana puquiensis</i>			4				3					0	3		10
13	<i>Eriotheca Vargasii</i>						0	3					0	3		6
14	<i>Escallonia myrtilloides</i>			4					2				0	3		9
15	<i>Escallonia resinosa</i>			4					2				0	3		9
17	<i>Gomphichis</i> sp.						0		2				0	3		5
18	<i>Kageneckia lanceolata</i>	6							2				0	3		11
19	<i>Lantana</i> sp.						0			0			0	3		3
20	<i>Pleurothallis</i> sp.						0		2				0	3		5
21	<i>Schinus molle</i>						0			0	2			3		5
22	<i>Tecoma arequipensis</i>			4					2			1		3		10
24	<i>Tecoma sambucifolia</i>				3				2			1		3		9
	Reptiles and amphibians															
25	<i>Chaunus spinulosus</i>				3					0			0	3		6
26	<i>Gastrotheca marsupiat</i>						0		2				0	3		5
27	<i>Liolaemus walkeri</i>						0		2				0	3		5
28	<i>Pleurodema marmorata</i>						0			0			0	3		3
29	<i>Stenocercus</i> aff. <i>apurimacus</i>						0	3					0	3		6
30	<i>Tachymenis peruviana</i>						0			0			0	3		3

	Mammals														
31	<i>Akodon cf. juninensis</i>					0	3		0			0		0	3
32	<i>Akodon subfuscus</i>					0		2				0		0	2
33	<i>Akodon cf. torques</i>					0	3					0		0	3
34	<i>Artibeus lituratus</i>					0			0			0		0	0
35	<i>Calomys sorellus</i>					0	3					0		0	3
36	<i>Conepatus chinga</i>					0			0			0		0	0
37	<i>Desmodus rotundus</i>					0			0			0		0	0
38	<i>Histiotus sp.</i>					0		2				0		0	2
39	<i>Lycalopex (Pseudalopex) culpaeus</i>							2				0		0	2
40	<i>Odocoileus virginianus</i>								0			0		0	0
41	<i>Phyllotis cf. xanthopygus posticalis</i>						3			2				0	5
42	<i>Puma concolor</i>			3					0			0		0	3
43	<i>Sturnira erythromos</i>								0			0		0	0
	Birds														
44	<i>Aglaeactis cupripennis</i>								0			0		0	0
45	<i>Agriornis andicola</i>			4				2				0		0	6
46	<i>Amazilia chionogaster</i>					0		2				0		0	2
47	<i>Anairetes flavirostris</i>					0			0			0		0	0
48	<i>Anas flavirostris</i>					0		0	0			0		0	0
49	<i>Asthenes sp.</i>					0		2				0		0	2
26	<i>Asthenes virgata</i>					0	3					0		0	3
50	<i>Buarremon torquatus</i>					0			0			0		0	0
51	<i>Cinclus leucocephalus</i>					0		2				0		0	2
52	<i>Chloephaga melanoptera</i>					0		2		2				0	4
53	<i>Colaptes rupicola</i>					0			0			0		0	0
54	<i>Colibri coruscans</i>					0			0	2				0	2
55	<i>Cranioleuca albicapilla</i>					0	3					0		0	3
56	<i>Crotophaga ani</i>					0			0			0		0	0
57	<i>Falco femoralis</i>					0			0			0		0	0
58	<i>Falco sparverius</i>					0			0			0		0	0
59	<i>Geranoaetus melanoleucus</i>					0			0			0		0	0
60	<i>Glaucidium jardinii</i>					0		2				0		0	2
61	<i>Knipolegus aterrimus</i>					0			0			0		0	2
62	<i>Lesbia nuna</i>					0		2		2				0	4
63	<i>Lophonetta specularioides</i>					0			0			0		0	0
64	<i>Nothoprocta ornata</i>					0		2				0		0	2
65	<i>Nothoprocta pentlandii</i>					0		2				0		0	2

66	<i>Notiochelidon murina</i>					0		2				0		0	2
67	<i>Ochthoeca leucophrys</i>					0		2				0		0	2
68	<i>Oreonympha nobilis</i>					0	3					0		0	3
69	<i>Oreotrochilus estella</i>					0		2				0		0	2
70	<i>Oxyura ferruginea</i>					0		2				0		0	2
71	<i>Patagioenas maculosa</i>					0		2				0		0	2
72	<i>Patagona gigas</i>					0			0			0		0	0
73	<i>Phalcoboenus megalopterus</i>					0			0			0		0	0
74	<i>Pheucticus aureoventris</i>					0			0			0		0	0
38	<i>Phrygilus plebejus</i>					0			0			0		0	0
39	<i>Phrygilus unicolor</i>					0			0			0		0	0
75	<i>Podiceps occipitalis</i>					0		2				0		0	2
76	<i>Poospiza caesar</i>					0	3					0		0	3
77	<i>Poospiza hispaniolensis</i>					0		2				0		0	2
78	<i>Rollandia rolland</i>					0			0			0		0	0
79	<i>Saltator aurantirostris</i>					0			0			0		0	0
80	<i>Scytalopus sp.</i>					0		2				0		0	2
81	<i>Turdus chiguanco</i>					0			0			0		0	0
82	<i>Vultur gryphus</i>		5						0			0		0	5
83	<i>Zenaida auriculata</i>					0			0			0		0	0

Protection Status*:

CR= Critically endangered 6 points
 EN= Endangered 5 points
 VU= Vulnerable 4 points
 NT= Near threatened 3 points
 B= Low (Others) 2 points
 N= Not listed 0 points

Σ= Sensitivity value

1 - 5: Low
6 - 10: Medium
11 or higher: High

Species Distribution:

Local = (Endemic locally or to an EBA**) 3 points
 Regional = (Regional endemic in Andes or Coast) 2 points
 Widespread = (Across S. America or cosmopolitan) 0 points

Mobility:

Immobile = (restricted movement or in very short distance) 3 points
 Mobile = 0 points

Local Uses:

Permanent= 2 points
 Seasonal = 1 point
 None = 0 points

***Protection Status:** According IUCN (2006) or National Legislation (D.S. No. 034-2004-AG/D.S. No. 043-2005-AG)

****EBA:** Areas determined by Birdlife International, which includes at least 2 bird species with less than 50,000 km² of known distribution range.

10.3.4 HABITAT SENSITIVITY ANALYSIS

Based on the presence of high and medium sensitivity species presented in Table 10.9, the Cultivated Areas and the Thorny Scrub of the Torobamba River Valley ELU are considered to be of High Sensitivity due to the presence of two High Sensitivity plant species and seven Medium Sensitivity plant species, and one High Sensitivity plant species respectively. The Dry Deciduous Forest of the Torobamba River Valley ELU is considered to be of Medium Sensitivity due to the presence of two Medium Sensitivity animal species. None of the other habitats in this ELU meet the criteria for a high or medium sensitivity habitat as described in Section 7.2 of these EFS.

The ESIA identified the "Uras valley and the adjacent thicket" as an area used by the white-tailed deer and spectacled bears (*Tremarctos ornatus*), based on anecdotal reports. The ESIA recognized this as one "of a number of sectors of the pipeline [identified by the biological baseline study] as ecologically sensitive" and noted that the deer are hunted and that "their presence is currently scarce."¹²

10.4 KEY ISSUES

Soils

Adequate topsoil stripping prior to construction and preservation during construction phase will enhance the success of revegetation after construction. Steep slopes and low fertility indicate potential restrictions to natural regeneration of plants in the area during reinstatement.

Taking into account the rainfall patterns, the project should focus on erosion control in the rainy season. During the construction phase temporary erosion control devices such as diversion berms, silt fences, slope breakers and wooden barriers must be implemented and maintained and the topsoil must be protected against contamination or loss.

Water bodies

Numerous water bodies are crossed by the ROW; and are listed in Table 10.3. To minimize sediments contamination of water bodies erosion control must be implemented and maintained on adjacent slopes and protective buffer zones left along the edge of

¹² ESIA, Vol IV (ESMP), page 2-10.

water bodies until immediately prior to pipe installation. Pollution prevention and control best practices should be followed along water bodies.

Physical Risk

According to the Physical analysis (Table 10.4), there are eight sectors of high physical sensitivity. Soil erosion control focused on mass movement in slopes and conservation of topsoil during its relocation in the ROW must be enforced, with particular attention during the rainy season when the risk is greatest.

It is considered that sectors with slightly unstable areas will not require special or additional biorestorement works, but highly unstable ones in areas of steep slopes or close to water bodies should be considered for additional biorestorement techniques such as fertilizers application and hydro seeding.

Habitats and Species

Odocoileus virginianus is a species of economic importance as a game species according to the ESIA although was not observed in the Ecological Field Survey.

Table 10.10 summarizes the key ecological issues and recommendations for ELU 3.

Table 10.10. Key Issues - ELU 3

Issue	KP Reference	Action	Reference
Risk of mass wasting in Unstable terrains	41+800 – 42+500	Erosion controls, biorestorement including fertilizers application and hydro seeding in highest risk areas	ECOMP/RP
Loss of cactus (<i>corryocactus quadrangularis</i>) and shrub (<i>Kageneckia lanceolata</i>) during ROW clearance	Thorn scrub habitat	Replacement with new cactus plants and shrubs during post-construction biorestorement	ECOMP/RP
Game bird, <i>Odocoileus virginianus</i> (Uras valley)	25+000 to 32+000	Pre-clearance Survey to identify and relocate from ROW prior to site clearance activities	ECOMP / RP
Reptiles – <i>Warty toad and lizards</i>	Across ELU	Pre-clearance Survey to identify and relocate from ROW prior to site clearance activities	ECOMP/RP
Bird – white-tailed shrike-tyrant	Across ELU	Identify any nests during Pre-clearance Survey if site clearance during nesting season	ECOMP

River and stream crossings	30+000, 32+000, 38+000, 29+000, 30+000 y 39+500	Buffer zone protection, erosion control, best practice crossing techniques to minimize turbidity	ECOMP

Source: EFS Fieldwork

11.0 ELU 4: SILLACCASA SIERRA (KP 44+350 - 56+783)

11.1 GENERAL DESCRIPTION

The Cerro Sillaccasa, at 4,222 m, is the highest point of this high mountain landscape dominated by puna, with small areas of sward-forming grassland and peat bog wetlands, and lagoons such as Laguna Yanacocha. ROW elevations range from approximately 3,566 to 4,222 m. Peat bogs (bofedales) are very important for local farmers who used them as pasture areas. This short ELU (12.55 km) includes the Socos, Sillaccasa, Incapara, and Motoynioc mountains.

The mean annual precipitation ranges from 500 to 600 mm, depending on altitude. This unit includes the settlements of Soccos and Huaychao. Soils are generally of low fertility. In general, this area is of high physical stability with only a small section of about 600 m of ROW classified as high risk. The ELU has 4 habitat types, with tussock grassland covering some 82% of the ROW.

11.2 PHYSICAL CHARACTERISTICS

11.2.1 PRECIPITATION

Precipitation is seasonal. The wet season is from January to March, and is known locally as the “winter” or rainy season, even though it actually corresponds with the climatologically-defined austral summer. The dry season extends from April to December. Table 11.1 shows precipitation values for each season.

Table 11.1. Precipitation - ELU 4

Estimated Precipitation (mm)			
Peak (January - March)		General (September - April)	
KP Range	Precipitation (mm)	KP Range	Precipitation (mm)
44+350 - 47+000	300 – 400	44+300 – 56+783	500-600
47+000 - 56+783	400 - 500		

Source: ESIA, Environmental Baseline

11.2.2 GEOLOGY

The geological units of the Sierra Sillaccasa ELU 4 include slates, limestones, and sandstones, with lesser contributions siltstones and marls, sometimes alternating with superficial glacial and alluvial deposits of the Quaternary period. The rocks of this ELU are very hard and do not pose significant risks of instability except for very isolated sectors where highly fissured slates and marls are present.

Near KP 45+000 and westward, there are granite rock outcrops, with varying slopes and levels of erosion.

11.2.3 SOILS

Soils in ELU 4 are generally stony, of variable depth, and of slightly to strongly acid pH.

The surface horizon has a sandy loam texture and a medium to shallow depth over the whole ELU, despite the steep slopes. Organic matter content registered was high in all points except at KP 45+000, where there is an extensive rocky area. Fertility based on phosphorus content is low.

Soils present low available levels of phosphorus in most of the ELU as shown in Table 11.2.

The subsoils are generally sandy loams, with lower nutrient and organic matter levels. Drainage is generally very good. Subsoils are very loose and soil aggregates are of low stability.

Table 11.2. Surface Horizon Characteristics - ELU 4

KP	pH	Surface horizon depth	Organic matter	Fertility	Slope (%)
45+000	Very stable rocky substrate with no topsoil development				
45+000	Slightly acid	Medium	Low	Low	
46+000	Strongly acid	High	High	Low	50-60%
47+000	Moderately acid	Medium	High	Medium	
53+000	Strongly acid	High	High	Low	>60%

Source: ESIA, Environmental Baseline and Domus.

pH: Strongly acid = Less than 5.5; Moderately acid = 5.6 to 6.0; Slightly acid = 6.1 – 6.5; Neutral = 6.6 - 7.0; Slightly alkaline = 7.1 – 7.8; Moderately alkaline = 7.9 to 8.4; Strongly alkaline = 8.5 or greater.

Surface horizon depth: Low = Less than 5 cm; Medium = 5 cm to 15 cm; High = More than 15 cm.

Organic matter: Low = Less than 2%; Medium = 2% to 4%; High = More than 4%.

Fertility based on Available Phosphorus: Low = Less than 7.0 ppm; Medium = 7.0 to 14.0 ppm; High = More than 14.0 ppm.

11.2.4 WATER BODIES AND WETLANDS

ELU 4 area includes four lagoons: Socos (48+000), Totoracocha (48+100), Yanacocha I (48+800) and Nina Orco (51+200). The lagoon closest to the ROW is Yanacocha I (20 m) and the most distant, Nina Orcco, is 700 m from the ROW.

Also the ROW at 250 m from Soccosmayo Stream, at KP 49+500. A bog is crossed at KP 48+128. All crossings are shown in Table 11.3.

Table 11.3. Principal Waterbody Crossings - ELU 4

Waterbody Type or Name	KP Mid-channel	Elevation (m)
Bug	48+128	
QUEBRADA	48+294.63	4097.86
QUEBRADA	48+902.23	4106.06
QUEBRADA	49+612.66	4102.05
QUEBRADA NINO ORCO	51+152.02	4103.60

Source: Peru LNG Pipeline Project Alignment Sheets (Gulf Interstate Engineering, 2006).

11.2.5 *INSTABILITY AND PHYSICAL RISK*

Low instability is a feature of this ELU with only about 5% of the ROW categorized as unstable towards the western edge of the section.

Table 11.4. Distribution of Physical Risk Categories – ELU 4

Type of risk	KP Start	KP Finish	Length (m)	
Low	44+315	45+816	1,501	11,956
	46+345	56+800	10,455	
High	44+250	44+315	65	594
	45+816	46+345	529	

Source: ESIA, Environmental Baseline

11.2.6 *INFRASTRUCTURE*

Table 11.5 shows information on accessory infrastructure planned for the Sierra Sillaccasa ELU.

Table 11.5. Planned Project Infrastructures – ELU 4

Type of Infrastructure	KP	Name	Action	Related to
Camps	50+836	Las Nubes 2 Mobile Camp	Topsoil strip prior to Camp construction	ECOMP
Shooflies	56+500	NN		
	57+505	KM 57.5	Topsoil protection / Erosion control devices and slope revegetation	ECOMP/RP

Source: ESIA, Project Description

11.3 HABITATS AND SPECIES

11.3.1 HABITAT DISTRIBUTION

Table 11.6 presents the series of habitat types found along the proposed pipeline ROW in the Sillaccasa Sierra ELU.

Table 11.6. Habitats Sequence – ELU 4

Habitat Type	Length (m)	KP Start	KP Finish
Resinous Scrub	173	44+350	44+473
Tussock grassland	3321	44+473	47+794
Peat Bogs	42	47+794	47+836
Tussock grassland	802	47+836	48+638
Peat Bogs	103	48+638	48+741
Sward-forming grassland	459	48+741	49+200
Peat Bogs	12	49+200	49+212
Tussock grassland	393	49+212	49+605
Peat Bogs	127	49+605	49+732
Sward-forming grassland	509	49+732	50+241
Peat Bogs	156	50+241	50+397
Sward-forming grassland	586	50+397	50+983
Tussock grassland	5800	50+983	56+783

Table 11.7 summarizes the lengths of the habitat types that comprise the Sillaccasa Sierra ELU.

Table 11.7. Habitat Summary – ELU 4

Habitat Units	Length (m)	KP Start	KP Finish
Peat Bog wetlands	42	47+794	47+836
	103	48+638	48+741
	12	49+200	49+212
	127	49+605	49+732
	156	50+241	50+397
Total	440	3.52%	
Sward-forming grassland	459	48+741	49+200
	509	49+732	50+241
	586	50+397	50+983
Total	1554	12.45%	
Resinous Scrub	173	44+300	44+473
Total	173	1.39%	
Tussock grassland	3321	44+473	47+794
	802	47+836	48+638
	393	49+212	49+605
	5800	50+983	56+783
Total	10,316	82.64%	
Total ELU 4:	12,483		

Source: ESIA, Environmental Baseline and Domus.

11.3.2 HABITAT DESCRIPTIONS

Tussock grassland

Tussock grasslands dominate the Sierra Sillaccasa landscape, covering about 82.64% of the ROW length. These grasslands are characterized by the dominance of the grass *Jarava ichu*, and the presence of a very scarce terrestrial orchid belonging to the genus *Aa*. The orchid was encountered near Yanacocha I lagoon and KP 50+000.

Peat bogs

In this ELU, peat bogs occupy approximately 3.52% of the ROW length and are characterized by the predominance of *Distichia muscoides* and the presence of the *Myrosmodes* orchid. These orchids are characteristic of very cold altitudes (above 3,500

m) and grow along the ground, protected by the grasses. These bogs are very important for the local population as forage livestock and water supply source.

Sward-forming grassland

Sward-forming grasslands cover about 12.45% of the ELU length, generally growing on flat land with moist soils. It is often an intermediate vegetation type between the peat bogs and tussock grassland. The most common species are the grasses *Calamagrostis vicunarum* and *Aciachne pulvinata*. Sward-forming grasslands are very important, being used as preferred pastures by locals. The shrub *Escallonia myrtilloides* and the herb *Perezia coerulescens* are classified as vulnerable species by INRENA.

Resinous Scrub

Resinous scrub habitat occupies only around 1.39% of this ELU, being restricted to the lowest areas near the Torobamba River Valley. Typical elements are *Tecoma arequipensis* and *Schinus molle*.

Key Fauna

Large fauna include the mountain lion (*Puma concolor*) and the Andean condor (*Vultur gryphus*). Other mammals reported in this ELU were the mice *Akodon juninens* and *Calomys sorellus*. Other key birds registered in this ELU were the Andean tinamou (*Nothoprocta pentlandii*), silvery grebe (*Podiceps occipitalis*), puna snipe *Gallinago andina*, and the band-tailed seedeater (*Catamenia analis*).

The lagoons support sensitive populations of silvery grebes (INRENA near threatened) and ducks.

Hydrobiology

Table 11.8 presents water bodies sampled along ELU 4. No salient characteristics were found in this ELU.

Table 11.8. Water bodies Sampled – ELU 4

Station	Habitat	Waterbody	Name	Height (m)	KP
Hi-32	Altoandino	Bofedal	Nina Orcco		53+200
Hi-33	Altoandino	Laguna	Nina Orcco	4080	51+200
Hi-34	Interandino	Quebrada	Soccosmayo	2459	49+500
Hi-35	Interandino	Laguna	Yanacocha	4115	48+800

11.3.3 SPECIES SENSITIVITY ANALYSIS

The *Aa* and *Myrosmodes* (INRENA near threatened) orchids are considered to be of Medium sensitivity due to their scarcity.

Escallonia myrtilloides and *Perezia coerulescens* are regional endemics and classified as vulnerable species by INRENA and are thus also considered to be of Medium sensitivity.

The bog moss, *Distachia muscoides*, is also considered to be of Medium Sensitivity because of its limited distribution and seasonal use by the local community.

Due to high its high mobility and widespread geographic ranges, the mountain lion is considered to be of low sensitivity and would not be directly affected by construction activities.

Under the EFS species sensitivity classification, the Andean condor, *vultur grypus*, is classified as Medium sensitivity.

Table 11.9 shows the sensitive species found during the EFS fieldwork.

Table 11.9. Species Sensitivity Criteria - ELU 4

No	Species	Protection Status						Spatial Distribution			Local Use			Mobility		Σ
		CR	EN	VU	NT	L	N	Local	Regional	Widespread	Permanent	Seasonal	None	Immobile	Mobile	
	Plants															
4	<i>Aa</i> sp.						0	3					0	3		6
2	<i>Aciachne pulvinata</i>						0		2				0	3		5
3	<i>Calamagrostis vicunarium</i>						0			0	2			3		5
4	<i>Distichia muscoides</i>						0		2			1		3		6
5	<i>Escallonia myrtilloides</i>			4						0	2			3		9
	<i>Jarava ichu</i>						0			0			0	3		3
6	<i>Lachemilla pinnata</i>						0			0			0	3		5
7	<i>Luzula racemosa</i>						0		2		2	1		3		4
8	<i>Myrosmodes</i> sp.				3			3					0	3		9
9	<i>Perezia coerulescens</i>			4			0		2				0	3		9
10	<i>Plantago rigida</i>						0		2				0	3		5
12	<i>Ranunculus praemorsus</i>						0			0		1		3		4
13	<i>Scirpus americanus</i>						0			0	2			3		5
	<i>Schinus molle</i>						0			2	2			3		5
15	<i>Werneria pygmaea</i>						0		2				0	3		5
	Reptiles and amphibians															
16	<i>Gastrotheca marsupiata</i>						0		2				0	3		5
17	<i>Liolaemus</i> cf. <i>walkeri</i>						0		2				0	3		5
18	<i>Liolaemus walkeri</i>						0		2				0	3		5
19	<i>Pleurodema marmorata</i>						0			0			0	3		3
	Mammals															
20	<i>Akodon</i> cf. <i>juninensis</i>						0	3					0		0	3
21	<i>Calomys sorellus</i>						0	3					0		0	3
22	<i>Lycalopex (Pseudalopex) culpaeus</i>						0		2				0		0	2
23	<i>Puma concolor</i>				3					0			0		0	3
	Birds															
24	<i>Asthenes</i> sp.						0		2				0		0	2
	<i>Catamenia analis</i>						0			0			0		0	0
25	<i>Gallinago andina</i>						0		2				0		0	2
26	<i>Metallura tyrianthina</i>						0			0			0		0	0

	<i>Nothoprocta pentandlii</i>					0		2				0		0	2
27	<i>Phrygilus plebejus</i>					0			0			0		0	0
28	<i>Phrygilus unicolor</i>					0			0			0		0	0
	<i>Podiceps occipitalis</i>					0		2				0		0	2
29	<i>Vultur gryphus</i>		5						0			0		0	5

Protection Status*:

CR= Critically endangered 6 points
 EN= Endangered 5 points
 VU= Vulnerable 4 points
 NT= Near threatened 3 points
 B= Low (Others) 2 points
 N= Not listed 0 points

Σ= Sensitivity value

1 - 5: Low

6 - 10: Medium

11 or higher: High

Species Distribution:

Local = (Endemic locally or to an EBA**) 3 points
 Regional = (Regional endemic in Andes or Coast) 2 points
 Widespread = (Across S. America or cosmopolitan) 0 points

Mobility:

Immobile = (restricted movement or in very short distance) 3 points
 Mobile = 0 points

Local Uses:

Permanent= 2 points
 Seasonal = 1 point
 None = 0 points

***Protection Status:** According IUCN (2006) or National Legislation (D.S. No. 034-2004-AG/D.S. No. 043-2005-AG)

****EBA:** Areas determined by Birdlife International, which includes at least 2 bird species with less than 50,000 km² of known distribution range.

11.3.4 HABITAT SENSITIVITY ANALYSIS

Based on the presence of medium sensitivity species presented in Table 11.9 the Tussock Grassland of the Sillaccasa Sierra ELU is considered to be of Medium Sensitivity due to the presence of four Medium Sensitivity plant species. None of the other habitats in this ELU meet the criteria for a high or medium sensitivity habitat as described in Section 7.2 of these EFS.

11.4 KEY ISSUES AND RECOMMENDATIONS

Soils

Soils are generally strongly acidic, of low fertility and with steep slopes in some stretches. Soils will need special treatments to accelerate remediation results.

Considering into seasonal precipitation levels, implementation and maintenance of erosion control measures during construction should focus on the rainy season. During the construction, erosion control devices as silt fences, slope breakers and wooden barriers must be implemented.

Areas of steep slopes and low fertility should be considered for additional bioremediation techniques during reinstatement including hydro seeding and fertilizers application.

Water bodies and Wetlands

The ROW passes close to a sensitive habitat close to Yanacocha I lagoon (20m away from KP 48+800), which is important for flora, fauna, and the local population. As a wetland it is a resting place for migrant birds and supports waterfowls and other important birds. The impacts on the wetland should be managed by site-specific measures for wetland crossings.

Peat bogs are very important for local farmers who use them as pasture areas.

Flora and Fauna

Two plant species classified as sensitive could be managed by relocation or revegetation. Both, *Escallonia myrtilloides* and *Perezia coerulescens* are classified as vulnerable species by INRENA. The *Myrosmodes* and Aa Sp. orchid is considered to be sensitive due to its scarcity and whenever practicable the plants should be translocated from peat bog prior to construction.

Turf and topsoil strip prior to construction should assist with peat bog habitat regeneration including the bog moss, *Distachia muscoides*.

The Andean condor, although listed as an Endangered species, is highly unlikely to be impacted by construction, being mobile and likely to temporarily move away from any disturbed areas.

Table 11.10 summarizes the key issues and recommendations for the Sillaccasa Sierra ELU.

Table 11.10. Key Issues and Recommendations – ELU 4

Issue	KP Reference	Recommendations	Reference
Physical instability	44+250 – 44+315 45+816 – 46+345	Temporary and permanent erosion controls including consideration of additional biorestation methods (fertilizer and mulch applications and hydro seeding) in highest risk areas	ECOMP
Yanacocha lagoon	48+800	Final routing to minimize disturbance to the lagoon and fringing wetlands.	ECOMP
Peat bog habitat	48+121 – 48+418	Translocation of orchids (<i>Aaa sp.</i> and <i>Myrosmodes sp.</i>) and shrubs <i>Escalonia myrtilloides</i>) before construction. Topsoil strip and protection during construction phase for respreading during reinstatement	ECOMP
		Turf and topsoil strip prior to construction. Restoration of topsoil and plants during abandonment. Native species seed mix, where practicable, during	RP

		bioreinstatement	

Source: EFS

12.0 ELU 5: YUCAY RIVER VALLEY (KP 56+783 – 74+199)

12.1 GENERAL DESCRIPTION

The Yucay River Valley ELU contains extensive cultivated areas around the villages of Chunucancha, Huaychao, Acocro, Tambo, Cuchucancha, Seccelambras, Pomapuquio, and others. The relict native vegetation patches are composed of resinous and thorny scrublands. The natural vegetation is part of the upper Mantaro Dry Forest System as is determined by the seasonally dry climate and elevations from 2,850 to 3,864 m. The ROW crossing the Yucay River at 2,850 m is the second lowest ROW elevation point in the Ayacucho Department.

The KP 58+900 – 62+600 around Huaychao area presents a high risk of water erosion and landslides and the formation of extensive gullies. Topsoil fluctuates from 0-15 to 0-30 cm depth depending on site-specific conditions. Bulk density and mechanical resistance is medium so compaction could be a concern if appropriate land conservation practices are not implemented. Colluvial and conglomerate soils predominate. Soil fertility is from low to medium.

The ELU has 6 habitat types. The largest habitat type is constituted by Cultivated Areas that represent the 81.76% of the ELU total length, and the smallest one, peat bogs sums 0.26%. Tables 12.6 and 12.7 show the sequence of the habitat types along the ROW and their total lengths, respectively.

12.2 PHYSICAL CHARACTERISTICS

12.2.1 *PRECIPITATION*

Precipitation in ELU 5 is seasonal. The wet season is from January to March, and is known locally as the “winter” or rainy season, even though it actually corresponds with the climatologically-defined austral summer. The dry season extends from April to December. Table 12.1 shows precipitation values during both seasons.

Table 12.1. Precipitation - ELU 5

Estimated Precipitation (mm)			
Peak		General	
(January - March)		(September - April)	
KP Range	Precipitation (mm)	KP Range	Precipitation (mm)
56+783 - 58+000	400 - 500	56+783 - 68+000	500 - 600
58+000 - 62+000	300 - 400		
62+000 - 72+000	200 - 300	68+000 - 74+199	600 - 700
72+000 - 74+199	300 - 400		

Source: ESIA, Environmental Baseline

12.2.2 *GEOLOGY*

Intrusive complexes of highly fractured grey to pink granites with granular texture dominate the Yucay River Valley ELU from KP 56+800 to near 61+000. These rocks are weathered on the surface, although the fragments are hard and strong.

Approaching KP 61+000 and westward, andesitic rocks and rather weathered granitic rocks predominate. Along this area there are signs of mass wasting and other erosive processes. Well defined outcrops occur near Acocro between KP 70+000 and KP 74+000.

12.2.3 Soils

Soil pH ranges from slightly to strongly acidic, with one sample with a slightly alkaline characteristic at KP 61+000.

Surface Horizon Characteristics

Surface horizon depth is generally medium along the ELU, despite the variable slope. Organic matter content is variable, being high at KPs 59+000, 72+000 and 73+000, medium at KPs 63+000 and 69+000, and low at KPs 61+000 and 63+000. Slopes vary from nearly flat to very steep in some areas, especially at KP 73+000.

Based on available levels of phosphorus, the topsoil is of low fertility at KPs 59+000, 61+000 and 73+000; medium at KPs 63+000 and 66+00; and high at KPs 63+000 and 72+000.

Surface horizon characteristics are shown in Table 12.2.

Subsoil Characteristics

Subsoil physical characteristics like texture (fluctuating from sandy loam to sandy clay loam) are similar, but the level of nutrients and organic matter are lower. The Subsoil is generally well drained. Soils with higher sand content are very loose and soil aggregates are of low stability. A clayey Subsoil that could affect infiltration from the A horizon was observed at a depths of 15 to 50 cm at Kp 63+000.

Table 12.2. Surface Horizon Characteristics - ELU 5

KP	pH	Surface horizon depth	Organic matter	Fertility	Slope (%)
59+000	Strongly acid	Medium	high	low	20%
61+000	Slightly alkaline	High	low	low	10-15%
63+000	Moderately acid	Medium	low	medium	15-20%
69+000	Moderately acid	Medium	medium	high	30%
66+000	Slightly acid	Medium	medium	medium	20%
72+000	Strongly acid	Low	medium	high	30%
73+000	Strongly acid	medium	high	low	>100%

Source: ESIA, Environmental Baseline and Domus.

pH: Strongly acid = Less than 5.5; Moderately acid = 5.6 to 6.0; Slightly acid = 6.1 – 6.5; Neutral = 6.6 - 7.0; Slightly alkaline = 7.1 – 7.8; Moderately alkaline = 7.9 to 8.4; Strongly alkaline = 8.5 or greater.

Surface horizon depth: Low = Less than 5 cm; Medium = 5 cm to 15 cm; High = More than 15 cm.

Organic matter: Low = Less than 2%; Medium = 2% to 4%; High = More than 4%.

Fertility based on Available Phosphorus: Low = Less than 7.0 ppm; Medium = 7.0 to 14.0 ppm; High = More than 14.0 ppm.

12.2.4 WATER BODIES

The ROW crosses the Yucay River at approximately KP 62+380, it passes 200 m far from the Sontorhuaycco Stream, and for 200m parallel to another stream, which is a tributary of the Yucay River. At KP 71+000, the ROW gets closer to Jatunchancara Stream, 500 m away. In this ELU, the ROW crosses one peat bog and does not cross lagoons or lakes, as is shown in Table 12.3.

Table 12.3. Principal Waterbody Crossings - ELU 5

Waterbody Type or Name	KP Mid-channel	Elevation (m)
Quebradas		
QUEBRADA	63+460.18	3112.70
QUEBRADA	63+609.90	3112.01
QUEBRADA	64+963.24	3289.09
QUEBRADA	72+275.56	3613.93
QUEBRADA	72+537.51	3650.20
QUEBRADA	72+782.92	3689.34
QUEBRADA 2	73+405.19	3772.10
QUEBRADA 1	73+446.98	3773.46
Rivers		
YUCAY	62+380.52	2814.07

Source: Peru LNG Pipeline Project Alignment Sheets (Gulf Interstate Engineering, 2006).

12.2.5 INSTABILITY AND PHYSICAL RISK

Low physical risk zones cover 74.4% of the ELU, with Medium and High physical risk categories occupying 19.8% and 5.8% of the total length, respectively. The High risk areas are located in three zones between KP 58+900 and KP 62+626 on a long ridge top between the village of Huaychao and the Yucay River.

Table 12.4. Physical Risk - ELU 5

Risk Category	KP Start	KP Finish	Length (m)	
Low	56+800	57+140	340	12,789
	58+367	58+900	533	
	59+640	62+148	2,508	
	62+148	62+282	134	
	62+369	62+451	82	
	62+626	70+921	8,295	
	71+649	72+546	897	
Medium	57+140	58+367	1,227	3,409
	70+921	71+649	728	
	72+546	74+000	1,454	
High	58+900	59+640	740	1002
	62+282	62+369	87	
	62+451	62+626	175	

Source: ESIA, Environmental Baseline and Domus.

12.2.6 INFRASTRUCTURE

One shoofly is proposed for the Yucay River Valley ELU near KP 57+500. Two camps are considered in this ELU: the Central Huaychao at KP 60+020, and the Central Acocros at KP 70+623.

Table 12.7 shows infrastructure information.

Table 12.5. Planned Project Infrastructures – ELU 5

Type of Infrastructure	KP	Name	Action	Related to
Camps	60+020	Central – Huaychao	Topsoil strip and reinstatement	ECOMP/RP
	70+623	Central – Acocros	Topsoil strip and reinstatement	ECOMP/RP
Shooflies	56+519	KM 56.5	Topsoil protection / Erosion control devices and slope revegetation Reinstatement after construction	ECOMP/RP

Source: ESIA, Project Description

12.3 HABITATS AND SPECIES

12.3.1 HABITAT DISTRIBUTION

The habitats of ELU 5 are listed in sequential order in Table 12.6, including the length of each habitat unit and associated start and finish ROW KPs. Table 12.7 summarizes the lengths of each habitat type with ELU, including subtotals for each habitat type.

Table 12.6. Habitat Sequence – ELU 5

Habitats	Length (m)	KP Start	KP Finish
Thorny scrub	154	56+783	56+971
Cultivated areas	4347	56+971	61+318
Resinous Scrub	357	61+318	61+675
Cultivated areas	803	61+675	62+478
Resinous Scrub	1104	62+478	63+582
Cultivated areas	9116	63+582	72+698
Eucalyptus plantations	1088	72+698	73+786
Resinous Scrub	129	73+786	73+915
Peat Bogs	45	73+915	73+960
Resinous Scrub	239	73+960	74+199

Source: ESIA, Environmental Baseline and Domus.

Table 12.7. Habitat Summary – ELU 5

Habitat Types	Length (m)	KP Start	KP Finish
Peat bog	45	73+915	73+960
Total	45	0.26%	
Cultivated areas	4347	56+971	61+318
	803	61+675	62+478
	9116	63+582	72+698
Total	14,266	81.76%	
Eucalyptus plantations	1088	72+698	73+786
Total	1,088	6.24%	
Thorny scrub	171	56+800	56+971
Total	171	0.98%	
Resinous Scrub	357	61+318	61+675
	1104	62+478	63+582
	129	73+786	73+915
	239	73+960	74+199
Total	1,829	10.48%	
Tussock grassland	17	56+783	56+800
	32	74+167	74+199
Total	49	0.28%	
Total ELU 5:	17,448		

Source: ESIA, Environmental Baseline and Domus.

12.3.2 HABITAT DESCRIPTION

Cultivated Areas

Extensive cultivated areas around the villages of Chunucancha, Huaychao, Acocro, Tambo, Cuchucancha, and others occupy 81.76% of the ROW in the dry valley landscape of the upper Yucay River Basin.

Resinous Scrub

Relictual stands of resinous shrubs with predominance of *Schinus molle*, and *Agave americana*, coexist with intervened areas such as along trails, cultivated areas, corrals, accounting for 10.48% of the ROW length. The presence of *Cleistocactus morawetzianus*, *Corryocactus quadrangularis*, and *Echinopsis peruviana puquiensis* was registered. The latter two of these cacti are endemic and threatened, respectively.

Eucalyptus Plantations

Eucalyptus plantations have minimum ecological value and cover 6.24% of the highly modified Yucay River Valley ELU. Eucalyptus trees are exotic species that do not bring resources for feeding or nesting to local fauna, and are of low biodiversity.

Thorny Scrub

Thorny shrub formations composed of *Berberis* spp., *Dunalia spinosa*, are present, along with *Escallonia myrtilloides*, a non-endemic vulnerable species. These dispersed shrubs coexist with intervened areas (roads, cultivated areas, corrals) and comprise only about 1% of the habitat in ELU 5.

Fauna

Human settlements are associated with introduced mice and rats that are dispersed around the villages, cultivated fields, and dumps. Native rodents like *Calomys lepidus*, and *Phyllotis posticalis* were found in this ELU. Molina's hog-nosed skunk (*Conepatus chinga*) were registered in this ELU.

The bearded mountaineer (*Oreonympha nobilis*), a regional endemic of the Andes of southern Peru, was registered here. The Andean tinamou (*Nothoprocta pentlandii*), and Andean flicker (*Colaptes rupicola*), are also important.

Water bodies are used by water frogs (*Telmatobius* sp.) and two species of Andean catfishes (*Trichomycterus rivulatus* and *Astroblepus* sp.) All of them classified as sensitive species. The warty toad (*Chaunus spinulosus*; INRENA near threatened) was observed near the Yucay River.

Stenocercus frittsi, a Mantaro basin endemic, was observed in ELU 5. Probable new species of the lizard genus *Euspondylus* and the snake genus *Sibynomorphus* found in the Mantaro basin near the city of Huamanga are likely to be found in the Yucay River Valley due to similarity of the habitats.

Hydrobiology

Table 12.8 presents water bodies sampled along ELU 5. Two species were found in one of the stations (Hi-31) on the Yucay River. The genus *Astroblepus* presents endemic species and native species which can migrate to other water bodies when looking for food. *Trichomycterus* sp. is a native, low mobility species described for ELU 5.

Table 12.8. Water bodies Sampled – ELU 5

Station	Habitat	Waterbody	Name	Height (masl)	KP	Species
Hi-28	Interandino	Quebrada	Jatunchancara	3528	71+000	
Hi-29	Interandino	Quebrada	Affluent to Yucay	2848	62+500	
Hi-30	Interandino	Quebrada	Huaycco	2854	62+500	
Hi-31	Interandino	River	Yucay	2822	62+500	<i>Astroblepus sp.</i> <i>Trichomycterus sp.</i>

12.3.3 SPECIES SENSITIVITY ANALYSIS

Table 12.9 shows the sensitive species found during the EFS fieldwork.

One High Sensitivity plant species was identified (*Corryocactus quadrangularis*) and five other plant species were defined as Medium Sensitivity. Two fish species and three reptile species were also of Medium Sensitivity. One bird species was of Medium Sensitivity.

Table 12.9. Species Sensitivity Criteria - ELU 5

No	Species	Protection Status						Spatial Distribution			Local Use			Mobility		Σ
		CR	EN	VU	NT	L	N	Local	Regional	Widespread	Permanent	Seasonal	None	Immobile	Mobile	
	Plants									0						
	<i>Agave americana</i>						0			0	2			3		5
1	<i>Austrocylindropuntia subulata</i>						0		2				0	3		5
2	<i>Baccharis odorata</i>						0		2				0	3		5
3	<i>Baccharis tricuneata</i>						0		2				0	3		5
4	<i>Berberis flexuosa</i>						0	3					0	3		6
	<i>Chaunus spinulosus</i>				3					0			0	3		6
5	<i>Cleistocactus morawetzianus</i>						0	3					0	3		6
6	<i>Corryocactus quadrangularis</i>		5					3					0	3		11
7	<i>Echinopsis peruviana</i> ssp. <i>puquiensis</i>			4				3					0	3		10
8	<i>Escallonia myrtilloides</i>			4					2	0			0	3		9
	<i>Schinus molle</i>						0			0	2			3		5
	Fishes															
9	<i>Astroblepus</i> sp.						0			0	2			3		5
10	<i>Orestias</i> sp.						0		2		2		0	3		7
11	<i>Trichomycterus rivulatus</i>						0	3			2		0	3		8
	Reptiles and amphibians															
28	<i>Liolaemus</i> sp.						0	3					0	3		6
	<i>Stenocercus fritti</i>						0	3					0	3		6
12	<i>Telmatobius</i> sp.			4				3					0	3		10
	Mammals															
13	<i>Calomys lepidus</i>						0			0			0		0	0
14	<i>Conepatus chinga</i>						0			0			0		0	0
15	<i>Desmodus rotundus</i>						0			0			0		0	0
16	<i>Lycalopex (Pseudalopex) culpaeus</i>						0		2				0		0	2
17	<i>Phyllotis</i> cf. <i>xanthopygus posticalis</i>						0	3		0	2		0		0	5
	Birds															
18	<i>Aeronautes andecolus</i>						0			0			0		0	0
19	<i>Aglaeactis cupripennis</i>						0			0			0		0	0
20	<i>Agriornis montanus</i>						0			0			0		0	0
21	<i>Anairetes flavirostris</i>						0			0			0		0	0
22	<i>Asthenes</i> sp.						0		2				0		0	2
23	<i>Bolborhynchus orbygnesi</i>						0			0		1			0	1

24	<i>Carduelis atrata</i>					0		2				0		0	2
25	<i>Carduelis magellanica</i>					0			0			0		0	0
26	<i>Catamenia analis</i>					0			0			0		0	0
27	<i>Catamenia inornata</i>					0			0			0		0	0
28	<i>Colaptes rupicola</i>					0			0			0		0	0
29	<i>Columba livia</i>					0			0			0		0	0
30	<i>Conirostrum cinereum</i>					0		2				0		0	2
31	<i>Diuca speculifera</i>					0		2				0		0	2
32	<i>Geranoaetus melanoleucus</i>					0			0			0		0	0
33	<i>Metriopelia melanoptera</i>					0			0			0		0	0
34	<i>Nothoprocta ornata</i>					0		2				0		0	2
35	<i>Nothoprocta pentlandii</i>					0		2				0		0	2
36	<i>Oreonympha nobilis</i>					0	3					0		0	3
37	<i>Phalcoboenus megalopterus</i>					0			0			0		0	0
38	<i>Pheucticus aureoventris</i>					0			0			0		0	0
39	<i>Polioptila rufipennis</i>					0		2				0		0	2
40	<i>Saltator aurantirostris</i>					0			0			0		0	0
41	<i>Sicalis uropygialis</i>					0			0			0		0	0
42	<i>Turdus chiguanco</i>					0			0			0		0	0
43	<i>Vultur gryphus</i>		5						0			0		0	5

Protection Status*:

CR= Critically endangered 6 points
 EN= Endangered 5 points
 VU= Vulnerable 4 points
 NT= Near threatened 3 points
 B= Low (Others) 2 points
 N= Not listed 0 points

Σ= Sensitivity value

1 - 5: Low
6 - 10: Medium
11 or higher: High

Species Distribution:

Local = (Endemic locally or to an EBA**) 3 points
 Regional = (Regional endemic in Andes or Coast) 2 points
 Widespread = (Across S. America or cosmopolitan) 0 points

Mobility:

Immobile = (restricted movement or in very short distance) 3 points
 Mobile = 0 points

Local Uses:

Permanent= 2 points
 Seasonal = 1 point
 None = 0 points

***Protection Status:** According IUCN (2006) or National Legislation (D.S. No. 034-2004-AG/D.S. No. 043-2005-AG)

****EBA:** Areas determined by Birdlife International, which includes at least 2 bird species with less than 50,000 km² of known distribution range.

12.3.4 HABITAT SENSITIVITY ANALYSIS

Based on the presence of high and medium sensitivity species presented in Table 12.9 the Resinous Scrub of the Yucay River Valley ELU is considered to be of High Sensitivity due to the presence of one High Sensitivity plant species. The Yucay River of the Yucay River Valley ELU is considered to be of Medium Sensitivity due to the presence of two Medium Sensitivity animal species. None of the other habitats in this ELU meet the criteria for a high or medium sensitivity habitat as described in Section 7.2 of these EFS.

12.4 KEY ISSUES AND RECOMMENDATIONS

Soils

Physical Risk

Precipitation could produce erosive processes in the ELU, so preventive and mitigation measures should be implemented, especially in the zones categorized as presenting Medium and High physical risk.

Habitats and Species

Special consideration should be granted to the presence of the locally endemic cacti *Corryocactus quadrangularis* occurring in the Resinous Scrub habitat, which is listed as endangered by INRENA.

Streams and rivers must be protected to avoid contamination or any disturbance in order to protect native Andean fishes and aquatic frogs.

Although classified as Medium Sensitivity, the Andean condor, *Vulture gryphus*, is a mobile species and it is highly unlikely that it will be impacted by construction or require any special protective measures.

Table 12.10 summarizes the key issues and recommendations for the Yucay River Valley ELU.

Table 12.10. Key Issues and Recommendations - ELU 5

Issue	KP Reference	Recommendations	Related to
Risk of mass wasting in Unstable terrains	58+900 – 62+626	Erosion control and pollution prevention best practice is particularly important at water bodies including the Yucay River at KP 62+380 to safeguard water supply and avoid sediment inundation. Erosion controls and consideration of additional biorestore measures including fertilizer and mulch application and hydro seeding in highest risk areas.	ECOMP/RP
River and stream crossings (Protection of fish species <i>Orestias sp.</i> and <i>Trichomycterus rivulatus</i>)	62+500, 62+500, 62+500, 71+000 and 72+000	Ditch in dry season if possible, use best practice crossing techniques to minimize sediments and turbidity. Retain vegetative buffer zones at watercourse crossings until immediately prior to pipeline crossing installation Silt fence controls at stockpile where ROW is aligned close to streams.	ECOMP
Resinous Scrubs high sensitivity habitats	61+318 – 61+675 62+478 – 63+582 73+786 – 73+915 73+960 – 74+199	Regeneration of Resinous Scrub habitats by replacement of cactus species such as <i>Corryocactus Quadrangularis</i> and <i>Echinopsis peruviana</i>	ECOMP/RP

		<i>puquiensis</i> and <i>Escallonia myrtilloides</i> where impractical to translocate existing plants from ROW.	
Reptiles – Lizard (<i>Liolaemus sp.</i> and <i>stenocercus</i> and Water frog (<i>Telmatobius sp.</i>)	Several habitats	Pre-clearance survey to identify and relocate from ROW prior to site clearance activities.	ECOMP

Source: EFS Fieldwork

13.0 ELU 6: HUAMANGA-VISCHONGO WATERSHED DIVIDE (KP 74+199 TO 103+970)

13.1 GENERAL DESCRIPTION

After passing the cultivated areas of the Yucay River Valley to the east, the ROW rises up and follows the watershed divide between the Huamanga Valley to the north and the Vischongo river basin to the south, passing primarily through tall tussock puna grassland (91% of the ELU), with occasional narrow stretches of sward-forming grassland and peat bog wetlands in valleys and depressions.

The climate is dry and cold, with elevations between 3,864 and 4,250 m. Precipitation ranges from 300 to 700mm per year, depending on altitude. This unit includes the rural communities of Pinao Yantapacha, San Martin de Yanapiruro Ichubamba, Chiara, Chupas, Toccyascca, Tambocucho and San Basilio de Chupas.

From KP 103+000 to the end of the ELU at KP 103+970, in both sides of the Vischongo River valley, colluvial and volcanic soils predominate, which are very sensitive to erosion and landslides. Cropping systems with potato and other crops are predominant in the valley areas where the level of fertility is from medium to high due to the use of fertilizers. The colluvial unstable area is of low fertility and low levels of phosphorous will represent a limitation to the rate of revegetation after construction.

13.2 PHYSICAL CHARACTERISTICS

13.2.1 *PRECIPITATION*

Precipitation is highly seasonal along the Huamanga-Vischongo divides, with the three-month wet season almost double the amount of the nine-month dry season. The wet season is from January to March, and is known locally as the “winter” or rainy season, even though it actually corresponds with the climatologically-defined austral summer. The dry season extends from April to December. Table 13.1 shows precipitation values for each season.

Table 13.1. Precipitation - ELU 6

KP Range	Estimated Precipitation (mm)	
	Peak	General
	(January – March)	(September – April)
74+199 – 103+970	300 – 400	600 - 700

Source: ESIA, Environmental Baseline

13.2.2 *GEOLOGY*

A volcanic formation extends approximately from the edge of the Yucay River Valley (KP 74+199) to the Sallalli hacienda (KP 104+200) and consists of tuffs and lava effusions alternating with clays and siltstones and diatomites. The tuffaceous lithology has little resistance to erosion and therefore fractured and weathered areas may pose the risk of landslides and rock falls, despite the generally gentle topography. Notable erosional features were observed near KP 100+000.

13.2.3 Soils

Surface horizon characteristics

Soil pH in ELU 6 is strongly acidic. The surface horizon is generally of medium depth with isolated areas of deeper soils.

Organic matter content is predominantly high and soils of the ELU have a medium level fertility, based on phosphorus availability. Surface horizon characteristics are shown in Table 13.2.

Subsoil Characteristics

The Subsoil has a loamy sand texture, coarser than the sandy loam texture of the topsoil layer, and will not affect the movement of water. These layers are very loose and the aggregates are of low stability.

Table 13.2. Surface Horizon Characteristics - ELU 6

KP	pH	Surface horizon depth	Organic matter	Fertility	Slope (%)
75+000	Moderately acid	Medium	Low	Low	
78+000	Strongly acid	Medium	High	Medium	
81+000	Strongly acid	Medium	High	High	
84+000	Strongly acid	Medium	High	Medium	
87+000	Strongly acid	Medium	High	High	80%
88+000	Strongly acid	High	High	Medium	
90+000	Strongly acid	Medium	High	Medium	
93+000	Strongly acid	Medium	High	Medium	
96+000	Strongly acid	High	High	Medium	
99+000	Strongly acid	Medium	High	Medium	
100+000	Strongly acid	High	High	Low	30%
102+000	Strongly acid	Medium	Medium	Medium	

Source: ESIA, Environmental Baseline and EFS Field Work.

pH: Strongly acid = Less than 5.5; Moderately acid = 5.6 to 6.0; Slightly acid = 6.1 – 6.5; Neutral = 6.6 - 7.0; Slightly alkaline = 7.1 – 7.8; Moderately alkaline = 7.9 to 8.4; Strongly alkaline = 8.5 or greater.

Surface horizon depth: Low = Less than 5 cm; Medium = 5 cm to 15 cm; High = More than 15 cm.

Organic matter: Low = Less than 2%; Medium = 2% to 4%; High = More than 4%.

Fertility based on Available Phosphorus: Low = Less than 7.0 ppm; Medium = 7.0 to 14.0 ppm; High = More than 14.0 ppm.

13.2.4 WATERBODIES AND WETLANDS

ELU 6 passes within 250 m of the Choqueacgra lagoon, and within 500 m of 5 peat bogs, located between KP 80+800 and KP 92+500. It crosses one peat bog at KP 85+500. Waterbodies registered for this ELU are shown in Table 13.3.

Table 13.3. Principal Crossings - ELU 6

Waterbody Type or Name	KP Mid-channel	Elevation (m)
Arroyos		
ARROYO	79+570.36	4159.28
ARROYO	79+700.97	4149.14
ARROYO	80+697.27	4035.09
ARROYO CANMAYO	80+861.05	4023.62
ARROYO RODEAOHUAYCCO	83+158.73	4079.17
ARROYO	85+410.61	4017.99
ARROYO JATUN SALLAHUAYJO	85+561.50	4032.35
ARROYO	87+436.11	4066.75
ARROYO	88+982.82	4095.45
ARROYO ANCAPACHANHUAYCCO	90+365.12	4026.90
ARROYO	90+399.45	4027.98
ARROYO JOSCCO HUAYCCO	92+507.41	4117.64
ARROYO	95+248.77	4197.13
ARROYO	96+636.83	4166.83
ARROYO	96+966.41	4145.51
ARROYO SECO	99+208.35	4004.27
Quebradas		
QUEBRADA	77+592.61	4166.84
QUEBRADA SECA	77+606.10	4167.61
QDA TOROHUICHANAN	99+100	4020

Source: Peru LNG Pipeline Project Alignment Sheets (Gulf Interstate Engineering, 2006).

13.2.5 *INSTABILITY AND PHYSICAL RISK*

Nearly the entire length (i.e., 97.9%) of the Huamanga-Vischongo Watershed divide ELU is categorized as having Low physical risk (Table 13.4). A combined length of only 606 m at the western and eastern end of the ELU is categorized as presenting a Medium physical risk.

Table 13.4. Physical Risk - ELU 6

Risk Level	KP Start	KP Finish	Length (m)		Action	Related To
Low	74+600	103-964	29,364	29,364	Topsoil protection	ECOMP / RP
Medium	74+000	74+600	600	606	Topsoil protection	ECOMP / RP
	103+964	103+970	6			

Source: ESIA, Environmental Baseline and Domus.

13.2.6 *INFRASTRUCTURE*

There is no information currently available on camps, shooflies, or other accessory infrastructure that are planned to be installed in the Huamanga-Vischongo Watershed Divide ELU.

13.3 HABITATS AND SPECIES

13.3.1 *HABITAT DISTRIBUTION*

Table 13.5. Habitat Sequence – ELU 6

Habitat Type	Length (m)	KP Start	KP Finish
Tussock grassland	5500	74+199	79+699
Peat Bogs	8	79+699	79+707
Tussock grassland	168	79+707	79+875
Peat Bogs	9	79+875	79+884
Tussock grassland	973	79+884	80+857
Peat Bogs	221	80+857	81+078
Tussock grassland	187	81+078	81+265
Peat Bogs	21	81+265	81+286

Tussock grassland	1863	81+286	83+149
Peat Bogs	17	83+149	83+166
Tussock grassland	1047	83+166	84+213
Peat Bogs	545	84+213	84+758
Tussock grassland	651	84+758	85+409
Peat Bogs	224	85+409	85+633
Tussock grassland	1712	85+633	87+345
Peat Bogs	10	87+345	87+355
Tussock grassland	1624	87+355	88+979
Peat Bogs	32	88+979	89+011
Tussock grassland	1028	89+011	90+039
Peat Bogs	25	90+039	90+064
Tussock grassland	1978	90+064	92+042
Peat Bogs	22	92+042	92+064
Tussock grassland	51	92+064	92+115
Peat Bogs	96	92+115	92+211
Tussock grassland	293	92+211	92+504
Peat Bogs	48	92+504	92+552
Tussock grassland	1807	92+552	94+359
Peat Bogs	52	94+359	94+411
Tussock grassland	783	94+411	95+194
Sward-forming grassland	31	95+194	95+225
Peat Bogs	26	95+225	95+251
Sward-forming grassland	65	95+251	95+316
Peat Bogs	43	95+316	95+359
Sward-forming grassland	31	95+359	95+390
Tussock grassland	1239	95+390	96+629
Peat Bogs	23	96+629	96+652
Tussock grassland	2486	96+652	99+138
Sward-forming grassland	146	99+138	99+284
Tussock grassland	1440	99+284	10+724
Peat Bogs	99	100+724	100+823
Tussock grassland	367	100+823	101+190
Peat Bogs	74	101+190	101+264
Tussock grassland	43	101+264	101+307
Peat Bogs	77	101+307	101+384
Tussock grassland	621	101+384	102+005
Sward-forming grassland	244	102+005	102+249
Tussock grassland	1132	102+249	103+381
Sward-forming grassland	237	103+381	103+618
Cultivated areas	161	103+618	103+779
Tussock grassland	191	103+779	103+970

Table 13.6. Habitat Summary – ELU 6

Habitat Type	Length (m)	KP Start	KP Finish
Tussock grassland	5500	74+199	79+699
	168	79+707	79+875
	973	79+884	80+857
	187	81+078	81+265
	1863	81+286	83+149
	1047	83+166	84+213
	651	84+758	85+409
	1712	85+633	87+345
	1624	87+355	88+979
	1028	89+011	90+039
	1978	90+064	92+042
	51	92+064	92+115
	293	92+211	92+504
	1807	92+552	94+359
	783	94+411	95+194
	1239	95+390	96+629
	2486	96+652	99+138
	1440	99+284	10+724
	367	100+823	101+190
	43	101+264	101+307
	621	101+384	102+005
	1132	102+249	103+381
	191	103+779	103+970
Total	27,184	91.31%	
Sward-forming grassland	31	95+194	95+225
	65	95+251	95+316
	31	95+359	95+390
	146	99+138	99+284
	244	102+005	102+249
	237	103+381	103+618
Total	754	2.53%	
Peat Bogs	8	79+699	79+707
	9	79+875	79+884
	221	80+857	81+078
	21	81+265	81+286
	17	83+149	83+166
	545	84+213	84+758
	224	85+409	85+633
	10	87+345	87+355

	32	88+979	89+011
	25	90+039	90+064
	22	92+042	92+064
	96	92+115	92+211
	48	92+504	92+552
	52	94+359	94+411
	26	95+225	95+251
	43	95+316	95+359
	23	96+629	96+652
	99	100+724	100+823
	74	101+190	101+264
	77	101+307	101+384
Total	1672	5.62%	
Cultivated areas	161	103+618	103+779
Total	161	0.54%	
Total ELU 6:	29,771		

Source: ESIA, Environmental Baseline and Domus.

13.3.2 HABITAT DESCRIPTIONS

Tussock grassland

Tussock grasslands cover almost the entire length (91.31%) of the Huamanga-Vischongo Divide. This habitat type is largely covered by grasses of the genera *Festuca*, *Stipa*, *Jarava*, and *Calamagrostis*. Shrubs present include *Escallonia myrtilloides*, and *Parastrephia quadrangularis*, both listed as vulnerable by the INRENA.

Sward-forming grassland

Sward-forming grasslands, while occupying only 2.53% of the ROW length in ELU 6, are very important and are used as preferred grazing lands by local farmers. In this habitat type the most common species are the grasses *Calamagrostis vicunarum* and *Aciachne pulvinata*.

Peat Bogs

Peat bogs in ELU 6, which form 5.62% of the total cover, and differ from the bogs in the previous ELUs due to the presence of many roseate species along the Huamanga-Vischongo divide. Dominant species are *Calamagrostis* cf. *vicunarum* "crespillo", *Plantago tubulosa*, *Hypochaeris* spp., *Baccharis* spp., and *Aciachne pulvinata*.

Cultivated areas

The small shrub *Parastrephia quadrangularis*, an INRENA-vulnerable species, was encountered in association with cultivated areas in ELU 6, between field boundaries and as living fences.

Fauna

Three felids and the vicuna (*Vicugna vicugna*; IUCN conservation dependent and INRENA near threatened) were registered in this ELU, demonstrating the importance and richness of the ecosystem, despite its proximity to the city of Huamanga (Ayacucho). Felids registered were the Andean mountain cat (*Leopardus jacobitus*, IUCN/INRENA endangered), the Pampas cat (*Leopardus pajeros*), and the mountain lion (*Puma concolor*).

At the south part of the Huamanga Valley, the most notable bird observed was the dark-winged miner (*Geositta saxicolina*), a range-restricted endemic species of the high Andes of south-central Peru. The ESIA also reported in this ELU the presence of the Vilcabamba thistletail *Schizoeaca vilcabambae*, an endemic bird, commonly found in the Apurimac valley, between 2500 to 3500 m.

At the south of the Huamanga Valley frogs and tadpoles of a species allied to the *Telmatobius jelskii* were found in a small stream near KP 92+500, indicating high conservation status, as frogs of the genus *Telmatobius* are highly sensitive to environmental degradation.

Hydrobiology

Table 13.7 presents waterbodies sampled along ELU 6. One genus, *Orestias* was found.

Table 13.7. Waterbodies Sampled – ELU 6

Station	Habitat	Waterbody	Name	Height (masl)	KP	Species
Hi-24	Altoandino	Laguna	Choccehuacgra	4144	95+500	<i>Orestias sp.</i>
Hi-25	Altoandino	Bofedal	Chaquicocha	4053	92+200	
Hi-26	Altoandino	Bofedal	Achcacruz Orcco	3997	85+500	
Hi-27	Altoandino	Bofedal	Carimayo	4103	80+800	

13.3.3 SPECIES SENSITIVITY ANALYSIS

Table 13.8 shows the species found during the EFS fieldwork.

Shrubs of Medium Sensitivity present include *Escallonia myrtilloides* and *Parastrephia quadrangularis* which are included in the INRENA Vulnerable category and are very scarce in the ROW and surroundings. Their relocation and translocation should be attempted where practicable.

The rarely observed Andean cat *Leopardus jacobitus* (IUCN/INRENA endangered) was sighted in this ELU by the EFS field team. The area has importance for the production of the vicuña (*Vicugna vicugna*), a semi-wild relative of the llama with highly-valued wool and a member of the camelid family. *Telmatobius* frogs and the killifish (*Orestias sp.*) are found in some of the small streams within the ELU, indicating high-quality habitat, uncontaminated water.

Lizards (*Liolaemus sp.*), another Medium Sensitivity species, were observed in grassland habitats across the ELU.

Table 13.8. Species Sensitivity Criteria - ELU 6

No	Species	Protection Status						Spatial Distribution			Local Use			Mobility		Σ
		CR	EN	VU	NT	L	N	Local	Regional	Widespread	Permanent	Seasonal	None	Immobile	Mobile	
	Plants															
1	<i>Aciachne</i> cf. <i>acicularis</i>						0			0			0	3		3
2	<i>Aciachne pulvinata</i>						0		2				0	3		5
3	<i>Austrocylindropuntia floccosa</i>						0			0			0	3		3
4	<i>Azorella</i> sp.						0			0			0	3		3
	<i>Baccharis</i> spp.						0			0	2			3		5
5	<i>Calamagrostis</i> cf. <i>vicunarium</i>						0			0	2			3		5
7	<i>Erigeron</i> sp.						0			0			0	3		3
8	<i>Escallonia myrtilloides</i>			4					2	0			0	3		9
	<i>Festuca</i> sp.						0			0	2			3		5
9	<i>Gamochaeta</i> sp.						0			0			0	3		3
10	<i>Gentiana sedifolia</i>						0			0			0	3		3
11	<i>Hypochaeris</i> sp.						0			0			0	3		3
	<i>Jarava</i> sp.						0			0	2			3		5
12	<i>Juncus</i> cf. <i>bufonius</i>						0			0			0	3		3
13	<i>Lachemilla pinnata</i>						0		2				0	3		5
14	<i>Lysipomia</i> sp.						0			0			0	3		3
4	<i>Muhlenbergia</i> sp.						0			0	2			3		5
16	<i>Novenia acaulis</i>						0		2				0	3		5
17	<i>Oreithales integrifolia</i>						0			0			0	3		3
18	<i>Oreomyrrhis andicola</i>						0		2				0	3		5
19	<i>Parastrephia quadrangularis</i>			4				3		0			0	3		10
21	<i>Plantago tubulosa</i>						0			0			0	3		3
22	Poaceae						0			0			0	3		3
23	<i>Scirpus</i> cf. <i>rigidus</i>						0			0	2		0	3		5
24	<i>Stipa</i> sp.						0			0	2			3		5
25	<i>Viola pygmaea</i>						0		2				0	3		5
26	<i>Werneria nubigena</i>						0			0			0	3		3
	Fish															
27	<i>Orestias</i> sp.						0		2		2		0	3		7
	Reptiles and Amphibian															
28	<i>Liolaemus</i> sp.						0	3					0	3		6

29	<i>Telmatobius</i> sp.			4				3					0	3		10
	Mammals															
30	<i>Conepatus chinga</i>					0				0			0		0	0
31	<i>Leopardus (Oreailurus) jacobitus</i>		5					2					0		0	7
32	<i>Leopardus (Oreailurus) pajeros</i>					0		2					0		0	2
33	<i>Mustela frenata</i>									0			0		0	0
34	<i>Odocolleus virginianus</i>									0			0		0	0
35	<i>Phyllotis cf. xanthopygus posticalis</i>					0	3				2				0	5
36	<i>Puma concolor</i>				3					0			0		0	3
37	<i>Thylamys pallidior</i>									0	2				0	2
38	<i>Vicugna vicugna</i>		5							0	2				0	7
	Birds												0			0
39	<i>Aeronautes andecolus</i>					0				0			0		0	0
40	<i>Aglaeactis cupripennis</i>					0				0			0		0	0
41	<i>Amazilia amazilia</i>					0				0			0		0	0
42	<i>Anas flavirostris</i>					0				0			0		0	0
43	<i>Anas puna</i>					0		2			1				0	3
44	<i>Anthus furcatus</i>					0		2					0		0	2
45	<i>Asthenes humilis</i>					0		2					0		0	2
46	<i>Carduelis magellanica</i>					0				0			0		0	0
47	<i>Catamenia analis</i>					0				0			0		0	0
48	<i>Chloephaga melanoptera</i>					0		2			2				0	4
49	<i>Cinclodes atacamensis</i>					0		2					0		0	2
50	<i>Cinclodes fuscus</i>					0		2			2				0	4
54	<i>Geositta cunicularia</i>					0		2					0		0	2
55	<i>Geositta punensis</i>					0		2					0		0	2
56	<i>Geositta saxicolina</i>					0		2					0		0	2
57	<i>Hirundo rustica</i>					0				0			0		0	0
58	<i>Larus serranus</i>					0				0			0		0	0
59	<i>Muscisaxicola cinereus</i>					0		2					0		0	2
60	<i>Muscisaxicola maculirostris</i>					0				0			0		0	0
61	<i>Phrygilus alaudinus</i>					0				0			0		0	0

Protection Status*: CR= Critically endangered 6 points EN= Endangered 5 points VU= Vulnerable 4 points NT= Near threatened 3 points B= Low (Others) 2 points N= Not listed 0 points Σ= Sensitivity value 1 - 5: Low 6 - 10: Medium 11 or higher: High	Species Distribution: Local = (Endemic locally or to an EBA**) 3 points Regional = (Regional endemic in Andes or Coast) 2 points Widespread = (Across S. America or cosmopolitan) 0 points Mobility: Immobile = (restricted movement or in very short distance) 3 points Mobile = 0 points	Local Uses: Permanent= 2 points Seasonal = 1 point None = 0 points
*Protection Status: According IUCN (2006) or National Legislation (D.S. No. 034-2004-AG/D.S. No. 043-2005-AG) **EBA: Areas determined by Birdlife International, which includes at least 2 bird species with less than 50,000 km² of known distribution range.		

13.3.4 HABITAT SENSITIVITY ANALYSIS

Based on the presence of medium sensitivity species presented in Table 13.8 the Tussock Grassland of the Huamanga Vischongo Watershed Divide ELU is considered to be of Medium Sensitivity due to the presence of four Medium Sensitivity animal species. None of the other habitats in this ELU meet the criteria for a high or medium sensitivity habitat as described in Section 7.2 of these EFS.

13.4 KEY ISSUES AND RECOMMENDATIONS

Soils

Standard topsoil stripping and protection measures should be applied to all areas.

Waterbodies and Wetlands

Waterbodies are near to or crossed by the ROW at KPs 80+800, 84+000, 85+500, 92+200, and 92+500. Buffer zones should be retained at watercourse crossings and erosion controls installed and maintained, especially during the rainy season to prevent erosion and watercourse inundation with sediments.

Several peat bogs are present between KP 79+669 and KP 101+384.

Physical Risk

The Huamanga-Vischongo Divide ELU has no zones categorized as having High physical risk and less than 700 m of ROW length are categorized as Medium risk. Standard erosion controls should be maintained in these areas during the construction phase.

Habitats and Species

There are 5 threatened species reported in this ELU and 7 medium sensitivity species. The *Escallonia* and *Parastrephia* plants are sensitive species responsive to management practices. The Andean mountain cat (*Leopardus jacobitus*) and the camelid Vicuna (*Vicugna vicugna*) are both sensitive. Felids usually avoid human presence and are highly unlikely to be affected by site clearance and construction activities. Vicunas should be treated with special measures because of their social economic importance to minimize the risk of harm. Specific measures will be set out in the Ecological Management Plan and summarized in Table 13.9.

Waterbodies should be monitored because they are environmentally important to maintain *Telmatobius* frog populations. Frogs and tadpoles should be removed during crossings activities and relocated to a suitable unaffected location upstream if identified at the time of watercourse crossing pipeline installation. Erosion control and pollution prevention good practice should be adopted at watercourses.

Table 13.9 summarizes the key issues and recommendations for Huamanga-Vischongo Watershed Divide ELU.

Table 13.9. Key Issues and Recommendations - ELU 6

Issue	KP Reference	Action	Related to
River and stream crossings. Protection of killifish (<i>Orestias sp.</i>)	80+800, 84+000, 85+500, 92+200, and 92+500.	Ditch in dry season if possible and use best practice crossing techniques to minimize turbidity and hydrocarbon contamination.	ECOMP
Vicunas	103+000	Fencing, participative management and other specific protection measures, such as worker training, signage, speed controls, waste management and fauna crossing points left in trench and pipe string. Consultation with local community farmers.	ECOMP
Shrubs (<i>Escallonia myrtilloides</i> and <i>Parastrephia quadrangularis</i>)	Grassland habitats and cultivated areas	Translocation of individual shrubs if practicable prior to site clearance. Or alternatively planting of new shrubs from cuttings or seed collection as part of bioreinstatement programme.	ECOMP/RP
Reptiles – lizard (<i>Liolaemus sp.</i>) and and Water frog (<i>Telmatobius sp.</i>)	Grassland habitats	Pre-clearance Survey to identify and relocate from ROW prior to site clearance activities.	ECOMP
Peat bogs habitat	Several along KP 80+884 to KP 101+384	Relocation of plants and removal and storage of topsoil before construction.	ECOMP
		Restoration of topsoil and plants during reinstatement.	RP

Source: EFS Fieldwork

14.0 ELU 7: VINCHOS RIVER VALLEY (KP 103+970 TO 117+388)

14.1 GENERAL DESCRIPTION

The Vinchos River Valley is another largely cultivated valley landscape, with relict patches of resinous scrubland and perennial woodland, also part of the Mantaro basin as is the Yucay River Valley.

The climate is warm but dry and has elevations between 3,200 and 4,000 m. Mean annual precipitation ranges from 600 to 800 mm per year, with higher amounts on the higher eastfacing slopes. This ELU includes the small settlements of Urpaypampa, Mayopampa and Sallalli.

Colluvial and volcanic soils dominate both sides of the Vinchos River Valley from KP 104+000 to 105+000, which are very sensitive to erosion and landslides. Cropping systems with potato and other crops are predominant and so in the valley areas the level of fertility is from medium to high due to the use of fertilizers. The colluvial unstable area is of low fertility and low levels of phosphorous represent a problem.

The ELU has only 3 habitat types, of which cultivated areas represents 89.89% of the ROW length.

14.2 PHYSICAL CHARACTERISTICS

14.2.1 PRECIPITATION

Precipitation is highly seasonal. The wet season is from January to March, and is known locally as the “winter” or rainy season, even though it actually corresponds with the climatologically-defined austral summer. The dry season extends from April to December. Table 14.1 shows precipitation values for each season.

Table 14.1. Precipitation - ELU 7

Estimated Precipitation (mm)			
Peak (January - March)		General (September - April)	
KP Range	Precipitation (mm)	KP Range	Precipitation (mm)
103+970 - 107+000	300 - 400	103+970 - 109+000	600 - 700
107+000 - 117+388	400 - 500	109+000 - 117+388	700 - 800

Source: ESIA, Environmental Baseline

14.2.2 GEOLOGY

East of the Vinchos River, from KP 106+000 to 110+000, the ELU is dominated by intrusive complexes with pink-gray granites of granular texture that are highly fractured at the surface. To the west of the river, the landscape is formed from volcanic rocks with little resistance to erosion, as evidenced by the highly eroded rocks at KP 116+000. Despite the generally gentle topography, small rockfalls can occur on the slopes.

14.2.3 SOILS

Soil pH is moderately to strongly acid.

Surface Horizon Characteristics

Surface horizon has a medium depth along the ELU, with low to medium organic matter content. The terrain is mostly flat over large sectors, but with some very steep areas, as shown in Table 14.2. The surface horizon have low levels of available phosphorus in most of the ELU as shown in Table 14.2.

Subsoil Characteristics

The Subsoil has a loamy sand texture, coarser than the sandy loam texture of the surface horizon, and will not affect the movement of water. These layers are very loose and the aggregates are of low stability. Organic matter and nutrients are low in the Subsoil.

Table 14.2. Surface Horizon Characteristics - ELU 7

KP	pH	Surface horizon depth	Organic matter	Fertility	Slope (%)
108+000	Moderately acid	Medium	Medium	Medium	8–10%
111+000	Strongly acid	Medium	Medium	High	30%
114+000	Strongly acid	Medium	Medium	Low	10%
116+000	Strongly acid	High	Low	Low	15-60%
117+000	Strongly acid	Medium	Medium	Low	45%

Source: ESIA, Environmental Baseline and Domus.

pH: Strongly acid = Less than 5.5; Moderately acid = 5.6 to 6.0; Slightly acid = 6.1 – 6.5; Neutral = 6.6 - 7.0; Slightly alkaline = 7.1 – 7.8; Moderately alkaline = 7.9 to 8.4; Strongly alkaline = 8.5 or greater.

Surface horizon depth: Low = Less than 5 cm; Medium = 5 cm to 15 cm; High = More than 15 cm.

Organic matter: Low = Less than 2%; Medium = 2% to 4%; High = More than 4%.

Fertility based on Available Phosphorus: Low = Less than 7.0 ppm; Medium = 7.0 to 14.0 ppm; High = More than 14.0 ppm.

14.2.4 WATERBODIES AND WETLANDS

The ROW runs approximately 500 m from Vinchos River, and 200 m from the Moyobamba Stream. The ROW crossings are shown in Table 14.3.

The ROW crosses various streams and the Vinchos River in ELU 7. Also, there are considerable stretches within ELU 7 where the ROW runs more or less parallel to streams on narrow ridge tops from approximately KP 107+000 to 116+100.

Near KP 105+200, the ROW crosses the intermittent Huayjochacha stream above the small settlement of Sallalli, which likely utilizes this stream at least seasonally.

Table 14.3. Principal Waterbody Crossings - ELU 7

Waterbody Type or Name	KP Mid-channel	Elevation (m)
Arroyos		
ARROYO HUAYJOCHACHA	105+317.82	3693.57
ARROYO SECO	112+649.99	3355.13
ARROYO	116+027.48	3565.28

ARROYO	116+029.38	3565.29
ARROYO	116+589.57	3635.18
Quebradas		
QUEBRADA	110+180.42	3180.79
QUEBRADA PISCALAHUAYJO	110+200	3196
QUEBRADA JATUNPAMPAHUAYCCO	111+584.73	3168.81
QUEBRADA SECA JATUNPAMPAHUAYCCO	112+600	3368
Rivers		
RIO VINCHOS	110+682.68	3166.93

Source: Peru LNG Pipeline Project Alignment Sheets (Gulf Interstate Engineering, 2006).

14.2.5 *INSTABILITY AND PHYSICAL RISK*

High physical risk sectors comprise 55.1% of the ROW length in the Vinchos River Valley ELU, followed by Low risk at 28.7% and Medium risk at 16.2%.

Table 14.4 shows distribution of the physical risk categories.

Table 14.4. Physical Risk - ELU 7

Risk Level	KP Start	KP Finish	Length (m)	
Low	105+710	107+705	1,995	3,853
	109+639	111+135	1,496	
	117+038	117+400	362	
Medium	103+970	104+00	30	2,175
	104+000	105+000	1,000	
	115+893	117+038	1,145	
High	105+000	105+710	710	7,402
	107+705	109+639	1,934	
	111+135	115+893	4,758	

Source: ESIA, Environmental Baseline

14.2.6 INFRASTRUCTURE

A base camp and a pipe yard are proposed to be installed near the Vinchos River approximately 3 km south of KP 109 at a location used for this purpose during the construction of a previous regional pipeline. Table 14.5 shows infrastructure information.

Table 14.5. Planned Project Infrastructures – ELU 7

Type of Infrastructure	KP	Name	Action	Related to
Camps	106+803	Central Vinchos	Topsoil stripping, depending on existing site conditions	ECOMP/RP
Pipe Yards	106+803	Vinchos	Topsoil stripping and reinstatement	ECOMP/RP

Source: ESIA, Project Description

14.3 HABITATS AND SPECIES

14.3.1 HABITAT DISTRIBUTION

The habitats of ELU 7 are listed in sequential order in Table 14.6, including the length of each habitat unit as well as the associated start and finish ROW KPs. Table 17.7 presents habitat lengths over the ROW sorted by habitat type, with subtotals for each habitat.

Table 14.6. Habitat Sequence – ELU 7

Habitat Type	Length (m)	KP Start	KP Finish
Tussock grassland	198	103+970	104+168
Cultivated Areas	7,072	104+168	111+240
Resinous scrub	586	111+240	111+826
Cultivated Areas	590	111+826	112+416
Resinous scrub	380	112+416	112+796
Cultivated Areas	3,055	112+796	115+851
Resinous scrub	192	115+851	116+043
Cultivated Areas	1,345	116+043	117+4388

Table 14.7. Habitat Summary – ELU 7

Habitat Type	Length (m)	KP Start	KP Finish
Cultivated Areas	7,072	104+168	111+240
	590	111+826	112+416
	3,055	112+796	115+851
	1,345	116+043	117+400
Total	12,062	89.89%	
Resinous scrub	586	111+240	111+826
	380	112+416	112+796
	192	115+851	116+043
Total	1,158	8.63%	
Tussock grassland	168	104+000	104+168
Total	198	1.48%	
Total ELU 7:	13,418		

Source: ESIA, Environmental Baseline and Domus.

14.3.2 HABITAT DESCRIPTIONS

Cultivated Areas

Cultivated areas cover approximately 90% of the Vinchos River Valley ELU. Species of biological interest sometimes appear within the mosaic of cultivated areas, forming thickets and living fences, or living in the middle of cultivated areas including the Andean endemic cacti *Austrocylindropuntia floccosa* and *Oroya peruviana*.

Resinous Scrub

This habitat occurs over about 8.6% of the Vinchos River Valley ELU, representing small remnants of the original vegetation cover. These areas have an occasional presence of *Escallonia myrtilloides*, an INRENA-listed vulnerable species. Within this habitat type, there are areas with columnar cacti with the presence of the *Austrocylindropuntia subulata*, *Oroya peruviana* (regional endemic) and *Echinopsis peruviana puquiensis* (INRENA-vulnerable).

Tussock Grassland

Tussock grasslands are limited to only about 1.5% of ELU 7 and only at the transition to the Huamanga-Vischongo Watershed Divide ELU. This habitat type is largely covered by

grasses. Shrubs present include *Escallonia myrtilloides*, listed as vulnerable by the INRENA.

Key Fauna

Despite its domination by cultivated areas, the Vinchos River Valley ELU is an area with numerous uncommon species of birds, and where the bearded mountaineer (*Oreonympha nobilis*) is also found. Some other birds are the hummingbirds known as green-tailed trainbearers (*Lesbia nuna*), bare-faced ground-doves (*Metriopelia ceciliae*), and Andean flickers (*Colaptes rupicola*).

Hydrobiology

Table 14.8 presents waterbodies sampled along ELU 7. The species *Trichomycterus sp.*, was described in one of the stations (Hi-22).

Table 14.8. Waterbodies Sampled – ELU 7

Station	Habitat	Waterbody	Name	Height (masl)	KP	Species
Hi-22	Interandino	Río	Vinchos	3157	110+500	<i>Trichomycterus sp.</i>
Hi-23	Interandino	Quebrada	Urpaypampa	3210	110+000	

14.3.3 SPECIES SENSITIVITY ANALYSIS

Table 14.9 shows the sensitive species found during the EFS fieldwork.

Medium Sensitivity shrubs present include *Escallonia myrtilloides* and the cactus *Echinopsis peruviana ssp. Puquiensis* (INRENA – Vulnerable). Their relocation and translocation should be attempted.

The cacti, *Oroya peruviana*, is also considered to be of Medium Sensitivity. The Andean catfish (*Trichomycterus sp*) observed in the Vinchos River is also considered to be of Medium Sensitivity because of its limited local distribution and permanent local use.

Table 14.9. Species Sensitivity Criteria- ELU 7

No	Species	Protection Status						Spatial Distribution			Local Use			Mobility		Σ
		CR	EN	VU	NT	L	N	Local	Regional	Widespread	Permanent	Seasonal	None	Immobile	Mobile	
	Plants															
1	<i>Austrocylindropuntia floccosa</i>						0			0			0	3		3
2	<i>Austrocylindropuntia subulata</i>						0		2			0		3		5
3	<i>Echinopsis peruviana</i> ssp. <i>puquiensis</i>			4				3						3		10
4	<i>Escallonia myrtilloides</i>			4					2	0			0	3		9
	<i>Oroya peruviana</i>						0	3					0	3		6
	Fishes															
	<i>Trichomycterus rivulatus</i>						0	3			2		0	3		8
	Mammals															
7	<i>Oligoryzomys</i> cf. <i>destructor</i>						0			0			0		0	0
8	<i>Phyllotis amicus</i>						0			0			0		0	0
	Birds															
9	<i>Anairetes flavirostris</i>						0			0			0		0	0
10	<i>Anairetes reguloides</i>						0		2				0		0	2
11	<i>Carduelis magellanica</i>						0			0			0		0	0
12	<i>Catamenia analis</i>						0			0			0		0	0
13	<i>Catamenia inornata</i>						0			0			0		0	0
14	<i>Cinclodes fuscus</i>						0		2		2				0	4
15	<i>Colaptes rupicola</i>						0			0			0		0	0
16	<i>Diglossa brunneiventris</i>						0			0			0		0	0
17	<i>Falco sparverius</i>						0			0			0		0	0
18	<i>Geranoaetus melanocephalus</i>						0			0			0		0	0
19	<i>Leptotila verreauxi</i>						0			0			0		0	0
20	<i>Lesbia nuna</i>						0		2		2				0	4
21	<i>Metallura phoebe</i>						0		2		2				0	4
22	<i>Metriopelia ceciliae</i>						0		2				0		0	2
23	<i>Muscisaxicola maculirostris</i>						0			0			0		0	0
24	<i>Ochthoeca frontalis</i>						0		2				0		0	2
25	<i>Ochthoeca leucophrys</i>						0		2				0		0	2
26	<i>Oreonympha nobilis</i>						0	3					0		0	3
27	<i>Phrygilus fruticeti</i>						0			0			0		0	0

28	<i>Phrygilus punensis</i>					0		2				0		0	2
29	<i>Pterophanes cyanopterus</i>					0		2				0		0	2
30	<i>Sicalis sp.</i>					0			0			0		0	0
31	<i>Thraupis bonariensis</i>					0			0			0		0	0
32	<i>Thraupis cyanocephala</i>					0			0			0		0	0
33	<i>Troglodytes aedon</i>					0			0			0		0	0
34	<i>Turdus serranus</i>					0			0			0		0	0
35	<i>Zonotrichia capensis</i>					0			0			0		0	0

Protection Status*:

CR= Critically endangered 6 points
 EN= Endangered 5 points
 VU= Vulnerable 4 points
 NT= Near threatened 3 points
 B= Low (Others) 2 points
 N= Not listed 0 points

Σ= Sensitivity value

1 - 5: Low

6 - 10: Medium

11 or higher: High

Species Distribution:

Local = (Endemic locally or to an EBA**) 3 points
 Regional = (Regional endemic in Andes or Coast) 2 points
 Widespread = (Across S. America or cosmopolitan) 0 points

Mobility:

Immobile = (restricted movement or in very short distance) 3 points
 Mobile = 0 points

Local Uses:

Permanent= 2 points
 Seasonal = 1 point
 None = 0 points

***Protection Status:** According IUCN (2006) or National Legislation (D.S. No. 034-2004-AG/D.S. No. 043-2005-AG)

****EBA:** Areas determined by Birdlife International, which includes at least 2 bird species with less than 50,000 km2 of known distribution range.

14.3.4 HABITAT SENSITIVITY ANALYSIS

Based on the presence of medium sensitivity species presented in Table 14.9 the Cultivated Areas of the Vinchos River Valley ELU is considered to be of Medium Sensitivity due to the presence of three Medium Sensitivity plant species and one Medium Sensitivity animal species. None of the other habitats in this ELU meet the criteria for a high or medium sensitivity habitat as described in Section 7.2 of these EFS.

14.4 KEY ISSUES AND RECOMMENDATIONS

Soils

Some areas present some favorable conditions to restoration, as the stretch from KP 107+000 to KP 111+000, but in other areas the steeper slopes and low fertility are potential restrictions to natural regeneration of plants, during reinstatement.

Taking into account precipitation levels and the erodibility of the volcanic substrates to west of the Vinchos River, erosion controls should be implemented and maintained, especially in highly unstable areas set out in Table 14.4. During construction, erosion control devices as silt fences, slope breakers and wooden barriers must be implemented and the topsoil protected with geojute and revegetation.

Waterbodies and Wetlands

The ROW crosses the Vinchos River and tributary streams at several points in this ELU. Also the ROW runs parallel to and upslope of various streams in this ELU. Many of the crossings and places where the ROW is near waterbodies are areas mapped as having High Physical Risk. Therefore, waterbody protection is a key issue in the Vinchos River Valley ELU. Recommendations include scheduling crossings during the dry season using best practice techniques to minimize turbidity, river bank protection, erosion and sedimentation controls, and surface water quality monitoring during construction.

Infrastructure

A camp and a pipe storage yard are proposed to be installed near the Vinchos River. The selected location was used of this purpose in the past and is not a greenfield development.

Physical Risk

Low risk sectors will not require special restoration works, but Medium and High risk sectors will require detailed site review to determine if special restoration measures,

including fertilizers application and hydroseeding are appropriate during reinstatement to enhance revegetation.

Habitat and Species

The Vinchos River Valley is less diverse in habitats than other ELUs. It is mainly covered by cultivated areas.

Two medium sensitivity cactus species, *Echinopsis peruviana spp.* and Oroya peruviana, and the medium sensitivity shrub *Escallonia myrtilloides* are located in the higher parts of the ELU. Cactus plants lost during ROW clearance could be replaced by new plants established during the biorestoation phase after the completion of construction.

The Vinchos River contains a sensitive population of the Andean catfish (shrimp). *Trichmycterus rivulatus*, that could potentially be affected by works in the river during pipeline crossing installation.

Table 14.10 summarizes the key issues and recommendations.

Table 14.10. Key Issues and Recommendations - ELU 7

Issue	KP Reference	Action	Related to
Risk of mass wasting in Medium and High physical risk sectors	106+200 – 106+900	Install and maintain erosion controls especially during the rainy season.	ECOMP / RP
	107+900 – 111+600	Topsoil strip and protection during construction.	ECOMP / RP
	113+200 – 117+388	Possible extra biorestoreation techniques (hydroseeding, mulch and fertilizer applications) during reinstatement in highest risk areas areas	ECOMP / RP
ROW crossings and proximity to the Vinchos River and other streams (Protection of Andean catfish <i>Trichomycterus rivulatus</i> in Vinchos River)	110+500	River bank protection and erosion/sedimentation controls. Water quality monitoring during construction. Pollution prevention best practices and best practice crossing techniques to	ECOMP/RP

		minimize turbidity	
Cactus (<i>Echinopsis peruviana</i> spp. and <i>Oroya peruviana</i>) and Shrub (<i>Escallonia myrtilloides</i>)	Resinous scrub	Plants lost during ROW clearance works to be replaced by new plants during biorestore	ECOMP/RP

Source: EFS Field Work.

15.0 ELU 8: APACHETA HIGH SIERRAS (KP 117+388 TO 162+137)

15.1 GENERAL DESCRIPTION

In ELU 8, the ROW runs essentially from east to west over a series of high ridges with elevations ranging from 3,841 to 4,900 m in a landscape of scarcely vegetated zones, sward-forming grassland, peat bogs and tussock grassland.

The climate is cold and dry. The Maximum precipitation reaches 1000mm, on higher altitudes. This unit includes the Rural Communities of Occollo Azabran, Paccha, Churia and Rosaspampa.

This high area is subject to snow. Predominance of volcanic rock with high slopes greater than 60% but very stable because of its rocky (Granite) formation with no topsoil.

This ELU has 6 habitat types. The largest habitat type, the Scarcely Vegetated High Andean Area, represents 39.26% of the ELU length and the smallest one, Resinous scrub, 0.34%. The six habitat types are very fragmented. Tables 18.8 and 18.9 show the habitat types that comprise this ELU.

West of the Vinchos River Valley, the ROW runs essentially from east to west over a series of ridges (3,840 to 4,900 m). This high Andean landscape dominated by high areas is subject to seasonal snow, primarily in June to July, but occasionally in all other months. While largely very sparsely vegetated, this ELU contains sensitive plant species such as *Ephedra americana* (INRENA near-threatened), *Escallonia myrtilloides* (INRENA vulnerable), *Oroya peruana* (regional endemic), *Perezia coerulescens* (INRENA vulnerable), and *Perezia pinnatifida* (INRENA vulnerable). Of particular note, a potentially new species of *Ribes* (currant or gooseberry) was collected by the EFS field team. This sparsely populated area harbors populations of sensitive mammals such as pumas or mountain lions, Andean cats (*Leopardus jacobitus*), and vicuñas. While not observed by the EFS team, the ESIA reported sightings of the IUCN-endangered/INRENA-critically-endangered white-bellied cinclodes (*Cinclodes palliatus*), a bird endemic to high-Andean wetlands of central Peru.

15.2 PHYSICAL CHARACTERISTICS

15.2.1 *PRECIPITATION*

Precipitation has two very different seasons. The peak rain period is from January to March and is locally known as winter or rainy season (Wet Season) and the period of lesser precipitation from April to December known as the Dry Season. Table 15.1 shows precipitation values during both seasons.

Table 15.1. Precipitation - ELU 8

Estimated Precipitation (mm)			
Peak (January - March)		General (September - April)	
KP Range	Precipitation (mm)	KP Range	Precipitation (mm)
117+388 - 162+137	400 - 500	117+388 - 161+000	700 - 800
		161+000 - 162+137	800 - 1000

Source: ESIA, Environmental Baseline

Seasonal precipitation will influence the design of temporary erosion control measures and revegetation program along the RoW after construction completion.

15.2.2 *GEOLOGY*

The geological formations of the Apacheta High Sierras ELU are principally limestones interspersed in places with lutites, forming rugged mountains. Its rocks have been affected by karstic processes although the surface is little altered. The metallic mineralization present in certain areas of these rocks, visible at the surface as strongly colored bare soil with little vegetation, implies a risk of acid rock drainage (ARD).

There are local andesitic effusions, tuff and breccias, which result in an abundance of pyrite in the layers of this formation and also an increased risk of acid drainage.

Locally, there are Pleistocene glacial and fluvioglacial deposits, including moraines.

Table 15.2 shows the area with potential risk of acid rock drainage occurrence in the ROW, caused by construction phase activities.

Table 15.2. Risk of ARD – ELU 8

Risk of Generation ARD	Length (m)		Action	Related to
High Risk	KP 145+000 to KP 175+000	30,000	Isolate stockpiled material from waterbodies. Use geomembranes where practicable. Embankments and ditches to divert ARD away from sensitive watercourses and habitats. Water quality monitoring during rainy season.	ECOMP

Source: ESIA, Environmental Baseline.

15.2.3 SOILS

Soil pH is generally strongly acidic in the Apacheta High Sierras ELU, with a slightly alkaline sample collected at KP 155+000.

Surface Horizon Characteristics

Surface horizon of medium to high depth throughout ELU 8, despite the variable slope. Organic matter content is mostly low in most soil except in Kp 131 and 135 that presented high levels in a very deep topsoil.

Subsoil Characteristics

The sandy Subsoils will not affect the movement of water because both effective horizons (A and B) are well drained. Organic matter and nutrient levels are lower in the Subsoil.

Fertility, based on available phosphorus, is medium to high, as it can be seen in Table 15.3.

Table 15.3. Surface Horizon Characteristics - ELU 8

KP	pH	Surface horizon depth	Organic matter	Fertility	Slope (%)
120+000	Strongly acid	Medium	High	Medium	20%
130+000	Strongly acid	Medium	Medium	High	10%
131+000	Strongly acid	High	High	Medium	10-15%
134+000	Strongly acid	Medium	Low	High	30%
135+000	Strongly acid	medium	High	Medium	15%
140+000	Strongly acid	Medium	Medium	Medium	20%
145+000	Strongly acid	Medium	Low	High	15%
150+000	Strongly acid	Medium	Low	High	15%
155+000	Slightly alkaline	Medium	Low	Medium	35%
160+000	Strongly acid	Medium	Low	Medium	30%

Source: ESIA, Environmental Baseline and Domus.

pH: Strongly acid = Less than 5.5; Moderately acid = 5.6 to 6.0; Slightly acid = 6.1 – 6.5; Neutral = 6.6 - 7.0; Slightly alkaline = 7.1 – 7.8; Moderately alkaline = 7.9 to 8.4; Strongly alkaline = 8.5 or greater.

Surface horizon depth: Low = Less than 5 cm; Medium = 5 cm to 15 cm; High = More than 15 cm.

Organic matter: Low = Less than 2%; Medium = 2% to 4%; High = More than 4%.

Fertility based on Available Phosphorus: Low = Less than 7.0 ppm; Medium = 7.0 to 14.0 ppm; High = More than 14.0 ppm.

15.2.4 WATERBODIES AND WETLANDS

The ROW crosses the Churiac River at KP 147+500, and passes close to 5 lagoons (Yanacocha II, Challhuacocha, and three unnamed). It runs parallel Quebrada Chojehuaray from KP127+000 to 129+200.

The ROW is located next to Antacocha Stream near 149+500, 135 m away from Soytusoytu bog near KP 135+000, and 75 m away from Yaurilla peat bog near KP 162+000.

ELU 8 presents a wide distribution of peat bogs which the ROW crosses or passes nearby especially between KP 121+000 to 158+000.

The principal waterbody crossings are shown in Table 15.4

Table 15.4. Principal Waterbody Crossings - ELU 8

Waterbody Type or Name	KP Mid-channel	Elevation (m)
Quebradas		
QUEBRADA PANPANCCAHUAYCCO	123+574.17	3875.25
QUEBRADA	123+609.60	3875.75
QUEBRADA PANPANCCAHUAYCCO	124+250	3924
QUEBRADA CHOJEHUARAY	127+051.25	4030.38
QUEBRADA CHOJEHUARAY	129+200	4242
QUEBRADA	143+986.39	4648.04
QUEBRADA	146+824.23	4690.46
QUEBRADA	147+502.04	4571.05
QUEBRADA	147+824.09	4497.07
QUEBRADA	148+924.68	4575.86
QUEBRADA	149+109.05	4570.61
QUEBRADA	149+234.78	4551.74
QUEBRADA ANTACocha	149+540.40	4521.87
QUEBRADA	149+603.20	4522.91
QUEBRADA	149+769.55	4517.67
QUEBRADA	151+777.30	4677.20
Estero		
ESTERO	129+241.68	4233.28

Source: Peru LNG Pipeline Project Alignment Sheets (Gulf Interstate Engineering, 2006).

15.2.5 INSTABILITY AND PHYSICAL RISK

The Apacheta High Sierras comprise a stable landscape, with 95.33% of the ROW length falling into the Low physical risk category, 1.61% in the Medium risk category, and 3.04% in the High risk category, can be derived from the data presented in Table 15.5.

Table 15.5. Physical Risk - ELU 8

Risk Level	KP Start	KP Finish	Length (m)	
Low	117+400	122+708	5,308	42,651
	123+430	131+172	7,742	
	131+355	131+392	37	
	131+665	131+733	68	
	132+641	162+137	29,496	
Medium	122+708	123+430	722	722
High	131+172	131+355	183	1,364
	131+392	131+665	273	
	131+733	132+641	908	

Source: ESIA, Environmental Baseline and Domus.

15.2.6 INFRASTRUCTURE

The construction of a Base camp is proposed near KP 127+248 Ocollo 2, with lodging capacity for 300 people. Also there are 9 proposed shooflies in ELU 8 as shown in Table 15.6.

Table 15.6. Planned Project Infrastructures – ELU 8

Type of Infrastructure	KP	Name	Action	Related to
Camps	127+248	Ocollo 2	Topsoil Protection	ECOMP/RP
Shooflies	142+075	V187 to V191	Topsoil protection / Erosion control devices and slope revegetation Reinstatement to include compaction relief, topsoil respreading and revegetation using native or naturalized species typical of the surrounding area	ECOMP/RP
	144+415	V180 to V181	Topsoil protection / Erosion control devices and slope revegetation Reinstatement to include compaction relief, topsoil	ECOMP/RP

			respreding and revegetation using native or naturalized species typical of the surrounding area	
	147+202	V168 to V169	Topsoil protection / Erosion control devices and slope revegetation Reinstatement to include compaction relief, topsoil respreding and revegetation using native or naturalized species typical of the surrounding area	ECOMP/RP
	148+549	V166 to V167	Topsoil protection / Erosion control devices and slope revegetation Reinstatement to include compaction relief, topsoil respreding and revegetation using native or naturalized species typical of the surrounding area	ECOMP/RP
	149+299	NN	Topsoil protection / Erosion control devices and slope revegetation Reinstatement to include compaction relief, topsoil respreding and revegetation using native or naturalized species typical of the surrounding area	ECOMP/RP
	149+502	Shoe Fly to Km. 57.5	Topsoil protection / Erosion control devices and slope revegetation Reinstatement to include compaction relief, topsoil respreding and revegetation using native or naturalized species typical of the surrounding area	ECOMP/RP
	150+142	V161 to V165	Topsoil protection / Erosion control devices and slope revegetation Reinstatement to include compaction relief, topsoil respreding and revegetation using native or naturalized species typical of the surrounding area	ECOMP/RP
	157+750	V127 to V132	Topsoil protection / Erosion control devices and slope revegetation	ECOMP/RP
	159+536	V117 to V119	Reinstatement to include compaction relief, topsoil respreding and revegetation using native or naturalized species typical of the surrounding area	ECOMP/RP

Source: ESIA, Project Description

15.3 HABITATS AND SPECIES

15.3.1 HABITAT DISTRIBUTION

The habitats of ELU 8 are listed in sequential order in Table 15.7, including the length of each habitat unit and associated start and finish ROW KPs. Table 15.8 presents habitat lengths over the ROW sorted by habitat type, with subtotals for each habitat.

Table 15.7. Habitat Sequence – ELU 8

Habitat Types	Length (m)	KP Start	KP Finish
Cultivated Areas	12	117+388	117+400
Tussock grassland	400	117+400	117+800
Resinous Scrub	150	117+800	117+950
Tussock grassland	2446	117+950	120+396
Cultivated Areas	465	120+396	120+861
Sward-forming grassland	1195	120+861	122+056
Peat Bogs	24	122+056	122+080
Sward-forming grassland	92	122+080	122+172
Peat Bogs	71	122+172	122+243
Sward-forming grassland	392	122+243	122+635
Tussock grassland	705	122+635	123+340
Sward-forming grassland	147	123+340	123+487
Peat Bogs	76	123+487	123+563
Sward-forming grassland	616	123+563	124+179
Peat Bogs	11	124+179	124+190
Sward-forming grassland	15	124+190	124+205
Peat Bogs	41	124+205	124+246
Sward-forming grassland	2808	124+246	127+054
Peat Bogs	31	127+054	127+085
Sward-forming grassland	798	127+085	127+883
Peat Bogs	25	127+883	127+908
Sward-forming grassland	1505	127+908	129+413
Peat Bogs	546	129+413	129+959
Sward-forming grassland	439	129+959	130+398
Peat Bogs	153	130+398	130+551
Sward-forming grassland	231	130+551	130+782

Scarcely Vegetated High Andean Areas	605	130+782	131+387
Peat Bogs	39	131+387	131+426
Scarcely Vegetated High Andean Areas	155	131+426	131+581
Peat Bogs	85	131+581	131+666
Sward-forming grassland	339	131+666	132+005
Peat Bogs	22	132+005	132+027
Sward-forming grassland	390	132+027	132+417
Scarcely Vegetated High Andean Areas	486	132+417	132+903
Sward-forming grassland	350	132+903	133+253
Peat Bogs	58	133+253	133+311
Sward-forming grassland	84	133+311	133+395
Peat Bogs	33	133+395	133+428
Sward-forming grassland	57	133+428	133+485
Peat Bogs	103	133+485	133+588
Sward-forming grassland	493	133+588	134+081
Peat Bogs	81	134+081	134+162
Sward-forming grassland	5	134+162	134+167
Tussock grassland	336	134+167	134+503
Peat Bogs	29	134+503	134+532
Sward-forming grassland	249	134+532	134+781
Peat Bogs	24	134+781	134+805
Sward-forming grassland	73	134+805	134+878
Peat Bogs	25	134+878	134+903
Sward-forming grassland	48	134+903	134+951
Peat Bogs	36	134+951	134+987
Sward-forming grassland	76	134+987	135+063
Peat Bogs	26	135+063	135+089
Sward-forming grassland	125	135+089	135+214
Peat Bogs	359	135+214	135+573
Sward-forming grassland	124	135+573	135+697
Tussock grassland	982	135+697	136+679
Sward-forming grassland	77	136+679	136+756
Peat Bogs	21	136+756	136+777
Sward-forming grassland	49	136+777	136+826
Tussock grassland	429	136+826	137+255
Sward-forming grassland	69	137+255	137+324
Peat Bogs	30	137+324	137+354
Sward-forming grassland	22	137+354	137+376
Peat Bogs	63	137+376	137+439

Sward-forming grassland	61	137+439	137+500
Tussock grassland	91	137+500	137+591
Peat Bogs	22	137+591	137+613
Tussock grassland	82	137+613	137+695
Peat Bogs	10	137+695	137+705
Tussock grassland	85	137+705	137+790
Peat Bogs	29	137+790	137+819
Tussock grassland	103	137+819	137+922
Sward-forming grassland	49	137+922	137+971
Peat Bogs	98	137+971	138+069
Sward-forming grassland	16	138+069	138+085
Tussock grassland	242	138+085	138+327
Sward-forming grassland	150	138+327	138+477
Tussock grassland	57	138+477	138+534
Sward-forming grassland	18	138+534	138+552
Peat Bogs	40	138+552	138+592
Sward-forming grassland	12	138+592	138+604
Tussock grassland	368	138+604	138+972
Sward-forming grassland	162	138+972	139+134
Tussock grassland	93	139+134	139+227
Scarcely Vegetated High Andean Areas	3086	139+227	142+313
Sward-forming grassland	137	142+313	142+450
Peat Bogs	150	142+450	142+600
Sward-forming grassland	7	142+600	142+607
Scarcely Vegetated High Andean Areas	969	142+607	143+576
Sward-forming grassland	210	143+576	143+786
Scarcely Vegetated High Andean Areas	463	143+786	144+249
Peat Bogs	138	144+249	144+387
Scarcely Vegetated High Andean Areas	1444	144+387	145+831
Sward-forming grassland	112	145+831	145+943
Scarcely Vegetated High Andean Areas	57	145+943	146+000
Peat Bogs	650	146+000	146+650
Scarcely Vegetated High Andean Areas	563	146+650	147+213
Sward-forming grassland	464	147+213	147+677
Peat Bogs	240	147+677	147+917
Sward-forming grassland	315	147+917	148+232

Scarcely Vegetated High Andean Areas	473	148+232	148+705
Sward-forming grassland	256	148+705	148+961
Scarcely Vegetated High Andean Areas	523	148+961	149+484
Sward-forming grassland	98	149+484	149+582
Peat Bogs	444	149+582	150+026
Sward-forming grassland	35	150+026	150+061
Peat Bogs	37	150+061	150+098
Sward-forming grassland	745	150+098	150+843
Peat Bogs	150	150+843	150+993
Sward-forming grassland	647	150+993	151+640
Scarcely Vegetated High Andean Areas	3267	151+640	154+907
Peat Bogs	33	154+907	154+940
Scarcely Vegetated High Andean Areas	78	154+940	155+018
Peat Bogs	18	155+018	155+036
Scarcely Vegetated High Andean Areas	258	155+036	155+294
Peat Bogs	22	155+294	155+316
Scarcely Vegetated High Andean Areas	215	155+316	155+531
Peat Bogs	5	155+531	155+536
Scarcely Vegetated High Andean Areas	675	155+536	156+211
Peat Bogs	69	156+211	156+280
Scarcely Vegetated High Andean Areas	547	156+280	156+827
Peat Bogs	414	156+827	157+241
Scarcely Vegetated High Andean Areas	429	157+241	157+670
Peat Bogs	46	157+670	157+716
Scarcely Vegetated High Andean Areas	749	157+716	158+465
Peat Bogs	129	158+465	158+594
Scarcely Vegetated High Andean Areas	438	158+594	159+032
Sward-forming grassland	128	159+032	159+160
Peat Bogs	39	159+160	159+199
Sward-forming grassland	102	159+199	159+301
Scarcely Vegetated High Andean Areas	1112	159+301	160+413
Peat Bogs	216	160+413	160+629

Scarcely Vegetated High Andean Areas	548	160+629	161+177
Peat Bogs	41	161+177	161+218
Scarcely Vegetated High Andean Areas	367	161+218	161+585
Peat Bogs	163	161+585	161+748
Sward-forming grassland	328	161+748	162+076
Scarcely Vegetated High Andean Areas	61	162+076	162+137

Table 15.8. Habitat Summary – ELU 8

Habitat Type	Length (m)	KP Start	KP Finish
Scarcely Vegetated High Andean Areas	605	130+782	131+387
	155	131+426	131+581
	486	132+417	132+903
	3086	139+227	142+313
	969	142+607	143+576
	463	143+786	144+249
	1444	144+387	145+831
	57	145+943	146+000
	563	146+650	147+213
	473	148+232	148+705
	523	148+961	149+484
	3267	151+640	154+907
	78	154+940	155+018
	258	155+036	155+294
	215	155+316	155+531
	675	155+536	156+211
	547	156+280	156+827
	429	157+241	157+670
	749	157+716	158+465
	438	158+594	159+032
	1112	159+301	160+413
	548	160+629	161+177
	367	161+218	161+585
	61	162+076	162+137
Total	17568	39.26%	
Sward-forming grassland	1195	120+861	122+056
	92	122+080	122+172
	392	122+243	122+635
	147	123+340	123+487

	616	123+563	124+179
	15	124+190	124+205
	2808	124+246	127+054
	798	127+085	127+883
	1505	127+908	129+413
	439	129+959	130+398
	231	130+551	130+782
	339	131+666	132+005
	390	132+027	132+417
	350	132+903	133+253
	84	133+311	133+395
	57	133+428	133+485
	493	133+588	134+081
	5	134+162	134+167
	249	134+532	134+781
	73	134+805	134+878
	48	134+903	134+951
	76	134+987	135+063
	125	135+089	135+214
	124	135+573	135+697
	77	136+679	136+756
	49	136+777	136+826
	69	137+255	137+324
	22	137+354	137+376
	61	137+439	137+500
	49	137+922	137+971
	16	138+069	138+085
	150	138+327	138+477
	18	138+534	138+552
	12	138+592	138+604
	162	138+972	139+134
	137	142+313	142+450
	7	142+600	142+607
	210	143+576	143+786
	112	145+831	145+943
	464	147+213	147+677
	315	147+917	148+232
	256	148+705	148+961
	98	149+484	149+582
	35	150+026	150+061
	745	150+098	150+843
	647	150+993	151+640

	128	159+032	159+160
	102	159+199	159+301
	328	161+748	162+076
Total	14,920	33.34%	
Tussock grassland	400	117+400	117+800
	2446	117+950	120+396
	705	122+635	123+340
	336	134+167	134+503
	982	135+697	136+679
	429	136+826	137+255
	91	137+500	137+591
	82	137+613	137+695
	85	137+705	137+790
	103	137+819	137+922
	242	138+085	138+327
	57	138+477	138+534
	368	138+604	138+972
	93	139+134	139+227
Total	6,419	14.34%	
Peat bog	24	122+056	122+080
	71	122+172	122+243
	76	123+487	123+563
	11	124+179	124+190
	41	124+205	124+246
	31	127+054	127+085
	25	127+883	127+908
	546	129+413	129+959
	153	130+398	130+551
	39	131+387	131+426
	85	131+581	131+666
	22	132+005	132+027
	58	133+253	133+311
	33	133+395	133+428
	103	133+485	133+588
	81	134+081	134+162
	29	134+503	134+532
	24	134+781	134+805
	25	134+878	134+903
	36	134+951	134+987
	26	135+063	135+089
	359	135+214	135+573
	21	136+756	136+777

	30	137+324	137+354
	63	137+376	137+439
	22	137+591	137+613
	10	137+695	137+705
	29	137+790	137+819
	98	137+971	138+069
	40	138+552	138+592
	150	142+450	142+600
	138	144+249	144+387
	650	146+000	146+650
	240	147+677	147+917
	444	149+582	150+026
	37	150+061	150+098
	150	150+843	150+993
	33	154+907	154+940
	18	155+018	155+036
	22	155+294	155+316
	5	155+531	155+536
	69	156+211	156+280
	414	156+827	157+241
	46	157+670	157+716
	129	158+465	158+594
	39	159+160	159+199
	216	160+413	160+629
	41	161+177	161+218
	163	161+585	161+748
Total	5,215	11.65%	
Cultivated Areas	12	117+388	117+400
	465	120+396	120+861
Total	477	1.07%	
Resinous Scrub	150	117+800	117+950
Total	150	0.34%	
Total ELU 8:	44,749		

Source: ESIA, Environmental Baseline and Domus.

15.3.2 HABITAT DESCRIPTIONS

Scarcely Vegetated High Andean Areas

The Apacheta High Sierras ELU is characterized by extensive zones with no vegetation, and rocky areas, which account for approximately 39.26% of the ROW length. This ELU contains the highest elevation habitats crossed by the RoW, reaching elevations over 4800 m between KP 150 and KP 160 with a maximum elevation over 4900 m at KP 159.

Sward-forming grassland

Sward-forming grasslands cover some 33.34% of the ROW in ELU 8. Dominant species identified are *Aciachne* cf. *acicularis*, *Lachemilla pinnata*, *Pycnophyllum molle* and *Perezia pinnatifida*. Important species for conservation like *Perezia coerulecens*, *P. pinnatifida*, *Ephedra americana* and *Austrocylindropuntia floccosa* were observed. Both *Perezia* species are of vulnerable status according to INRENA. The *Ephedra*, despite its list as near threatened by the INRENA, is quite common along the ROW and the entire region. These grasslands are of importance to local communities as grazing lands for camelids, including llamas, alpacas and vicunas.

Tussock grassland

Tussock-forming grasses of the genera *Calamagrostis*, and *Jarava* characterize about 14.34% of the ROW length in ELU 8. Some *Berberis* bushes were found in this habitat type, along with *Escallonia myrtilloides*.

The relocation and translocation of this last one should be attempted. *Oroya peruviana* is a globular and endemic species that grows in spots at KPs 118+000 and 123+000, Its relocation and translocation is recommended. An important finding was a potential new species of currant or gooseberry (*Ribes* sp.) that was collected in rocky areas near KP 118+800.

Peat Bogs

The Apacheta High Sierras ELU is characterized by a large number of small bogs, occupying about 11.65% of the ELU. However, most of these are passed by rather than directly crossed by the ROW. Only near KP 140+000 and 150+000 are significant bogs crossed by the ROW. All bogs in the area are under high grazing pressure and are therefore in degraded condition. *Distichia muscoides* and *Plantago rigida* cushion plants are common in this habitat type.

Cultivated Areas

Cultivated areas are uncommon in ELU 8 due to the colder climate, accounting for only 1.07% of the ROW length.

Resinous Scrub

The only stand of resinous scrub is at the transition with the Vinchos River Valley ELU. The cactus *Austrocylindropuntia floccosa* was found here.

Key Fauna

In the Apacheta Sierra the endangered Andean mountain cat *Leopardus jacobitus* (IUCN/INRENA-EN) was sighted near KP 156+000. This may be the first confirmed sighting of this species in the Huancavelica Department. Two other felids were registered: the Pampas cat (*Leopardus pajeros*) and the mountain lion (*Puma concolor*). Camelids like llamas and vicunas were registered in the area too and form an important component of livestock farming.

A critical species not recorded during the field evaluation, but registered in the ESIA (Walsh 2006), is the White-bellied cinclodes (*Cinclodes palliatus*). It is tied to mineral-rich well-watered cushion-plant bogs (Bofedales) such as the ones covered by *Distichia* (Fjeldsa 1990). The White-bellied cinclodes is considered Critically Endangered by INRENA (2004), and it is restricted to a very small area in the high parts of the central Andes of Peru. It is considered critically endangered because of the destruction of peat bogs throughout its distribution range.

Other important birds registered are the Black-faced Ibis *Theristicus melanopis*, Andean condor *Vultur gryphus*, Gray-breasted Seedsnipe *Thinocorus orbignyianus*, and Andean flicker *Colaptes rupicola*, among others.

The lizard *Liolaemus cf melanogaster* was registered in the area. Naturalized species like the *Oncorhynchus mykiss* or Rainbow trout were registered in this ELU, as an important economic fish species (149+500 KP and 156+000 KP). This species was found in the Antacocha Stream and the Yanacocha II Lagoon.

Hydrobiology

Table 15.9 presents waterbodies sampled along ELU 8. The species *Oncorhynchus mykiss*, was described in two of the stations (Hi-17 and hi-18). This species is of economic importance to the surrounding communities and therefore particular attention is required during construction for the protection of watercourses.

Table 15.9. Waterbodies Sampled – ELU 8

Station	Habitat	Waterbody	Name	Height (masl)	KP	Species
Hi-17	Altoandino	Laguna	Yanacocha	4622	156+000	<i>Oncorhynchus mykiss</i>
Hi-18	Altoandino	Quebrada	Antacocha	4487	149+500	<i>Oncorhynchus mykiss</i>
Hi-19	Altoandino	Bofedal	Yanacancha		145+500	
Hi-20	Altoandino	Laguna	Challhuacocha	4498	136+700	
Hi-21	Altoandino	Bofedal	Soytusoytu	4391	135+000	

15.3.3 SPECIES SENSITIVITY ANALYSIS

Table 15.10 shows the critical and sensitive species found during the EFS fieldwork. There are seven Medium Sensitivity plant species, two lizard species, two mammal species (Andean mountain cat and vicuna) and three bird species.

Table 15.10. Species Sensitivity Criteria - ELU 8

No	Species	Protection Status						Spatial Distribution			Local Use			Mobility		Σ
		CR	EN	VU	NT	L	N	Local	Regional	Widespread	Permanent	Seasonal	None	Immobile	Mobile	
	Plants															
1	<i>Aciachne</i> cf. <i>acicularis</i>						0			0			0	3		3
2	Asteraceae						0			0			0	3		3
3	<i>Austrocylindropuntia floccosa</i>						0			0			0	3		3
	<i>Berberis</i> sp.						0	3					0	3		6
	<i>Calamagrostis</i> sp.						0			0	2			3		5
4	<i>Dissanthelium</i> sp.						0			0	2			3		5
5	<i>Distichia muscoides</i>						0			0		1		3		4
6	<i>Ephedra americana</i>				3				2				0	3		8
7	<i>Escallonia myrtilloides</i>			4					2	0			0	3		9
	Jarava sp.						0			0	2			3		5
8	Juncaceae						0			0			0	3		3
9	<i>Lachemilla pinnata</i>						0		2				0	3		5
10	<i>Oroya peruviana</i>						0	3		0			0	3		6
11	<i>Perezia coerulensis</i>			4					2				0	3		9
12	<i>Perezia pinnatifida</i>			4					2				0	3		9
13	<i>Plantago rigida</i>						0		2				0	3		5
14	<i>Plettkea</i> sp.						0		2				0	3		5
15	Poaceae						0			0			0	3		3
16	<i>Pycnophyllum molle</i>						0			0	2			3		5
17	<i>Ribes</i> sp.						0	3				1		3		7
	Fish															
17	<i>Oncorhynchus mykiss</i>						0			0	2			3		5
	Reptiles and Amphibian															
18	<i>Liolaemus walkeri</i>						0		2				0	3		5
19	<i>Liolaemus</i> cf. <i>melanogaster</i>						0	3					0	3		6
20	<i>Liolaemus melanogaster</i>						0	3					0	3		6
21	<i>Pleurodema marmorata</i>						0			0			0	3		3
	Mammals															
22	<i>Lagidium peruanum</i>						0	3			2				0	5
23	<i>Leopardus (Oreailurus) jacobitus</i>		5						2				0		0	7

24	<i>Leopardus (Oreailurus) pajeros</i>					0		2				0		0	2
25	<i>Mustela frenata</i>					0			0			0		0	0
26	<i>Odocoileus virginianus</i>					0			0			0		0	0
27	<i>Puma concolor</i>			3					0			0		0	3
28	<i>Thylamys pallidior</i>					0			0	2				0	2
	<i>Vicugna vicugna</i>		5						0	2				0	7
	Birds														
29	<i>Asthenes dorbignyi</i> (<i>huanacavelicae</i>)			4				3				0		0	7
30	<i>Asthenes ottonis</i>					0	3					0		0	3
31	<i>Asthenes wyatti</i>					0		2				0		0	2
32	<i>Attagis gayi</i>					0			0			0		0	0
33	<i>Buteo leucorrhous</i>					0			0			0		0	0
34	<i>Buteo magnirostris</i>					0			0			0		0	0
35	<i>Buteo poecilochrous</i>					0		2				0		0	2
36	<i>Carduelis magellanica</i>					0			0			0		0	0
37	<i>Chloephaga melanoptera</i>					0		2		2				0	4
38	<i>Cinclodes fuscus</i>					0		2		2				0	4
40	<i>Colaptes rupicola</i>					0			0			0		0	0
41	<i>Geositta punensis</i>					0		2				0		0	2
42	<i>Geositta saxicolina</i>					0		2				0		0	2
43	<i>Geranoaetus melanoleucus</i>					0			0			0		0	0
44	<i>Lessonia oreas</i>					0		2				0		0	2
45	<i>Mecocerculus stictopterus</i>					0			0			0		0	0
46	<i>Metriopelia aymara</i>					0		2				0		0	2
47	<i>Muscisaxicola cinereus</i>					0		2				0		0	2
48	<i>Muscisaxicola rufivertex</i>					0		2				0		0	2
49	<i>Oreopholus ruficollis</i>					0			0			0		0	0
50	<i>Oreotrochilus estella</i>					0		2				0		0	2
51	<i>Phalcoboenus megalopterus</i>					0			0			0		0	0
52	<i>Plegadis ridgwayi</i>					0			0			0		0	0
53	<i>Petrochelidon pyrrhonota</i>					0			0			0		0	0
54	<i>Phrygilus plebejus</i>					0			0			0		0	0

55	<i>Phrygilus unicolor</i>					0			0			0		0	0
56	<i>Polyonymus caroli</i>					0	2					0		0	2
57	<i>Sicalis luteola</i>					0			0			0		0	0
58	<i>Sicalis uropygialis</i>					0			0			0		0	0
59	<i>Streptoprocne zonaris</i>					0			0			0		0	0
60	<i>Theristicus melanopis</i>			4		0	2		0			0		0	6
61	<i>Thinocorus orbignyianus</i>					0			0	2				0	2
62	<i>Tringa melanoleuca</i>					0			0			0		0	0
63	<i>Upucerthia jelskii</i>					0	2					0		0	2
64	<i>Vanellus resplendens</i>					0	2					0		0	2
65	<i>Vultur gryphus</i>		5			0			0			0		0	5

Protection Status*:

CR= Critically endangered 6 points
 EN= Endangered 5 points
 VU= Vulnerable 4 points
 NT= Near threatened 3 points
 B= Low (Others) 2 points
 N= Not listed 0 points

Σ= Sensitivity value

1 - 5: Low

6 - 10: Medium

11 or higher: High

Species Distribution:

Local = (Endemic locally or to an EBA**) 3 points
 Regional = (Regional endemic in Andes or Coast) 2 points
 Widespread = (Across S. America or cosmopolitan) 0 points

Mobility:

Immobile = (restricted movement or in very short distance) 3 points
 Mobile = 0 points

Local Uses:

Permanent= 2 points
 Seasonal = 1 point
 None = 0 points

***Protection Status:** According IUCN (2006) or National Legislation (D.S. No. 034-2004-AG/D.S. No. 043-2005-AG)

****EBA:** Areas determined by Birdlife International, which includes at least 2 bird species with less than 50,000 km2 of known distribution range.

15.3.4 HABITAT SENSITIVITY ANALYSIS

Based on the presence of medium sensitivity species presented in Table 15.10 the Scarcely Vegetated High Andean Areas of the Apacheta High Sierras ELU are considered to be of Medium Sensitivity due to the presence of four Medium Sensitivity animal species. The Sward-forming Grassland of the Apacheta High Sierras are considered to be of Medium Sensitivity due to the presence of five Medium Sensitivity plant species and two Medium Sensitivity animal species. The Tussock Grassland of the Apacheta High Sierras is considered to be of Medium Sensitivity due to the presence of five Medium Sensitivity plant species and three Medium Sensitivity animal species. None of the other habitats in this ELU meet the criteria for a high or medium sensitivity habitat as described in Section 7.2 of these EFS.

15.4 KEY ISSUES AND RECOMMENDATIONS

Soils

Soils in the ELU generally have medium to high fertility, which will facilitate revegetation

In order to prevent and mitigate the potential impact of the ARD the ESIA consider rocks isolation from waterbodies, and the use of geomembranes. Other measures listed are the construction of embankments and ditches to encourage acid runoff to drain away from watercourses and monitoring of water from acid rock areas, to determine how acidic it is.

Physical Risk

There is a section oh highly unstable ground between KP 131 to KP 132 that will be especially vulnerable to erosion during the rainy season. In addition to the installation and maintenance of temporary and permanent erosion controls, biorestation techniques should be considered.

Waterbodies and Wetlands

Peat bogs are frequently crossed by the RoW and are sensitive areas to be protected as much as possible, taking notice of the highly previous human impact in the area. These wetland areas are an important source of water for all crops downstream during the dry winter season (May to November). Peat bogs must be considered sensitive areas, taking special measures during all activities, and taking care of the potential white-bellied cinclodes (*Cinclodes palliatus*) habitat. Bog species should be translocated when possible

prior to construction and adequate topsoil strip should be undertaken for respreading and habitat recreation after completion of construction.

Habitats and Species

The relocation of *Escallonia myrtilloides* and the *Ribes* and other sensitive plant species should be attempted prior to construction. *Oroya peruviana* is an endemic globular cactus that grows in isolated sites at KPs 118+000 and 123+000. Where cleared during ROW preparation it could be replaced by new plants during biorestoration after the completion of construction.

The vicuna, which occurs throughout the ELU should be managed by special measures summarized in Table 15.11. Being a mobile species and sensitive to noise it is not envisaged that the Andean mountain cat or the Andean condor, *Vultur gryphus* will be impacted by construction works.

Table 15.11 summarizes the key issues and recommendations for the Apacheta High Sierras ELU.

Table 15.11. Key Issues and Recommendations – ELU 8

Issue	KP Reference	Recommendations	Reference
Risk of mass wasting in Medium and High physical risk sectors	117+388 - 117+400	Install and maintain erosion controls, especially in the rainy season. Permanent erosion controls during reinstatement and consideration of extra biorestoration techniques (hydroseeding, mulching and fertilizer applications) in the highest risk areas.	ECOMP / RP
Lagoons River and stream crossings	Churiac river in KP 120+000 to 162+137, several wetlands	Ditch in dry season if possible using best practices crossings techniques to minimize turbidity. River bank protection	ECOMP
		Protection of the Tagracocha lake	
Vicunas	Along the ELU, several areas	Fencing, participative management and other specific protection measures, such as worker training, signage, speed controls, waste management and fauna crossing points left in trench and pipe string. Consultation with local community farmers.	ECOMP
Acid Rock Drainage	KP 145+000 to 162+137	Isolation of materials, water quality monitoring during rainy season	ECOMP
Bog Habitat/	123+000 – 162+137	Translocation of shrubs (<i>Escallonia myrtilloides</i> etc) prior to construction. Strip and store and protect topsoil from respreading during reinstatement.	ECOMP

		Erosion control to minimize sediment inundation of adjacent bog habitats. Revegetate with native plants during biorestorement.	
Birds - White-bellied cinclodes (<i>Cinclodes palliates</i>), Pale-tailed canastero (<i>Asthenes dorbignyi</i> (<i>Huancavelica</i>) and black-faced ibis (<i>Theristicus melanopsis</i>)	Bog Habitat	Protection and restablish bog habitat after construction. Noise monitoring during construction as per ESIA requirements. Identify any nests during pre-clearance survey if site clearance during the nesting season.	
Lizards (<i>Liolaemus sp.</i>)	Grassland Habitat	Pre-clearance Survey to identify and relocate from ROW prior to site clearance activities.	

Source: EFS Field Work.

16.0 ELU 9: PAMPAS-PALMITOS RIVER BASINS (KP 162+137 TO 195+050)

16.1 GENERAL DESCRIPTION

With elevations ranging between 4,000 and 4,700 m, the Pampas-Palmitos River Basins ELU is another very high Andean landscape dominated by tussock grasslands, sward-forming grasslands and scarcely vegetated areas, with smaller areas of peat bog wetlands and lagoons in the stream and river valleys. The high sierra landscape is dissected in two major places by the deep valleys of the Rivers Pampas and Palmitos at KP 175 and KP186 respectively. The climate is generally cold and dry characterized by seasonal precipitation. This unit includes the rural community of Caruaccpampa.

16.2 PHYSICAL CHARACTERISTICS

16.2.1 PRECIPITATION

Precipitation is seasonal, with a general wet season from September to April but with most of the precipitation falling between January and March, and a dry season from May to August.

Table 16.1 shows estimated precipitation ranges for the peak and general wet seasons. At these high elevations, during parts of the year some of the precipitation will be in the form of snow.

Table 16.1. Estimated Peak and General Wet Season Precipitation Ranges - ELU 9

Estimated Precipitation (mm)			
Peak (January - March)		General (September - April)	
KP Range	Precipitation (mm)	KP Range	Precipitation (mm)
162+137 - 166+000	500 - 600	162+137 - 169+000	800 - 1000
166+000 - 195+050	400 - 500	169+000 - 195+050	700 - 800

Source: ESIA Physical Baseline Maps 1.2-1 and 1.2-2.

16.2.2 GEOLOGY

The dominant geological formation in the Pampas-Palmitos River Basins ELU is comprised principally of limestones interspersed in places with lutites, forming a rugged mountain landscape. Its rocks have been affected by karstic processes although the surface is little altered. The metallic mineralization present in certain areas of these rocks implies a high risk of acid rock drainage (ARD), which could become temporarily accelerated in association with pipeline installation earthworks activities.

Table 16.2 lists the sectors with potential risk of acid rock drainage (ARD) occurrence along the ROW.

Table 16.2. Sectors of ARD Risk – ELU 9

Level of Risk	KP Range	Length (m)
High	170+000 – 175+000	5,000
High	190+000 – 195+000	5,000

Source: ESIA Physical Baseline Appendix 3.3.4.

Additionally, there are zones of glacial and fluvioglacial deposits, including moraines. Some areas such as KP 175+000 and KP 187+000 have colluvio-alluvial deposits, associated with erosion and depositional processes at steep slopes and in river valleys.

16.2.3 SOILS

Surface Horizon Characteristics

The EFS collected eight surface horizon samples in ELU 9. The surface horizon pH in all EFS samples was strongly acidic (less than 5.5) and is of a medium to deep depth along the whole ELU, which is typical of peat bog habitats and high sierra grasslands. Organic matter content along the ROW is variable with four samples low, one medium and one high. Based on levels of available phosphorus, fertility on the surface horizon was mostly low (4 out 8 samples), with three medium and one high sample. Surface horizon sample characteristics are presented in Table 16.3.

Table 16.3. Surface Horizon Characteristics - ELU 9

KP	pH	Surface horizon depth	Organic matter	Fertility	Slope (%)
165+000	Strongly acidic	Medium	Low	Medium	80-100%
170+000	Strongly acidic	Medium	Low	Medium	45%
175+000	Strongly acidic	Deep	Low	Medium	15-80%
180+000	Strongly acidic	Medium	Medium	High	30%
185+000	Strongly acidic	Medium	High	Low	25%
187+000	Strongly acidic	Deep	High	Low	15-100%
190+000	Strongly acidic	Medium	High	Low	60%
195+000	Strongly acidic	Medium	Low	Low	10-15%

Source: ESIA Physical Baseline and Domus.

pH: Strongly acidic = Less than 5.5; Moderately acidic = 5.6 to 6.0; Slightly acidic = 6.1 – 6.5; Neutral = 6.6 - 7.0; Slightly alkaline = 7.1 – 7.8; Moderately alkaline = 7.9 to 8.4; Strongly alkaline = More than or equal to 8.5.

Surface horizon depth: Shallow = Less than 5 cm; Medium = 5 cm to 15 cm; Deep = More than 15 cm.

Organic matter: Low = Less than 2%; Medium = 2% to 4%; High = More than 4%.

Fertility based on Available Phosphorus: Low = Less than 7.0 ppm; Medium = 7.0 to 14.0 ppm; High = More than 14.0 ppm.

Subsoil Characteristics

The subsoil texture is a generally loamy sand texture, like that of the surface horizon, and does not hinder the infiltration of water. However, both the surface horizon and subsoil are very loose and the stability of the soil aggregates is low. Organic matter and nutrients are generally low in the subsoil.

Overall, the soils are typical of a vegetated mountain environment of moderately high elevation with acidic, organic soils of low fertility and a distinctive surface horizon horizon.

16.2.4 WATERBODIES AND WETLANDS

The ROW will require 29 stream and quebrada crossings and 2 major river crossings in ELU 9,. Table 16.4 details the stream and river crossings for the Pampas-Palmitos River Basins ELU.

The ROW runs parallel to the Huayco Corral stream, at distances of approximately 45 to 265 m upslope from the stream, from approximately KP 170+000 to KP 173+873, where it crosses the stream. The RoW also runs parallel to Quebrada. Jaccachayocc at approximately KP 175+000 to 178+000.

The ROW passes within 25 m of a lagoon near KP 173+900.

Table 16.4. Principal Waterbody Crossings - ELU 9

Waterbody Type or Name	KP Mid-channel	Elevation (m)
Arroyos		
ARROYO	170+851.56	4474.49
ARROYO	170+999.44	4451.08
ARROYO	172+075.76	4404.14
ARROYO	172+315.76	4395.17
ARROYO	173+139.21	4362.74
ARROYO	179+257.44	4684.51
ARROYO	180+206.35	4672.20
ARROYO	181+900.57	4537.50
ARROYO	182+866.12	4447.89
ARROYO	186+023.52	4107.91
ARROYO	192+932.54	4569.56
ARROYO	192+990.85	4569.44
ARROYO	193+136.44	4567.87
ARROYO	193+928.69	4590.07
ARROYO	194+111.62	4587.84
ARROYO	194+532.56	4601.24
ARROYO	194+590.08	4597.20
Quebradas		
QUEBRADA	163+800	4790
QUEBRADA	165+200	4746
QUEBARADA	167+100	4672
QUEBRADA	170+193.68	4506.34
QDA. HUAYCO CORRAL	173+873.20	4332.54
QUEBRADA JACCACHAYOC	176+504.66	4300.86

QUEBRADA	178+169.15	4521.01
QUEBRADA	178+392.68	4582.50
QUEBRADA	178+558.75	4621.66
QUEBRADA	179+025.39	4654.42
QUEBRADA SECA	191+696.98	4514.03
QUEBRADA SECA	192+466.78	4566.57
QUEBRADA SECA	194+600	XXX
Rivers		
RIO PALMITOS	175+216.31	4123.46
RIO PAMPAS	186+773.05	3998.09

Source: Peru LNG Pipeline Project Alignment Sheets (Gulf Interstate Engineering, 2006).

In addition to the rivers and streams, there are many peat bog crossings typically less than 100 m each. However, the three largest and most important crossings are a 243-m section starting at KP 178+712, a 189-m section starting at KP 188+372, and 95-m section starting at KP 191+603 (see Table 16.8 for complete listing of peat bogs).

16.2.5 INSTABILITY AND PHYSICAL RISK

The level of instability and physical risk in ELU 9 is categorized as Low in 73.1 % of the ROW length and as Medium in the remaining 26.9% of the ROW (Table 16.5).

Table 16.5. Instability and Physical Risk Levels - ELU 9

Risk Level	KP Start	KP Finish	Length (m)	
Low	162+1370	170+365	8228	26,137
	170+477	170+771	294	
	171+000	176+048	5,048	
	177+887	180+363	2,476	
	181+726	181+755	29	
	183+050	186+332	3,282	
	186+435	186+827	392	
	187+273	193+000	5,727	
	193+388	193+450	62	
	193+679	194+278	599	

Medium	170+365	170+477	112	6,726
	170+771	171+000	229	
	176+048	177+887	1,839	
	180+363	181+726	1,363	
	181+755	183+050	1,295	
	186+332	186+435	103	
	186+827	187+273	446	
	193+000	193+388	388	
	193+450	193+679	229	
	194+278	195+000	722	

Source: ESIA Physical Baseline Map 1.1-4 and Domus.

16.2.6 INFRASTRUCTURE

The Central Rumichaca Base Camp, with lodging facilities for 500 people, and pipe yard may be installed at a site used formerly for these purposes and, therefore, does not represent a greenfield development. The site is located along the Pilpichaca-Rumichaca road just north of the latter community, at a distance of approximately 3,800 m from the ROW.

Table 16.6 lists the infrastructure information for ELU 9.

Table 16.6. Planned Project Infrastructures – ELU 9

Type of Infrastructure	KP	Name
Camp and Pipe Yard	188+063*	Central Rumichaca

*KP as indicated by the ESIA provided for reference only.

Source: ESIA Project Description.

16.3 HABITATS AND SPECIES

16.3.1 HABITAT DISTRIBUTION

The habitats of ELU 9 are listed in sequential order in Table 16.7, including the length of each habitat unit and associated start and finish ROW KPs. Table 16.8 presents habitat lengths over the ROW arranged by habitat type, with subtotals for each habitat.

Table 16.7. Habitat Sequence – ELU 9

Habitat Type	Length (m)	KP Start	KP Finish
Scarcely Vegetated High Andean Areas	152	162+137	162+289
Peat Bogs	89	162+289	162+378
Scarcely Vegetated High Andean Areas	340	162+378	162+718
Peat Bogs	25	162+718	162+743
Scarcely Vegetated High Andean Areas	610	162+743	163+353
Peat Bogs	48	163+353	163+401
Scarcely Vegetated High Andean Areas	89	163+401	163+490
Peat Bogs	88	163+490	163+578
Sward-forming grassland	169	163+578	163+747
Peat Bogs	58	163+747	163+805
Scarcely Vegetated High Andean Areas	60	163+805	163+865
Peat Bogs	42	163+865	163+907
Scarcely Vegetated High Andean Areas	480	163+907	164+387
Peat Bogs	17	164+387	164+404
Scarcely Vegetated High Andean Areas	221	164+404	164+625
Peat Bogs	74	164+625	164+699
Sward-forming grassland	149	164+699	164+848
Peat Bogs	359	164+848	165+207
Sward-forming grassland	20	165+207	165+227
Peat Bogs	285	165+227	165+512
Sward-forming grassland	223	165+512	165+735
Peat Bogs	79	165+735	165+814

Sward-forming grassland	115	165+814	165+929
Peat Bogs	43	165+929	165+972
Sward-forming grassland	810	165+972	166+782
Peat Bogs	27	166+782	166+809
Sward-forming grassland	215	166+809	167+024
Scarcely Vegetated High Andean Areas	509	167+024	167+533
Peat Bogs	72	167+533	167+605
Scarcely Vegetated High Andean Areas	1054	167+605	168+659
Sward-forming grassland	405	168+659	169+064
Tussock grassland	357	169+064	169+421
Sward-forming grassland	455	169+421	169+876
Tussock grassland	124	169+876	170+000
Tussock Grassland	170	170+000	170+170
Sward-forming Grassland	91	170+170	170+261
Peat Bog	18	170+261	170+279
Sward-forming Grassland	105	170+279	170+384
Tussock Grassland	96	170+384	170+480
Sward-forming Grassland	66	170+480	170+546
Peat Bog	29	170+546	170+575
Sward-forming Grassland	91	170+575	170+666
Tussock Grassland	471	170+666	171+137
Sward-forming Grassland	626	171+137	171+763
Tussock Grassland	665	171+763	172+428
Sward-forming Grassland	1753	172+428	174+181
Tussock Grassland	73	174+181	174+254
Sward-forming Grassland	976	174+254	175+230
Peat Bog	23	175+230	175+253
Sward-forming Grassland	220	175+253	175+473
Peat Bog	63	175+473	175+536
Sward-forming Grassland	79	175+536	175+615
Tussock Grassland	316	175+615	175+931
Peat Bog	138	175+931	176+069
Tussock Grassland	264	176+069	176+333
Peat Bog	27	176+333	176+360
Tussock Grassland	166	176+360	176+526
Peat Bog	62	176+526	176+588
Tussock Grassland	1310	176+588	177+898
Sward-forming Grassland	434	177+898	178+332
Tussock Grassland	380	178+332	178+712
Peat Bog	243	178+712	178+955

Sward-forming Grassland	592	178+955	179+547
Scarcely Vegetated High Andean Areas	637	179+547	180+184
Sward-forming Grassland	64	180+184	180+248
Scarcely Vegetated High Andean Areas	1271	180+248	181+519
Peat Bog	162	181+519	181+681
Scarcely Vegetated High Andean Areas	33	181+681	181+714
Tussock Grassland	6970	181+714	188+684
Sward-forming Grassland	775	188+684	189+459
Peat Bog	9	189+459	189+468
Sward-forming Grassland	54	189+468	189+522
Scarcely Vegetated High Andean Areas	219	189+522	189+741
Sward-forming Grassland	183	189+741	189+924
Tussock Grassland	345	189+924	190+269
Sward-forming Grassland	1334	190+269	191+603
Peat Bog	38	191+603	191+641
Sward-forming Grassland	116	191+641	191+757
Scarcely Vegetated High Andean Areas	2110	191+757	193+867
Sward-forming Grassland	397	193+867	194+264
Tussock Grassland	515	194+264	194+779
Scarcely Vegetated High Andean Areas	271	194+779	195+050

Source: ESIA Biological Baseline Map 2-1 and Domus.

Table 16.8. Habitat Summary – ELU 9

Habitat Type	Length (m)	KP Start	KP Finish
Tussock Grassland	357	169+064	169+421
	124	169+876	170+000
	170	170+000	170+170
	96	170+384	170+480
	471	170+666	171+137
	665	171+763	172+428
	73	174+181	174+254
	316	175+615	175+931
	264	176+069	176+333

	166	176+360	176+526
	1310	176+588	177+898
	380	178+332	178+712
	6970	181+714	188+684
	345	189+924	190+269
	515	194+264	194+779
Subtotal	12,222	46.96%	
Sward-forming Grassland	169	163+578	163+747
	149	164+699	164+848
	20	165+207	165+227
	223	165+512	165+735
	115	165+814	165+929
	810	165+972	166+782
	215	166+809	167+024
	405	168+659	169+064
	455	169+421	169+876
	91	170+170	170+261
	105	170+279	170+384
	66	170+480	170+546
	91	170+575	170+666
	626	171+137	171+763
	1753	172+428	174+181
	976	174+254	175+230
	220	175+253	175+473
	79	175+536	175+615
	434	177+898	178+332
	592	178+955	179+547
	64	180+184	180+248
	775	188+684	189+459
	54	189+468	189+522
	183	189+741	189+924
	1334	190+269	191+603
	116	191+641	191+757
	397	193+867	194+264
Subtotal	10,517	31.82%	
Scarcely Vegetated High Andean Areas	152	162+137	162+289
	340	162+378	162+718
	610	162+743	163+353
	89	163+401	163+490
	60	163+805	163+865
	480	163+907	164+387
	221	164+404	164+625

	509	167+024	167+533
	1054	167+605	168+659
	637	179+547	180+184
	1271	180+248	181+519
	33	181+681	181+714
	219	189+522	189+741
	2110	191+757	193+867
	271	194+779	195+050
Subtotal	8,056	17.96%	
Peat Bog	89	162+289	162+378
	25	162+718	162+743
	48	163+353	163+401
	88	163+490	163+578
	58	163+747	163+805
	42	163+865	163+907
	17	164+387	164+404
	74	164+625	164+699
	359	164+848	165+207
	285	165+227	165+512
	79	165+735	165+814
	43	165+929	165+972
	27	166+782	166+809
	72	167+533	167+605
	18	170+261	170+279
	29	170+546	170+575
	23	175+230	175+253
	63	175+473	175+536
	138	175+931	176+069
	27	176+333	176+360
	62	176+526	176+588
	243	178+712	178+955
	162	181+519	181+681
	9	189+459	189+468
	38	191+603	191+641
Peat Bogs Subtotal	2118	3.25%	
ELU 9 Total ROW Length:	32,913		

Source: ESIA Biological Baseline Map 2-1 and Domus.

16.3.2 HABITAT DESCRIPTIONS

Tussock Grasslands

Tussock grasslands are the most extensive habitat type in the Pampas-Palmitos River Basins ELU, occupying about 46.96% of the ROW length and typical of the high sierra landscape. Characteristic elements of the tussock grasslands in ELU 9 include the grass *Dissanthelium* sp. and the composite *Senecio* sp. There are also highly dispersed patches of the cactus *Austrocylindropuntia floccosa*.

Sward-forming Grassland

Sward-forming grasslands cover approximately 31.82% of the ROW in ELU 9 and are dominated by *Aciachne* cf. *acicularis*, *Lachemilla pinnata*, and *Pycnophyllum molle*.

Scarcely Vegetated High Andean Areas

Some 17.96% of the ROW in ELU 9 is more or less devoid of vegetative cover, with bare mineral soil and rock at the surface. This corresponds to steep slopes and rocky outcrops and the highest sections of the RoW above the deep valleys cut by the Pampas and Palmitos rivers.

Peat Bogs

The remaining 3.25% of the ROW in the Pampas-Palmitos River Basins ELU is comprised on peat bog wetlands dominated by *Distichia muscoides* and *Plantago rigida*. These habitats have generally been highly degraded by alpaca grazing.

Key Fauna

Mammals registered in this ELU were Andean fox (*Lycalopex culpaeus*), the Andean Mountain Cat (*Leopardus jacobitus*), and Molina's hog-nosed skunk (*Conepatus chinga*).

Important Peruvian endemic bird species appear in this ELU like the black-breasted hillstar (*Oreotrochilus melanogaster*) and the Pale-tailed canastero (*Asthenes dorbignyi huanacavelicae*; INRENA-vulnerable). Other birds registered are the Andean tinamou (*Nothoprocta pentlandii*), the torrent duck (*Merganetta armata*), and the gray-breasted seedsnipe (*Thinocorus orbignyianus*).

The series of *Liolaemus* lizards collected in the Pampa-Palmitos River Basin by the EFS field team appears to represent an undescribed species of the *montanus* section, related to the *L. melanogaster/polystictus* complex.

Hydrobiology

Table 16.9 presents waterbodies sampled along ELU 9. No salient characteristics were observed for this ELU.

Table 16.9. Waterbodies Sampled – ELU 9

Station	Habitat	Waterbody	Name	Height (masl)	KP
Hi-13	Altoandino	Río	Pampas	4027	186+500
Hi-14	Altoandino	Quebrada	Pichjahuasi	4326	175+500
Hi-15	Altoandino	Quebrada	Huaycco Corral	4153	173+800
Hi-16	Altoandino	Bofedal	Yuarilla	4814	162+000

16.3.3 SPECIES SENSITIVITY ANALYSIS

Table 16.10 shows the high and medium sensitivity species observed during the EFS Field Survey, based on the species sensitivity criteria presented in Section 7.1 of the EFS.

There are two Medium Sensitivity plant species, one lizard species, two mammal and one bird species that were identified during the EFS fieldwork. Another sensitive bird species, the cinclodes, was identified in the ESIA but not observed along the ROW or surrounding area during the field survey.

Table 16.10. Species Sensitivity Criteria - ELU 9

No	Species	Protection Status						Spatial Distribution			Local Use			Mobility		Σ
		CR	EN	VU	NT	L	N	Local	Regional	Widespread	Permanent	Seasonal	None	Immobile	Mobile	
	Plants															
1	<i>Aciachne cf. acicularis</i>						0			0			0	3		3
2	<i>Astragalus</i> sp.						0			0			0	3		3
3	<i>Austrocylindropuntia floccosa</i>						0			0			0	3		3
4	<i>Baccharis odorata</i>						0		2				0	3		5
	<i>Dissanthelium</i> sp.						0			0	2			3		5
5	<i>Distichia muscoides</i>						0		2			1		3		6
	<i>Lachemilla pinnata</i>						0		2				0	3		5
6	<i>Perezia coerulescens</i>			4					2				0	3		9
	<i>Plantago rigida</i>						0		2				0	3		5
8	<i>Poaceae</i>						0			0			0	3		3
	<i>Pycnophyllum molle</i>						0			0	2			3		5
9	<i>Senecio</i> sp.						0		0			2			3	5
10	<i>Valerianaceae</i>						0		0			0		3		3
	Reptile															
10	<i>Liolaemus</i> sp.						0	3					0	3		6
	Mammals															
11	<i>Conepatus chinga</i>						0			0			0		0	0
25	<i>Leopardus (Oreailurus) jacobitus</i>		5						2				0		0	7
12	<i>Lycalopex (Pseudalopex) culpaeus</i>						0		2				0		0	2
	<i>Vicugna vicugna</i>		5							0	2				0	7
	Birds															
13	<i>Anas flavirostris</i>						0			0			0		0	0
14	<i>Asthenes dorbignyi (huancavelicae)</i>			4				3					0		0	7
16	<i>Attagis gayi</i>						0			0			0		0	0
17	<i>Buteo polyosoma</i>						0			0			0		0	0
18	<i>Chloephaga melanoptera</i>						0		2		2				0	4
19	<i>Geranoaetus melanoleucus</i>						0			0			0		0	0
20	<i>Haplochelidon andecola</i>						0		2				0		0	2

47	<i>Larus serranus</i>					0			0			0		0	0
48	<i>Lessonia oreas</i>					0		2				0		0	2
21	<i>Merganetta armata</i>					0			0			0		0	0
22	<i>Nothoprocta ornata</i>					0		2				0		0	2
23	<i>Nothoprocta pentlandii</i>					0		2				0		0	2
24	<i>Nycticorax nycticorax</i>					0			0			0		0	0
55	<i>Phalacrocorax macrorhynchos</i>					0			0			0		0	0
25	<i>Phrygilus plebejus</i>					0			0			0		0	0
26	<i>Phrygilus unicolor</i>					0			0			0		0	0
27	<i>Ochthoeca oenanthoides</i>					0		2				0		0	2
28	<i>Oreotrochilus melanogaster</i>					0	3					0		0	3
29	<i>Phalacrocorax macrorhynchos</i>					0			0			0		0	0
30	<i>Sicalis luteola</i>					0			0			0		0	0
31	<i>Sicalis olivascens</i>					0			0			0		0	0
32	<i>Sicalis uropygialis</i>					0			0			0		0	0
33	<i>Thinocorus orbignyianus</i>					0			0	2				0	2
34	<i>Upucerthia jelskii</i>					0		2				0		0	2
68	<i>Vanellus resplendens</i>					0		2				0		0	2

Protection Status*:

CR= Critically endangered 6 points
 EN= Endangered 5 points
 VU= Vulnerable 4 points
 NT= Near threatened 3 points
 B= Low (Others) 2 points
 N= Not listed 0 points

Σ = Sensitivity value

1 - 5: Low

6 - 10: Medium

11 or higher: High

Species Distribution:

Local = (Endemic locally or to an EBA**) 3 points
 Regional = (Regional endemic in Andes or Coast) 2 points
 Widespread = (Across S. America or cosmopolitan) 0 points

Mobility:

Immobile = (restricted movement or in very short distance) 3 points
 Mobile = 0 points

Local Uses:

Permanent= 2 points
 Seasonal = 1 point
 None = 0 points

***Protection Status:** According IUCN (2006) or National Legislation (D.S. No. 034-2004-AG/D.S. No. 043-2005-AG)

****EBA:** Areas determined by Birdlife International, which includes at least 2 bird species with less than 50,000 km2 of known distribution range.

16.3.4 HABITAT SENSITIVITY ANALYSIS

Based on the presence of medium sensitivity species presented in Table 16.10 the Tussock Grassland of the Pampas Palmitos River Basins ELU is considered to be of Medium Sensitivity due to the presence of 2 Medium Sensitivity animal species. None of the other habitats in this ELU meet the criteria for a high or medium sensitivity habitat as described in Section 7.2 of this EFS.

16.4 KEY ISSUES AND RECOMMENDATIONS

Geology

The ESIA defined a high potential for Acid Rock Drainage in the sectors between KPs 170+000-175+000 and KPs 190+000-195+000. These sections of the ROW cross numerous small streams and 2 rivers that could be vulnerable to additional loadings of acidity caused by ARD, especially during the rainy season. Excavated materials such as from earthwork cuts and trench spoils should be isolated from waterbodies. Runoff or seepage from ROW stockpiled material should be managed by use of geomembranes, embankments, and ditches to limit the effects of potentially acidic runoff entering waterbodies and wetlands. Routine water quality monitoring of these areas should be performed in these areas especially during the rainy season.

Soils

Some areas with deep and relatively fertile topsoils present some favorable conditions to restoration, such as the stretch from KP 175+000 to KP 180+000, but in other areas the steep slopes and low fertility indicate potential restrictions to natural regeneration of plants, during and after the construction phase. This is especially critical in these high elevation areas where climatic extremes and short growing season inhibit plant growth. In grassland habitats, use of nitrogen-fixing species to promote soil fertility should be used.

Taking into account precipitation levels, especial in the wet season, erosion controls should be installed and maintained, especially in the rainy season. During the construction, erosion and sediment control devices as silt fences, slope breakers and wooden barriers are especially important on steep slopes near watercourses. Topsoil best practice is also critical during construction as preservation of the material will be critical in successful long-term reinstatement of these mountain habitats. Topsoil should be carefully stripped during site clearing and grading and protected from loss or deterioration caused by erosion or contamination during construction.

Waterbodies and Wetlands

There are more than 25 waterbodies and 10 wetlands to be crossed by the ROW in this ELU where best practice erosion and sedimentation controls and pollution prevention must be followed to protect waterbodies against possible contamination by sediment and hydrocarbons. Especially important are the upland waterbodies of the Rivers Pampas and Palmitos at KP 175 and KP 186 respectively.

Vegetative buffer zones should be retained along the edges of these waterbodies where crossed by the RoW and only cleared immediately before pipeline crossing and installation works.

Waterbody and wetlands crossing must at minimum meet the requirements of the ESIA's ESMP, with scheduling to minimize the time the wetland stretches remain open. Temporary erosion and sedimentation controls should be employed at all Waterbody crossings to prevent or minimize the amount of sediment entering during rain events. Special care should be taken in terms of erosion and sedimentation controls along the ROW for the sector where it runs parallel to the Huayco Corral stream.

Physical Risk

Sectors categorized as Medium physical risk in Table 16.5 will require temporary erosion controls during construction and permanent controls during reinstatement. In areas of particular vulnerability, including waterbodies, river and stream crossings, additional restoration measures including hydroseeding and fertilizer application should be considered.

Habitats and Species

The shrub *Perezia coerulescens*, listed as Medium sensitivity in Table 16.10, should be translocated from the habitat locations prior to construction.

Any sensitive lizards (*Liolaemus* sp.), which are especially likely to be found in the Tussock Grassland habitats should be identified along the RoW prior to site clearing and grading so that they can be relocated to safe undisturbed areas beyond the RoW. The lizards will be moved to an area of same or similar habitat at a reasonable distance outside the zone of impact by construction activities.

Table 16.11 summarizes the key issues and recommendations for the Pampas-Palmitos River Basins ELU.

Noise monitoring of construction activities should be undertaken in areas known to be nesting sites of the white-bellied cinclodes and pale-tailed canastero. Where possible, construction activities should be scheduled to avoid or minimize noise disturbances at the most sensitive time of the year including breeding and nesting.

Table 16.11. Key Issues and Recommendations - ELU 9

Issue	KP Reference	Recommendations	Reference
Generation of ARD	170+000 – 175+000 and 190+000 – 195+000	Isolate material from water. Use of geomembranes. Embankments and ditches. Visual and empirical monitoring.	ECOMP
Lagoons River and stream crossings	190+000 – 195+000	Ditch in dry season if possible, use less intrusive technique. River bank protection	ECOMP
		Protection of the Tagracochoa lake. Erosion and Sedimentation Control & Pollution Prevention Best Practices.	
Vicunas	Along the ELU, several areas	Fencing, participative management and other specific protection measures, such as worker training, signage, speed controls, waste management and fauna crossing points left in trench and pipe string. Consultation with local community farmers.	ECOMP
Peat bog Habitat, <i>Distichia muscoides</i>	162+137 - 163+000 See Table 16.8	Relocation of plants and topsoil storage before construction. Turf and topsoil strip, storage and protection during construction.	ECOMP / RP
		Restoration of topsoil and plants during reinstatement. Use of native species, where practicable, during bioreinstatement.	
Risk of physical instability	See Table 16.5	Temporary and permanent erosion controls.	ECOMP / RP
		Restoration of topsoil and plants during reinstatement.	
Lizards (<i>Liolaemus</i>)	See Table 16.10	Pre-Clearance Survey to identify and relocate from ROW prior to site clearance activities.	ECOMP
Birds - Pale-tailed canastero (<i>Asthenes dorbignyi</i>) (Huancavelica) and white-bellied cinclodes	Bog Habitats	Identify any nests during pre- clearance survey if site clearance during the nesting season. Reinstatement of original habitat after construction.	ECOMP
Acid Rock Drainage	KP 162+137 to 175+000	Isolation of materials, water quality monitoring	ECOMP

Source: EFS Fieldwork

17.0 ELU 10: HUAYTARÁ HIGH PLAINS AND RIDGES (KP 195+050 TO 249+538)

17.1 GENERAL DESCRIPTION

The Huaytará High Plains and Ridges landscape unit is composed of relatively flat, broad ridge tops, plains and rolling topography at high altitude, dominated by increasingly drier and shorter tussock grasslands, sward-forming grasslands, peat bogs, and scarcely vegetated areas, where vicuñas are common and important as a resource to local communities. At elevations between 4,000 and 4,650 m, the climate is generally cold and dry with precipitation becoming progressively lower from east to west.

Although the Huaytara highlands are generally very stable there is a small area from KP 218+000 to 220+000, where there are steeper mountains with colluvial soils that are very sensitive to water erosion and landslides.

17.2 PHYSICAL CHARACTERISTICS

17.2.1 PRECIPITATION

Precipitation is seasonal, with a general wet season from September to April with most rain falling between January and March, and a dry season from May to August.

Table 17.1 shows estimated precipitation ranges for the peak and general wet seasons based on the isohyets developed by the ESIA.

Table 17.1. Estimated Peak and General Wet Season Precipitation Ranges - ELU 10

Estimated Precipitation			
Peak (January – March)		General (September – April)	
KP Range	Precipitation (mm)	KP Range	Precipitation (mm)
195+050 – 233+000	400 - 500	195+050 – 216+000	700 - 800
233+000 - 245+000	300 - 400	216+000 - 231+000	600 - 700
245+000 - 249+538	200 - 300	231+000 - 249+538	500 - 600

Source: ESIA Physical Baseline Maps 1.2-1 and 1.2-2.

Total wet season precipitation ranges from 500 mm in the western sector to 800 mm in the eastern sector of the Huaytará High Plains and Ridges ELU and this drying trend is visible by the increasingly sparser vegetation towards the west.

17.2.2 GEOLOGY

The Huaytará highlands formation consists of well-bonded quartzite sandstone posing no significant risk of instability. Another formation frequently in the ELU is composed of very dense volcanic lava, which also poses no risk of instability. The ESIA Physical Baseline does not identify any sectors along the ROW identified as having Medium or High risk of Acid Rock Drainage.

17.2.3 SOILS

Surface Horizon Characteristics

The EFS collected eight surface horizon samples in ELU 10. The pH in seven of the EFS samples was strongly acidic, with one moderately acidic sample. According to EFS samples, surface horizon is of medium (6 samples) to deep (2 samples) depths along the whole ELU, despite the variable slope. Organic matter content from samples along

the ROW is generally low (4 samples) to medium (3 samples), with a single high sample. Conversely, fertility of EFS surface horizon samples, based on levels of available phosphorus, was mostly high (5 samples) to medium (2 samples), with a single sample of low fertility. Surface Horizon sample characteristics are presented in Table 17.2.

Table 17.2. Surface Horizon Characteristics - ELU 10

KP	pH	Surface horizon depth	Organic matter	Fertility	Slope (%)
200+000	Strongly acid	Medium	Low	Medium	10-15%
205+000	Strongly acid	Medium	Low	High	15%
210+000	Strongly acid	Deep	Low	Medium	20%
215+000	Strongly acid	Medium	Medium	High	10%
220+000	Moderately acid	Medium	High	High	50%
225+000	Strongly acid	Medium	Medium	High	30%
227+000	Strongly acid	Deep	Medium	High	50%

Source: ESIA Physical Baseline and Domus.

pH: Strongly acid = Less than 5.5; Moderately acid = 5.6 to 6.0; Slightly acid = 6.1 – 6.5; Neutral = 6.6 - 7.0; Slightly alkaline = 7.1 – 7.8; Moderately alkaline = 7.9 to 8.4; Strongly alkaline = 8.5 or greater.

Surface horizon depth: Shallow = Less than 5 cm; Medium = 5 cm to 15 cm; Deep = More than 15 cm.

Organic matter: Low = Less than 2%; Medium = 2% to 4%; High = More than 4%.

Fertility based on Available Phosphorus: Low = Less than 7.0 ppm; Medium = 7.0 to 14.0 ppm; High = More than 14.0 ppm.

Subsoil Characteristics

The sandy loam texture of the subsoil is like that of the surface horizon and will not affect the movement of water. However, both the surface horizon and subsoil are very loose and the stability of the soil aggregates is low. Subsoil organic matter is medium.

17.2.4 WATERBODIES AND WETLANDS

ELU 10 crosses three rivers the Leche Leche, Canya, and Llactachayoc, and the Quinsacocha lagoon at KP 211+500.

The ROW in this ELU does not cross lakes, but passes near 3 streams, crossing 2 more, Canya (KP 212+000) and Tacpampa (224+000). Waterbodies associated with this ELU are shown in Table 17.3.

The ROW runs parallel to a creek from approximately KP 198+000 to 201+000 where it crosses it.

Table 17.3. Principal Waterbody Crossings - ELU 10

Waterbody Type or Name	KP Mid-channel	Elevation (m)
Arroyos		
ARROYO	196+103.25	4532.85
ARROYO	198+234.60	4478.99
ARROYO	198+318.40	4472.87
ARROYO	198+443.47	4467.01
ARROYO	198+556.48	4462.40
ARROYO	202+934.54	4359.12
ARROYO	203+055.33	4349.49
ARROYO	204+762.82	4415.67
ARROYO	205+306.40	4451.20
ARROYO	205+853.78	4442.96
ARROYO	206+384.16	4445.47
ARROYO	206+613.31	4437.93
ARROYO	206+661.92	4436.18
ARROYO	206+773.69	4430.65
ARROYO	206+954.61	4424.70
ARROYO	209+412.01	4465.88
Quebradas		
QUEBRADA	196+766.75	4499.37
QUEBRADA	200+554.26	4379.94
QUEBRADA	200+996.12	4344.97
QUEBRADA	201+015.14	4344.50
QDA. TAYARANGRA	201+576.38	4366.02

QDA AGUADA	202+950	XXXX
QDA CHAUPI	203+100	XXXX
QDA CUCHUHUASI	205+800	XXXX
QUEBRADA PUCAMACHAY	212+291.33	4400.78
QUEBRADA	214+000	XXXX
QUEBRADA	215+258.77	4432.10
QUEBRADA	216+409.48	4465.50
QDA TANTACCE	218+300	XXXX
QUEBRADA	219+569.74	4207.50
QUEBRADA	219+675.99	4173.08
QUEBRADA	219+736.10	4158.28
QUEBRADA	222+600	XXXX
QDA SECA	224+000	XXXX
QDA SECA	225+600	XXXX
QDA TEPERUMI	231+200	XXXX
QDA SECA	243+400	XXXX
QUEBRADA	246+244.55	4267.60
QUEBRADA	249+451.24	4012.71

Source: Peru LNG Pipeline Project Alignment Sheets (Gulf Interstate Engineering, 2006).

17.2.5 *INSTABILITY AND PHYSICAL RISK*

The level of instability and physical risk in ELU 10 is categorized as Low in 85.4 % of the ROW length, as Medium 11.2% of the ROW, and as High in the remaining 3.4% (Table 17.4).

Table 17.4. Instability and Physical Risk Levels – ELU 10

Type of risk	Initial Kp	KP Finish	Length (m)	
Low	195+192	196+687	1495	46559
	197+694	216+192	18498	
	218+452	218+509	57	
	219+921	224+421	4500	
	225+577	243+753	18176	
	244+584	246+121	1537	
	247+204	249+500	2296	
Medium	195+050	195+192	142	6027
	196+687	197+694	1007	
	216+192	218+000	1808	
	224+421	225+577	1156	
	243+753	244+584	831	
	246+121	247+204	1083	
High	218+000	218+452	452	1864
	218+509	219+921	1412	

Source: ESIA Physical Baseline Map 1.1-4.

17.2.6 INFRASTRUCTURE

Infrastructure requirements such as camps and access roads are based on assumptions set out in the ESIA Project Description and are subject to change, depending on the specific details of the construction program.

The Central Huaytará Base Camp, with lodging facilities for 400 people, and pipe yard will be installed at a site which has been used formerly for these purposes and, therefore, does not represent a greenfield development. The site is located at a distance of approximately 1 km m from the ROW to the southeast of KP 233.

Table 17.5 lists the infrastructure information for ELU 10.

Table 17.5. Planned Project Infrastructures – ELU 10

Type of Infrastructure	KP	Name
Camp and Pipe Yard	233	Central Huaytará

Source: ESIA Project Description.

17.3 HABITATS AND SPECIES

17.3.1 HABITAT DISTRIBUTION

The habitats of ELU 10 are listed in sequential order in Table 17.6, including the length of each habitat unit and associated start and finish ROW KPs. Table 17.7 presents habitat lengths over the ROW sorted by habitat type, with subtotals for each habitat.

Table 17.6. Habitat Sequence – ELU 10

Habitat Type	Length (m)	KP Start	KP Finish
Scarcely Vegetated High Andean Area	1158	195+050	196+208
Sward-forming Grassland	217	196+208	196+425
Scarcely Vegetated High Andean Area	181	196+425	196+606
Peat Bogs	24	196+606	196+630
Scarcely Vegetated High Andean Area	102	196+630	196+732
Sward-forming Grassland	333	196+732	197+065
Scarcely Vegetated High Andean Area	526	197+065	197+591
Sward-forming Grassland	96	197+591	197+687
Tussock Grassland	214	197+687	197+901
Sward-forming Grassland	768	197+901	198+669
Scarcely Vegetated High Andean Area	1055	198+669	199+724
Sward-forming Grassland	1017	199+724	200+741
Peat Bogs	26	200+741	200+767
Sward-forming Grassland	683	200+767	201+450
Peat Bogs	14	201+450	201+464

Sward-forming Grassland	1330	201+464	202+794
Tussock Grassland	156	202+794	202+950
Sward-forming Grassland	437	202+950	203+387
Tussock Grassland	219	203+387	203+606
Sward-forming Grassland	250	203+606	203+856
Peat Bogs	249	203+856	204+105
Sward-forming Grassland	416	204+105	204+521
Tussock Grassland	228	204+521	204+749
Sward-forming Grassland	420	204+749	205+169
Tussock Grassland	949	205+169	206+118
Sward-forming Grassland	135	206+118	206+253
Tussock Grassland	126	206+253	206+379
Sward-forming Grassland	393	206+379	206+772
Tussock Grassland	61	206+772	206+833
Sward-forming Grassland	287	206+833	207+120
Tussock Grassland	273	207+120	207+393
Sward-forming Grassland	515	207+393	207+908
Tussock Grassland	1974	207+908	209+882
Peat Bogs	54	209+882	209+936
Tussock Grassland	293	209+936	210+229
Peat Bogs	60	210+229	210+289
Tussock Grassland	2131	210+289	212+420
Sward-forming Grassland	197	212+420	212+617
Tussock Grassland	117	212+617	212+734
Sward-forming Grassland	168	212+734	212+902
Tussock Grassland	295	212+902	213+197
Sward-forming Grassland	397	213+197	213+594
Tussock Grassland	100	213+594	213+694
Sward-forming Grassland	547	213+694	214+241
Tussock Grassland	1653	214+241	215+894
Scarcely Vegetated High Andean Area	527	215+894	216+421
Tussock Grassland	1892	216+421	218+313
Sward-forming Grassland	345	218+313	218+658
Tussock Grassland	3160	218+658	221+818
Sward-forming Grassland	1151	221+818	222+969
Tussock Grassland	1136	222+969	224+105
Sward-forming Grassland	381	224+105	224+486
Tussock Grassland	1496	224+486	225+982
Sward-forming Grassland	205	225+982	226+187
Tussock Grassland	1602	226+187	227+789
Sward-forming Grassland	375	227+789	228+164

Tussock Grassland	551	228+164	228+715
Sward-forming Grassland	122	228+715	228+837
Tussock Grassland	1445	228+837	230+282
Sward-forming Grassland	226	230+282	230+508
Tussock Grassland	1285	230+508	231+793
Sward-forming Grassland	147	231+793	231+940
Tussock Grassland	120	231+940	232+060
Sward-forming Grassland	69	232+060	232+129
Tussock Grassland	1569	232+129	233+698
Sward-forming Grassland	87	233+698	233+785
Tussock Grassland	303	233+785	234+088
Sward-forming Grassland	142	234+088	234+230
Tussock Grassland	2491	234+230	236+721
Sward-forming Grassland	483	236+721	237+204
Tussock Grassland	367	237+204	237+571
Sward-forming Grassland	92	237+571	237+663
Tussock Grassland	164	237+663	237+827
Sward-forming Grassland	235	237+827	238+062
Tussock Grassland	406	238+062	238+468
Peat Bogs	265	238+468	238+733
Tussock Grassland	424	238+733	239+157
Sward-forming Grassland	770	239+157	239+927
Tussock Grassland	1084	239+927	241+011
Sward-forming Grassland	263	241+011	241+274
Tussock Grassland	420	241+274	241+694
Sward-forming Grassland	2428	241+694	244+122
Tussock Grassland	4852	244+122	248+974
Peat Bogs	466	248+974	249+440
Tussock Grassland	98	249+440	249+538

Table 17.7. Habitat Summary – ELU 10

Habitat Type	Length (m)	KP Start	KP Finish
Scarcely Vegetated High Andean Area	1158	195+050	196+208
	181	196+425	196+606
	102	196+630	196+732
	526	197+065	197+591
	1055	198+669	199+724
	527	215+894	216+421
Total	3,549	6.51%	
Peat Bogs	24	196+606	196+630
	26	200+741	200+767
	14	201+450	201+464
	249	203+856	204+105
	54	209+882	209+936
	60	210+229	210+289
	265	238+468	238+733
	466	248+974	249+440
Total	1,158	2.13%	
Sward-forming grassland	217	196+208	196+425
	333	196+732	197+065
	96	197+591	197+687
	768	197+901	198+669
	1017	199+724	200+741
	683	200+767	201+450
	1330	201+464	202+794
	437	202+950	203+387
	250	203+606	203+856
	416	204+105	204+521
	420	204+749	205+169
	135	206+118	206+253
	393	206+379	206+772
	287	206+833	207+120
	515	207+393	207+908
	197	212+420	212+617
	168	212+734	212+902
	397	213+197	213+594
	547	213+694	214+241
	345	218+313	218+658
	1151	221+818	222+969
	381	224+105	224+486

	205	225+982	226+187
	375	227+789	228+164
	122	228+715	228+837
	226	230+282	230+508
	147	231+793	231+940
	69	232+060	232+129
	87	233+698	233+785
	142	234+088	234+230
	483	236+721	237+204
	92	237+571	237+663
	235	237+827	238+062
	770	239+157	239+927
	263	241+011	241+274
	2428	241+694	244+122
Total	16,127	29.60%	
Tussock grassland	214	197+687	197+901
	156	202+794	202+950
	219	203+387	203+606
	228	204+521	204+749
	949	205+169	206+118
	126	206+253	206+379
	61	206+772	206+833
	273	207+120	207+393
	1974	207+908	209+882
	293	209+936	210+229
	2131	210+289	212+420
	117	212+617	212+734
	295	212+902	213+197
	100	213+594	213+694
	1653	214+241	215+894
	1892	216+421	218+313
	3160	218+658	221+818
	1136	222+969	224+105
	1496	224+486	225+982
	1602	226+187	227+789
	551	228+164	228+715
	1445	228+837	230+282
	1285	230+508	231+793
	120	231+940	232+060
	1569	232+129	233+698
	303	233+785	234+088
	2491	234+230	236+721

	367	237+204	237+571
	164	237+663	237+827
	406	238+062	238+468
	424	238+733	239+157
	1084	239+927	241+011
	420	241+274	241+694
	4852	244+122	248+974
	60	249+440	249+500
Total	33,616	61.69%	
Mixed Scrub	38	249+500	249+538
Total	38	0.07%	
Total ELU 10:	54,488		

Source: ESIA, Environmental Baseline and EFS fieldwork.

17.3.2 HABITAT DESCRIPTIONS

Tussock Grassland

This is the most dominant habitat in ELU 10 forming 61.7% of the area crossed by the RoW. This habitat type is largely covered by grasses of the genera *Senecio* sp. Due to increasing aridity along the transect from east to west, the tussock grasslands in the Huaytará High Plains and Ridges ELU are much lower in stature and of lower density than those of more humid ELUs to the east.

Sward-forming grassland

This habitat type is notable because of its higher species richness than tussock grassland. Dominant species are *Aciachne* cf *acicularis*, and *Perezia coerulecens*. *Perezia coerulecens* is considered vulnerable for Peru but in this particular area is quite common, so populations will not be significantly damaged. All the habitat type is significantly damaged by camelids overgrazing.

Scarcely Vegetated High Andean Areas

Some 6.51% of the ROW in ELU 10 is more or less devoid of vegetative cover, with bare mineral soil and rock at the surface, with highly dispersed elements of other habitat types. These occur at the highest elevations of the ELU between KP 195 to KP 200 (at approximately 4600 m) and KP 215 to KP 216 (4500 m)

Peat Bogs

Peat Bogs are not particularly dominant in this ELU, only 2.13%, although at least 8 sections, typically of a 100 m or less are crossed. These peat bogs are dominated by

Distichia muscoides and *Plantago* sp. While they have been degraded by overgrazing, still provide water and grazing lands.

Fauna

Vicuñas (*Vicugna vicugna*) are common throughout the Huaytará High Plains and Ridges ELU.

The EFS Field Survey also reported also the Andean fox (*Lycalopex culpaeus*).

The pale-tailed canastero (*Asthenes dorbignyi huancavelicae*), considered as sensitive species was registered in this ELU. The Andean flicker (*Colaptes rupicola*) and the gray-breasted seedsnipe (*Thinocorus orbignyianus*), were also registered.

The ESIA reported for this ELU the presence of *Asthenes pudibunda*, Canyon canastero, and a bird fairly common in rocky montane scrubs, endemic to Peru. This bird was not registered by the EFS field team.

Three species of *Liolaemus* lizard were identified in this ELU. Two of them could represent a new species for science.

Hydrobiology

Table 17. presents waterdbodies sampled along ELU 10. No salient characteristics were described for this ELU.

Table 17.8. Waterbodies Sampled – ELU 10

Station	Habitat	Waterbody	Name	Height (m)	KP
Hi-07	Altoandino	Bofedal	Taccra	4304	241+000
Hi-08	Altoandino	Quebrada	Tacpampa	4031	224+000
Hi-09	Altoandino	Quebrada	Canya	4431	212+200
Hi-10	Altoandino	Laguna	Quinsacocha	4479	211+500
Hi-11	Altoandino	Río	Leche Leche	4344	209+500
Hi-12	Altoandino	Quebrada	NN (Tayarangra)	4373	201+000

17.3.3 SPECIES SENSITIVITY ANALYSIS

Vicuñas are considered a medium sensitivity species because of their economic importance, sensitivity to pipeline construction activities and legal protection (endangered species).

The bird species *Asthenes dorbigny (huancaavelicae)* is also considered of medium sensitivity, classified as vulnerable and of only local distribution.

Lizards (*liolaemus sp. Ramirez* and *liolaemus cf. polystictus*) are also considered of medium sensitivity because of their limited local distribution and immobility.

Only one plant species is classified as medium sensitivity (*perezia coerulescens*) being designated of vulnerable protection status, immobility and regional distribution status.

No plants or animals species were identified of High Sensitivity.

Table 17.9 shows sensitivity of species observed during the EFS Field Survey, based on the species sensitivity criteria presented in Section 7.1 of the EFS.

Table 17.9. Species Sensitivity Criteria - ELU 10

No	Species	Protection Status						Spatial Distribution			Local Use			Mobility		Σ
		CR	EN	VU	NT	L	N	Local	Regional	Widespread	Permanent	Seasonal	None	Immobile	Mobile	
	Plants															
1	<i>Aciachne cf. acicularis</i>						0			0			0	3		3
	<i>Distichia muscoides</i>						0			0		1		3		4
2	<i>Perezia coerulescens</i>			4			0		2				0	3		9
	<i>Plantago rigida</i>						0		2				0	3		5
	<i>Senecio sp.</i>						0			0	2			3		5
	Reptiles						0									
3	<i>Liolaemus sp. (Ramirez)</i>						0	3					0	3		6
4	<i>Liolaemus cf. polystictus</i>						0	3					0	3		6
5	<i>Liolaemus cf. wiliamsi</i>						0		2				0	3		5
	Mammals						0									
6	<i>Lycalopex (Pseudalopex) culpaeus</i>						0		2				0		0	2
7	<i>Phyllotis xanthopygus posticalis</i>						0	3			2				0	5
8	<i>Vicugna vicugna</i>		5							0	2				0	7
	Birds						0									
9	<i>Anthus bogotensis</i>						0			0			0		0	0
10	<i>Asthenes dorbignyi (huancavelicae)</i>			4				3					0		0	7
	<i>Attagis gayi</i>						0			0			0		0	0
	<i>Buteo polyosoma</i>						0			0			0		0	0
16	<i>Chloephaga melanoptera</i>						0		2		2				0	4
17	<i>Colaptes rupicola</i>						0			0			0		0	0
18	<i>Geositta tenuirostris</i>						0		2				0		0	2
19	<i>Geranoaetus melanoleucus</i>						0			0			0		0	0
20	<i>Muscisaxicola albifrons</i>						0		2				0		0	2
21	<i>Muscisaxicola alpinus</i>						0		2				0		0	2
22	<i>Phalcoboenus megalopterus</i>						0			0			0		0	0
23	<i>Phrygilus plebejus</i>						0			0			0		0	0
24	<i>Phrygilus unicolor</i>						0			0			0		0	0
25	<i>Sicalis luteola</i>						0			0			0		0	0
26	<i>Sicalis uropygialis</i>						0			0			0		0	0

27	<i>Stelgidopteryx andecola</i>					0		2				0		0	2
28	<i>Thinocorus orbignyianus</i>					0			0	2				0	2
29	<i>Vanellus resplendens</i>					0		2				0		0	2

Protection Status*:

CR= Critically endangered 6 points
 EN= Endangered 5 points
 VU= Vulnerable 4 points
 NT= Near threatened 3 points
 B= Low (Others) 2 points
 N= Not listed 0 points

Σ= Sensitivity value

1 - 5: Low

6 - 10: Medium

11 or higher: High

Species Distribution:

Local = (Endemic locally or to an EBA**) 3 points
 Regional = (Regional endemic in Andes or Coast) 2 points
 Widespread = (Across S. America or cosmopolitan) 0 points

Mobility:

Immobile = (restricted movement or in very short distance) 3 points
 Mobile = 0 points

Local
Uses:

Permanent= 2 points
 Seasonal = 1 point
 None = 0 points

***Protection Status:** According IUCN (2006) or National Legislation (D.S. No. 034-2004-AG/D.S. No. 043-2005-AG)

****EBA:** Areas determined by Birdlife International, which includes at least 2 bird species with less than 50,000 km2 of known distribution range.

17.3.4 HABITAT SENSITIVITY ANALYSIS

Based on the presence of medium sensitivity species presented in Table 17.9 the Scarcely Vegetated High Andean Areas, the Sward-forming Grassland and the Tussock Grassland habitats of the Huaytará High Plains and Ridges ELU are considered to be of Medium Sensitivity due to the presence of two, three and four Medium Sensitivity animal species respectively. None of the other habitats in this ELU meet the criteria for a high or medium sensitivity habitat as described in Section 7.2 of this EFS.

The ESIA identifies the Chaupi area (KP 202 to 205) as a Sensitive Sector because it is inhabited by numerous viscachas (part rabbit, part chinchilla).

17.4 KEY ISSUES AND RECOMMENDATIONS

ELU 10, Huaytará high plains and ridges, is a typical high Andean area, used extensively as grazing lands by camelids, particularly vicuñas. Overgrazing as a common practice is causing degradation of all habitat types.

The ROW crosses or passes by several waterbodies, including 3 rivers, 5 streams and several small peat bogs. Also, there are unstable areas classified as Moderately Unstable and Highly Unstable areas between KP 218 to 220. Therefore erosion prevention measures need to be implemented during construction phase. Areas of high instability should be considered for additional bio restoration techniques such as fertilizers application and hydroseeding during reinstatement.

Three threatened species were identified in this ELU, along with one medium sensitivity plant species and four medium sensitivity animal species.

This ELU is dominated by cespitose vegetation and relatively sparse tussock grasslands of low sensitivity, with impacts due to the presence of camelids. Management of camelids in the area during construction activities must be an issue considered in the ECOMP.

Soils

Some areas present some favorable conditions to restoration, as the stretch from KP 215+000 to KP 227+000. However, a medium erosion risk could exist between KP 215+000 and 227+000, caused by precipitation and gradient.

During the construction, erosion control devices as silt fences, slope breakers and wooden barriers must be implemented and permanent erosion controls installed during reinstatement.

Habitats and Species

The ESIA describes a sector where vicuñas should be protected at KP 226+000 to 232+000. Fencing and speed reduction should be applied in this area.

According to ESIA commitments, the Viscacha population at KP 202+000 to 205+000 must be protected as well although these were not observed at the time of the Field Survey.

Table 17.10. Key Issues - ELU 10

Issue	KP Reference	Action	Reference
Risk of mass wasting in high Unstable terrains	218+000 – 220+000	Soil erosion control focused on mass movement in slopes and conservation of topsoil during its relocation in ROW.	ECOMP
Peat bog near Chaupi	202+000 - 205+000	Relocation of wild vischacias prior to site clearing	ECOMP
Vicuñas	195+000 – 250+000	Fencing, participative management and other specific protection measures, such as worker training, signage, speed controls, waste management and fauna crossing points left in trench and pipe string.	ECOMP

		Consultation with local community farmers.	
Peat bog Habitat	241+000	Turf and topsoil strip and protection during construction.	ECOMP
		Restoration of topsoil and plants during abandonment.	RP
Lizards (<i>Liolaemus spp.</i>)	195+000 – 250+000	Pre-Clearance Survey to identify and relocate from ROW prior to site clearance activity.	ECOMP
Herb (<i>Perezia coerulescens</i>)	Sword forming grassland habitats	Collect seed where practicable to use for RoW reseedling during bioreinstatement.	RP
Viscacha	KP 202-205	Pre-Clearance Survey (above) and monitoring during topsoil strip/earthworks to facilitate relocation to safe areas if burrows are disturbed by machines.	ECOMP
Birds – Pale-tailed canastero (<i>Asthenes dorbignyi</i> (<i>Huancavelica</i>))	Bog habitats	Identify any nests during pre-clearance survey if site clearance during the nesting season. Noise monitoring. Schedule construction to minimize noise generation during breeding and nesting season	ECOMP/RP

		Reinstatement of original habitat after construction.	

Source: EFS Field Work.

18.0 ELU 11: PISCO-ICA WATERSHED DIVIDE (KP 249+538 TO 272+181)

18.1 GENERAL DESCRIPTION

To the west of the town of Huaytará, the ridges narrow and lower towards the coast, and the dominant vegetation changes abruptly from grasslands to mixed and thorny scrublands.

The climate is dry and cold, and covers elevations between 2,850 and 4,000 m. Maximum precipitation ranges from 300 to 500 mm per year, depending on altitude. This ELU is comprised of the lands of the Rural Communities of Huaytará, Ayavi and Huancacasa.

This ELU has three habitat types. The largest one is the Mixed Scrub which represents almost 79% of the ELU total length, the Thorny Scrub covers approximately 21% of the ELU and Desert Scrub which is less than 1% of the total length. Table 18.8 shows the habitat types that comprise this ELU.

18.2 PHYSICAL CHARACTERISTICS

18.2.1 PRECIPITATION

Precipitation is seasonal, with a general wet season from September to April with most of the precipitation falling between January and March, and a dry season from May to August.

Table 18.1 shows estimated precipitation ranges for the peak and general wet seasons based on the isohyets developed by the ESIA. No precipitation data are available for the dry season.

Table 18.1. Estimated Peak and General Wet Season Precipitation Ranges - ELU 11

Estimated Precipitation (mm)			
Peak (January – March)		General (September – April)	
KP Range	Precipitation (mm)	KP Range	Precipitation (mm)
249+538 - 272+181	200-300	249+538 – 257+000	400-500
		257+000 - 272+181	300-400

Source: ESIA, Environmental Baseline

18.2.2 GEOLOGY

This principal geological formation of the Pisco-Ica Watershed Divide ELU is composed of limestones and calcareous sandstones partially interspersed with lutite. The coastal batholith is a gigantic intrusion, with outcrops in the westernmost Andes starting in the western part of ELU 10 and extending to the eastern part of ELU 13. It comprises a set of intrusive formations that include tonalite, granites, monzonite, granodiorites, diorites, monzodiorites, monzogabros, and grabbros. These intrusions form a chain of steep hills, generally without thick covering of residue except at the toe of the slopes where there are thick colluvial deposits. These rocks are typically extremely hard below the superficial depth of weathering. They present a moderate to high level of fracturing and moderate to intense weathering at the ground surface.

The metallic mineralization present in certain areas of these rocks implies a risk of acid rock drainage (ARD), which could become temporarily accelerated in association with ground disturbance caused by pipeline installation earthworks activities.

Table 18.2 lists the sectors with potential risk of acid rock drainage (ARD) occurrence along the ROW.

Table 18.2. Sectors of Medium to High ARD Risk – ELU 11

Risk Level	Length (m)	
Medium	KP 255+000 to KP 265+000	10,000

Source: EFS Fieldwork

18.2.3 SOILS

Surface Horizon Characteristics

The EFS collected three surface horizon samples in ELU 11. The samples pH was either alkaline (2 samples) or strongly acidic (1 sample). The alkaline sample from KP 256+000 had high level of CaCO_3 (27.1%). According to EFS samples, surface horizon is of medium depth along the whole ELU. Organic matter content along the ROW is variable with one sample high and two medium. Fertility of the surface horizon, based on levels of available phosphorus, was mostly medium (two samples) or low (one sample). Surface horizon sample characteristics are presented in Table 18.3.

Table 18.3. Surface Horizon Characteristics - ELU 11

KP	pH	Surface horizon depth	Organic matter	Fertility	Slope (%)
251+000	Strongly acid	Medium	High	Low	70%
256+000	Lightly alkaline	Medium	Medium	Medium	80%
260+000	Lightly alkaline	Medium	Medium	Medium	80%

Source: ESIA Physical Baseline and Domus.

pH: Strongly acidic = Less than 5.5; Moderately acidic = 5.6 to 6.0; Slightly acidic = 6.1 – 6.5; Neutral = 6.6 - 7.0; Slightly alkaline = 7.1 – 7.8; Moderately alkaline = 7.9 to 8.4; Strongly alkaline = More than or equal to 8.5.

Surface horizon depth: Shallow = Less than 5 cm; Medium = 5 cm to 15 cm; Deep = More than 15 cm.

Organic matter: Low = Less than 2%; Medium = 2% to 4%; High = More than 4%.

Fertility based on Available Phosphorus: Low = Less than 7.0 ppm; Medium = 7.0 to 14.0 ppm; High = More than 14.0 ppm.

Subsoil Characteristics

The subsoil texture fluctuates from loamy sand to loam and does not hinder the infiltration of water. However, both the surface horizon and subsoil are very loose and the stability of the soil aggregates is low. Organic matter and nutrients are low in the subsoil.

Overall, the soils are typical of a vegetated mountain environment of moderately high elevation with acidic, organic soils of low fertility and a distinctive surface horizon.

18.2.4 WATERBODIES

ELU 11 is a very dry region with only intermittent streams typically flowing only during flash floods or parts of the rainy season. Also, the ROW has limited stream crossings due as well to its location being almost entirely along ridge tops.

According to the EFS data base, ELU 11 crosses only three streams referred to in Table 18.4.

Table 18.4. Principal Waterbody Crossings - ELU 11

Waterbody Type or Name	KP Mid-channel	Elevation (m)
Arroyos		
ARROYO	255+870.53	3678.31
ARROYO	256+353.70	3698.56
ARROYO	257+789.0	3443.43
Quebradas		
QUEBRADA	257+472.0	3464.93
QUEBRADA	259+170.67	3321.15
QUEBRADA	259+480.20	3348.59
QUEBRADA	261+210.52	3576.25

QUEBRADA	261+931.13	3502.35
QUEBRADA	261+952.75	3504.52
QUEBRADA	262+290.78	3521.04
QUEBRADA	262+307.84	3519.46
QUEBRADA	263+327.44	3433.30
QUEBRADA	263+444.70	3453.74
QUEBRADA	265+395.72	3029.38
QUEBRADA	266+206.91	2931.62
QUEBRADA	266+561.42	2907.50
QUEBRADA	267+638.25	2848.52
QUEBRADA	268+111.63	2879.79
QUEBRADA	268+268.31	2873.82
QUEBRADA	268+557.52	2861.06
QUEBRADA	268+995.32	2833.06
QUEBRADA	269+069.15	2808.32
QUEBRADA	269+778.35	2838.01
QUEBRADA	269+970.01	2803.82
QUEBRADA	270+125.36	2805.20

Source: Peru LNG Pipeline Project Alignment Sheets (Gulf Interstate Engineering, 2006).

18.2.5 *INSTABILITY AND PHYSICAL RISK*

The level of instability and physical risk in ELU 9 is categorized as Low in approximately 19% of the ROW length, and as Medium and High in the remaining 65% and 16% of the ROW, respectively (Table 18.5).

Table 18.5. Instability and Physical Risk - ELU 11

Risk Level	KP Start	KP Finish	Length (m)
Low	249+538	249+643	105
	252+399	253+542	1143
	256+731	259+743	3012
Medium	249+643	252+399	2756
	253+542	255+000	1458
	255+162	256+222	1060
	260+163	263+524	3361
	265+646	272+181	6535
High	255+000	255+162	162
	256+222	256+731	509
	259+743	260+163	420
	263+524	265+646	2122

Source: ESIA Physical Baseline Map 1.1-4 and Domus.

18.2.6 INFRASTRUCTURE

Infrastructure requirements such as camps and access roads are based on assumptions set out in the ESIA Project Description and are subject to change, depending on the requirements outlined in the Contractor's Plan of Work.

Six shooflies are proposed to facilitate the construction phase. A Base Camp is proposed near KP 266+369, Huancaccasa. This camp may include a pipe yard.

Table 18.6. Planned Project Infrastructures – ELU 11

Type of Infrastructure	KP	Name
Camps and Pipeyards	266+369	Huancaccasa
Shooflies	252+308	Km. 452 to KM 462
	259+140	VVR1 to VVR3
	263+828	VVR8 to VVR20
	268+506	VVR29 to VVR37
	270+847	VVR38 to VVR38A
	271+796	VVR39 to VVR40

Source: ESIA Project Description.

18.3 HABITATS AND SPECIES

18.3.1 HABITAT DISTRIBUTION

The habitats of ELU 11 are listed in sequential order in Table 18.7, including the length of each habitat unit and associated start and finish ROW KPs. Table 18.8 presents habitat lengths over the ROW sorted by habitat type, with subtotals for each habitat.

Table 18. 7. Habitat Sequence – ELU 11

Habitat Type	Length (m)	KP Start	KP Finish
Mixed Scrub	3,847	249+538	253+385
Thorny Scrub	916	253+385	254+301
Mixed Scrub	5,637	254+301	259+938
Thorny Scrub	3,674	259+938	263+612
Mixed Scrub	8,388	263+612	272+000
Desert Scrub	181	272+000	272+181

Table 18.8. Habitat Summary – ELU 11

Habitat Type	Length (m)	KP Start	KP Finish
Thorny scrub	916	253+385	254+301
	3,674	259+938	263+612
Total	4,590	20.27%	
Mixed scrub (Mixed Underbrush - MM)	3,847	249+538	253+385
	5,637	254+301	259+938
	8,388	263+612	272+000
Total	17,872	78.93%	
Desert Scrub	181	272+000	272+181
Total	181	0.80%	
Total ELU 11:	22,643		

Source: ESIA Biological Baseline Map 2-1 and Domus.

18.3.2 HABITAT DESCRIPTIONS

Thorny scrub

In the Pisco-Ica Watershed Divide ELU, thorny scrub occupies 20.27% of the ROW length and tends to be located on medium to steep slopes and rocky substrates, where the combination of weakly developed soils, seasonal rainfall and steep slopes result in extensive erosion. In areas with more gradual slopes, more dense vegetation develops approaching heights of approximately 1.3 m. and *Berberis* spp. and *Dunalia* sp. are common shrubs in this habitat type.

Mixed Scrub

Mixed scrub habitats accounts for 78.93% of the ELU 11 ROW length and consists of poorly vegetated slopes with patches dominated by species of the genera *Lupinus*, and *Junellia*. The most important species observed in the mixed scrub of ELU 11 is *Chersodoma arequipensis* listed as critically endangered by the INRENA.

Desert Scrubs

This habitat accounts for less than 1% of the RoW from the final 200m of the western edge of the ELU. The cactus *Senecio tovari*, was observed in this habitat.

Key Fauna

A pampas cat (*Leopardus pajeros*) was registered in this ELU (KP 253+000). Other mammals registered were the rodents *Phyllotis* cf. *xanthopygus* and *Calomys* sp. Locals mentioned the presence of the pallid fat-tailed opossum (*Thylamys pallidior*), Andean fox (*Lycalopex culpaeus*), long-tailed weasel (*Mustela frenata*), Molina's hog-nosed skunk (*Conepatus chinga*) and northern viscacha (*Lagidium peruanum*).

Birds registered in this ELU were the aplomado falcon (*Falco femoralis*), red-back hawk (*Buteo polyosoma*), Andean flicker (*Colaptes rupicola*), among others. The ESIA reported an observation of the rufous-breasted warbling-finch (*Poospiza rubecula*), a species listed as endangered by both the IUCN and the INRENA, from a location in Mixed Scrub about 1,300 m downslope of the ROW near KP 249+000.

The EFS Field Survey collected lizards in mixed scrub at elevations between 3760 and 3900 m, that may be an undescribed montane form related to *Microlophus tigris* (INRENA-NT) or a unique high elevation population of this species. The lizard *Microlophus tigris* (INRENA-NT) and *Liolaemus* spp. were common among the rocks.

Hydrobiology

No hydrobiologic analysis was performed in this ELU.

18.3.3 SPECIES SENSITIVITY ANALYSIS

Table 18.9 shows the high and medium sensitivity species observed during the EFS Field Survey, based on the species sensitivity criteria presented in Section 7.1 of the EFS.

One high sensitivity plant species (*Chersodoma arequipensis*) was observed in the ELU which is of critically endangered protection status, of localized spatial distribution and used locally.

There is one other plant species of Medium Sensitivity (*Senecio tovari*) which is not classified as threatened but is only of local distribution.

Two reptile species (*Iloaemus sp*) and *microlophus affitigiris* are also of Medium Sensitivity.

18.3.4 SPECIES SENSITIVITY ANALYSIS

Table 18.9. Species Sensitivity Criteria - ELU 11

No	Species	Protection Status						Spatial Distribution			Local Use			Mobility		Σ
		CR	EN	VU	NT	L	N	Local	Regional	Widespread	Permanent	Seasonal	None	Immobile	Mobile	
	Plants															
1	<i>Chersodoma arequipensis</i>	6						3			2			3		14
2	<i>Croton ruizianus</i>					0			2	0			0	3		5
3	<i>Dunalia spinosa</i>					0			2				0	3		5
4	<i>Erodium cicutarium</i>					0				0			0	3		3
5	<i>Junellia juniperina</i>					0			2	0			0	3		5
6	<i>Senecio tovari</i>					0		3			2		0	3		8
7	<i>Solanum</i> sp.					0				0			0	3		3
8	<i>Stenomesson incarnatum</i>					0			2				0	3		5
	Reptiles and amphibians															
9	<i>Liolaemus</i> sp.					0		3					0	3		6
10	<i>Microlophus</i> aff. <i>tigris</i>				3				2				0	3		8
	Mammals															
11	<i>Conepatus chinga</i>					0				0			0		0	0
12	<i>Lagidium peruanum</i>					0		3			2				0	5
13	<i>Leopardus (Oreailurus) pajeros</i> (L. <i>colocolo garieppi</i>)					0			2				0		0	2
14	<i>Lycalopex (Pseudalopex) culpaeus</i>					0			2				0		0	2
15	<i>Mustela frenata</i>					0				0			0		0	0
16	<i>Phyllotis amicus</i>					0				0			0		0	0
17	<i>Phyllotis magister</i>					0				0			0		0	0
18	<i>Phyllotis xanthopygus posticalis</i>					0		3		0	2		0		0	5
19	<i>Thylamys pallidior</i>					0				0	2				0	2
	Birds															
20	<i>Buteo polyosoma</i>					0				0			0		0	0
21	<i>Colaptes atricollis</i>					0			2				0		0	2
22	<i>Colaptes rupicola</i>					0				0			0		0	0
23	<i>Falco femoralis</i>					0				0			0		0	0
24	<i>Geranoaetus melanoleucus</i>					0				0			0		0	0
25	<i>Nothoprocta ornata</i>					0			2				0		0	2

26	<i>Phalcoboenus megalopterus</i>					0			0			0		0	0
27	<i>Thinocorus orbignyianus</i>					0			0	2				0	2
28	<i>Vanellus resplendens</i>					0		2				0		0	2

Protection Status*: CR= Critically endangered 6 points EN= Endangered 5 points VU= Vulnerable 4 points NT= Near threatened 3 points B= Low (Others) 2 points N= Not listed 0 points Σ = Sensitivity value 1 - 5: Low 6 - 10: Medium 11 or higher: High	Species Distribution: Local = (Endemic locally or to an EBA**) 3 points Regional = (Regional endemic in Andes or Coast) 2 points Widespread = (Across S. America or cosmopolitan) 0 points Mobility: Immobile = (restricted movement or in very short distance) 3 points Mobile = 0 points	Local Uses: Permanent= 2 points Seasonal = 1 point None = 0 points
*Protection Status: According IUCN (2006) or National Legislation (D.S. No. 034-2004-AG/D.S. No. 043-2005-AG) **EBA: Areas determined by Birdlife International, which includes at least 2 bird species with less than 50,000 km2 of known distribution range.		

18.3.5 HABITAT SENSITIVITY ANALYSIS

Rufous-breasted warbling-finch (*Poospiza rubecula*) and pale-tailed canastero (*Asthenes huanacavelicae*) were reported by ESIA in Huaytará area, between KP 245+000 to 250+000, proposed by ESIA sensitivity analysis as a sensitive sector. However none were observed during the EFS survey.

Based on the information presented in Table 18.10, the Mixed Scrub and the Thorny Scrub habitats of the Pisco Ica Watershed Divide habitats of ELU 11 are considered to be of High Sensitivity due to the presence of one High Sensitivity plant species (*Chersodoma arequipensis*) in each.

The potential occurrence of populations of the endangered rufous-breasted warbling finch would also raise the Mixed Scrub to the High Sensitivity category.

18.4 KEY ISSUES AND RECOMMENDATIONS

Soils

Precipitation in this ELU is not high, but steep slopes combined with rain during the wet season can cause erosion. The Highly Unstable area (KP 255+000 to KP 265+000) needs special measures to avoid erosive processes. Biorestation techniques including hydroseeding should be considered for this stretch.

This ELU presents some characteristics that are favorable to revegetation. During the construction, erosion control devices as silt fences, slope breakers and wooden barriers must be implemented.

Instability and Physical Risk

A Highly Unstable area was registered in 264+900 - 267+000. It is considered that stretches with Slightly Unstable areas will not require special Biorestation works, but Moderately Unstable ones need some measures that are described in the Key Issues section (Table 18.10).

Habitats and Species

Chersodoma arequipensis is listed as a critically-endangered species by the INRENA and should thus receive special attention. *Senecio tovari* is a local endemic species sensitive to habitat loss. Collection of seeds of both species should be arranged for later propagation prior to RoW clearance to be used to revegetate the habitats as close as reasonably possible to the original conditions during reinstatement.

Where lizards (*Liolaemus sp* and *Microlophus*) are identified in the RoW during the pre-clearance survey, especially in the mixed scrub habitats above 3400 m, these should be relocated to safe areas prior to site clearing and grading construction activities commence.

Sightings of the Rufous-breasted warbling finch (*Poospiza rubecula*) were reported from slopes below the ridge to the north of the ROW in the ESIA but not observed at the time of the EFS. The construction schedule for RoW site clearance should be designed to minimise the impact on this species' breeding and nesting season and pre-construction survey should identify the presence of any active nests.

Table 18.10 summarizes the key issues and recommendations for the Pisco-Ica Watershed Divide ELU.

Table 18.10. Key Issues and Recommendations - ELU 11

Issue	KP Reference	Action	Reference
Risk of mass wasting in Highly Unstable terrains	264+900 - 267+000	Geotectonic and hydro-geologic studies on-going to inform final permanent design.	ECOMP/RP
		Soil erosion control focused on mass movement in slopes and protection of topsoil for use during reinstatement. Extra biorestation techniques (hydroseeding, mulching, fertilizer) considered in highest risk areas.	
<i>Chersodoma arequipensis</i> and <i>senocio tovari</i>	253+385 – 254+301 259+938 – 263+612 (Mixed Scrub, Thorny Scrub)	Collection and storage of <i>Chersodoma arequipensis</i> seeds prior to site clearance for production of plants for ROW bioreinstatement.	ECOMP/RP
Lizards (<i>Liolaemus</i> and <i>Microlophus</i>)	All areas	Pre-Clearance Survey to identify and relocate from ROW prior to site clearance activities.	ECOMP
Rufous-breasted warbling finch (Endangered bird)	249+000 – 260+000	Design of construction schedule to minimize impacts of site clearance during bird nesting season	ECOMP/RP

Source: EFS Fieldwork

19.0 ELU 12: COASTAL BAT HILLS (KP 272+181 TO 308+000)

19.1 GENERAL DESCRIPTION

This high coastal desert foothills landscape is dominated by drought-adapted scrub and scattered cacti in dry hills and valleys at elevations from 750 to 3,100 m.

This ELU is arid with very scarce rains ranging from less than 50 mm each wet season in the west to over 200 mm in the higher elevations to the east. The topography is very variable, with mountains and dry river beds, which occasionally can transport water and large boulders in the form of flash floods.

This arid and rocky landscape is home to threatened species such as long-snouted bats (*Platalina genovensium*) and the lizard *Microlophus tigris*. This unit corresponds to the Seco river basin and is named after the presence of the *Platalina* bats as well as the Quebrada Murciélagos ("Bat Stream").

19.2 PHYSICAL CHARACTERISTICS

19.2.1 PRECIPITATION

Precipitation is seasonal, with a general wet season from September to April with most of the precipitation falling between January and March, and a dry season from May to August.

Precipitation is markedly less at the westernmost end of the ELU at the foot of the Andes Mountains and the edge of the coastal plain at elevations between 750 to 1,000 m.

Table 19.1 shows estimated precipitation ranges for the peak and general wet seasons based on the isohyets developed by the ESIA. No precipitation data are available for the dry season.

**Table 19.1. Estimated Peak and General Wet Season
Precipitation Ranges - ELU 12**

Estimated Precipitation			
Peak (January – March)		General (September-April)	
KP Range	Precipitation (mm)	KP Range	Precipitation (mm)
272+181 – 282+000	200-300	272+181 – 279+000	300-400
282+000 - 288+000	100-200	279+000 - 286+000	200-300
288+000 - 302+000	50-100	286+000 - 297+000	100-200
302+000 - 308+000	0 - 5	297+000 - 304+000	50-100
		304+000 - 308+000	10 - 50

Source: ESIA Physical Baseline Maps 1.2-1 and 1.2-2.

19.2.2 GEOLOGY

The geology of the Coastal Bat Hills ELU is dominated by intrusive formations, with gabbro, diorities, tonalites, and granodiorites, resulting in a steep, rocky landscape between KPs 272+181 and 299+000. These are intrusive formations interrupted by the volcanic Copará formation between KPs 277+700 and 284+300, which is the highest elevation sector of the ELU. From KP 299+000 westward, the ROW follows the valley floor margin of the Seco River through Pleistocene and Holocene alluvial deposits.

The metallic mineralization present in certain areas of these rocks implies a risk of acid rock drainage in the event of an extraordinary rainy event, which could become temporarily accelerated in association with pipeline installation earthworks activities.

Table 19.2 lists the sectors with potential risk of acid rock drainage (ARD) occurrence along the ROW.

Table 19.2. Sectors of ARD Risk – ELU 12

Level of Risk	Length (m)	
Medium	KP 285+000 to KP 300+000	15,000

Source: ESIA Physical Baseline Appendix 3.3.4.

Due to the low rainfall values and the absence of perennial waterbodies or wetlands in this desert ELU, the risk associated with potential ARD materials in this ELU is minimal.

19.2.3 SOILS

One surface horizon sample was taken in ELU 12 (Table 19.3). Soil pH was moderately alkaline, but without evidence of salinization. Organic matter and fertility based on available phosphorus were low. The surface horizon has a high depth along all the ELU, despite the variable slope in the ROW. The surface horizon and subsoil textures are sandy and the soil is very well drained.

Table 19.3. Surface Horizon Characteristics - ELU 12

KP	pH	Surface horizon depth	Organic matter	Fertility	Slope (%)
290+000	Moderately alkaline	High	low	low	30%

Source: ESIA Physical Baseline and Domus.

pH: Strongly acidic = Less than 5.5; Moderately acidic = 5.6 to 6.0; Slightly acidic = 6.1 – 6.5; Neutral = 6.6 - 7.0; Slightly alkaline = 7.1 – 7.8; Moderately alkaline = 7.9 to 8.4; Strongly alkaline = More than or equal to 8.5.

Surface horizon depth: Shallow = Less than 5 cm; Medium = 5 cm to 15 cm; Deep = More than 15 cm.

Organic matter: Low = Less than 2%; Medium = 2% to 4%; High = More than 4%.

Fertility based on Available Phosphorus: Low = Less than 7.0 ppm; Medium = 7.0 to 14.0 ppm; High = More than 14.0 ppm.

19.2.4 WATERBODIES AND WETLANDS

The Coastal Bat Hills are highly dissected and the ROW crosses various channels that have only ephemeral or intermittent flows. Nevertheless, the ROW runs parallel to some quebradas between approximately KP 299+000 to 308+000. Table 19.4 details waterbody crossings for this ELU.

Table 19.4. Principal Waterbody Crossings - ELU 12

Waterbody Type or Name	KP Mid-channel	Elevation (m)
Quebradas		
QUEBRADA	274+144.39	2897.86
QUEBRADA	274+818.40	2905.72
QUEBRADA	275+001.16	2891.35
QUEBRADA	276+046.52	2768.90
QUEBRADA	277+055.21	2854.79
QUEBRADA	277+407.77	2851.91
QUEBRADA	277+485.01	2844.74
QUEBRADA	277+585.10	2843.88
QUEBRADA	277+790.04	2828.27
QUEBRADA	277+839.27	2824.35
QUEBRADA	277+948.08	2820.98
QUEBRADA	277+987.86	2822.16
QUEBRADA	278+297.31	2844.46
QDA. SAN JUAN	288+019.73	1803.69
QUEBRADA	288+108.01	1811.05
QUEBRADA	288+192.82	1831.48
QUEBRADA	299+464.46	1088.14
QUEBRADA	299+651.25	1081.98
QUEBRADA	299+974.68	1076.10
QUEBRADA	300+010.90	1078.30
QUEBRADA	300+022.54	1077.98
QUEBRADA	300+048.90	1078.55
QUEBRADA	300+062.14	1076.41
QUEBRADA	300+222.01	1062.36
QUEBRADA	300+377.53	1045.59

QUEBRADA	300+560.63	1036.73
QUEBRADA	301+580.95	997.98
QUEBRADA	302+080.34	965.74
QUEBRADA	302+177.93	961.42
QUEBRADA	302+437.05	962.24
QUEBRADA	302+521.15	960.85
QUEBRADA	302+588.47	961.03
QUEBRADA	302+996.79	930.33
QUEBRADA	303+292.84	914.66
QUEBRADA	304+237.93	874.70
QUEBRADA	307+334.02	745.48
QUEBRADA	307+420.16	742.29
QUEBRADA	307+922.88	728.94

Source: Peru LNG Pipeline Project Alignment Sheets (Gulf Interstate Engineering, 2006).

19.2.5 *INSTABILITY AND PHYSICAL RISK*

Precipitation levels in the ELU are not enough to promote significant erosion processes, except in unusual years or occasional storms.

Table 19.5. Instability and Physical Risk - ELU 12

Risk Level	KP Start	KP Finish	Length (m)
Low	274+387	278+578	4191
	293+241	294+895	1654
	303+574	304+123	549
	304+776	304+946	170
Medium	272+181	274+387	2206
	278+578	280+150	1572
	280+394	286+273	5879
	288+467	293+241	4774
	297+865	298+854	989
	298+908	299+149	241
	299+655	300+620	965
	301+426	302+165	739

High	280+150	280+394	244	11,890
	286+273	288+467	2194	
	294+895	297+865	2970	
	298+854	298+908	54	
	299+149	299+655	506	
	300+620	301+426	806	
	302+165	303+574	1409	
	304+123	304+776	653	
	304+946	308+000	3054	

Source: ESIA, Environmental Baseline

19.2.6 INFRASTRUCTURE

Four shooflies are proposed at this ELU and listed in Table 19.6

Table 19.6. Planned Project Infrastructures – ELU 12

Type of Infrastructure	KP	Name
Shooflies	276+297	VVR56 to VVR58
	278+217	VVR60 to VVR37-38
	278+831	VVR60 to VVR61
	289+088	San Juan Stream right margin

Source: ESIA Project Description.

19.3 HABITATS AND SPECIES

19.3.1 HABITAT DISTRIBUTION

ELU 12 has only two habitat types as detailed in Table 19.7. Within the Project area, both of these habitats are found only in the Coastal Bat Hills ELU.

Table 19.7. Habitat Sequence – ELU 12

Habitat Type	Length (m)	Percentage of Length	KP Start	KP Finish
Desert Scrub	15,743	43.95%	272+181	287+924
Columnar Cacti and Scrub	20,076	56.05%	287+924	308+000

Source: ESIA Biological Baseline Map 2-1 and Domus.

19.3.2 HABITAT DESCRIPTION

Desert Scrub

Desert scrub is present in the eastern sector part of the ELU between KPs 272 and 288, largely in zones with rainfall exceeding 200 m. This habitat type is dominated by saltbush (*Atriplex peruviana*). Columnar cacti such as *Browningia candelaris* (INRENA vulnerable) and *Cleistocactus* sp. appear sporadically. Other important species in this habitat type are the shrub *Bulnesia retama* and the locally endemic cacti *Armatocereus procerus* and *Cleistocactus acanthurus* (INRENA endangered).

Columnar Cacti and Scrub

This formation is characterized by the prevalence of taller tree-like or “organ-pipe” cacti, usually over a meter in height, which are species of the genera *Armatocereus*.

At the bottom of the Seco River, near the Bolivar mine, there is a patch of columnar cacti with deciduous shrubs that stands out due to the presence of species of conservation interest such as the locally endemic cacti *Armatocereus procerus*, *Neoraimondia arequipensis* and *Cleistocactus acanthurus* (INRENA endangered), and the locally-endemic drought-deciduous tree *Orthopterygium huacui*.

Another notable plant observed by the EFS Survey within the columnar cacti and scrub habitat was the INRENA near-threatened *Ephedra americana*.

Key Fauna

Although not observed during the EFS Field Survey, the ESIA field studies documented the presence of the long-snouted bat (*Platalina genovensium*) at the Bolívar Mine (located approximately 800 from the ROW near KP 299+000), a species that feeds on the nectar of night-blooming cacti and which is categorized as vulnerable by the IUCN and as critically endangered by the INRENA. This species is included in the ESIA commitments.

Other representative mammals registered in the ELU were Andean fox (*Lycalopex culpaeus*), Argentine gray fox (*Lycalopex* cf. *griseus*), Molina's hog-nosed skunk (*Conepatus chinga*), mice of the genus *Phyllotis*, and montane guinea pig (*Cavia tschudii*).

Birds registered in the area were the streaked tit-spinetail (*Leptasthenura striata*, thick-billed miner (*Geositta crassirostris*), coastal miner (*Geositta peruviana*), and the cactus canastero (*Asthenes cactorum*).

The INRENA near-threatened lizard *Microlophus tigris* is a typical element of the rock-strewn habitats which was observed by the EFS Field Survey. The gecko lizard, *Phyllodactylus lepidopygus*, was also observed in this ELU.

Hydrobiology

No hydrobiologic analysis was performed in this ELU.

19.3.3 SPECIES SENSITIVITY ANALYSIS

Table 19.8 shows the high and medium sensitivity species observed during the EFS Field Survey, as well as those documented by the ESIA, based on the species sensitivity criteria presented in Section 7.1 of the EFS.

One High Sensitivity plant species observed was *Cleistocactus acanthurus*, which is listed as Endangered, is only of local distribution and has a local use for the community.

There are six Medium Sensitivity plant species with protection status and only local or regional distribution.

Two Medium Sensitivity reptile species were also observed, *Microlophus tigris* and *Phyllodactylus lepidopygus*.

Table 19.8. Species Sensitivity Criteria - ELU 12

No	Species	Protection Status						Spatial Distribution			Local Use			Mobility		Σ
		CR	EN	VU	NT	L	N	Local	Regional	Widespread	Permanent	Seasonal	None	Immobile	Mobile	
	Plants															
1	<i>Alternanthera halimifolia</i>						0			0			0	3		3
2	<i>Armartocereus procerus</i>						0		2	0			0	3		5
3	<i>Atriplex peruviana</i>						0		2				0	3		5
4	<i>Boerhavia coccinea</i>						0			0	2			3		5
5	<i>Browningia candelaris</i>			4					2					3		9
6	<i>Bulnesia retama</i>						0		2	0			0	3		5
7	<i>Cleistocactus acanthurus</i>		5					3			2			3		13
8	<i>Cnidoscolus basiacanthus</i>			4					2				0	3		9
9	<i>Ephedra americana</i>				3				2				0	3		8
10	<i>Loasa incana</i>						0	3					0	3		6
11	<i>Neoraimondia arequipensis</i>						0	3					0	3		6
12	<i>Orthopterygium huacui</i>						0	3					0	3		6
13	<i>Tiquilia paronychioides</i>						0		2				0	3		5
	Reptiles and amphibians															
14	<i>Microlophus tigris</i>				3				2				0	3		8
15	<i>Phyllodactylus lepidopygus</i>						0	3					0	3		6
	Mammals															
16	<i>Cavia tschudii</i>						0			0			0		0	0
17	<i>Conepatus chinga</i>						0			0			0		0	0
18	<i>Didelphis pernigra</i>						0			0			0		0	0
19	<i>Histiotes sp.</i>						0		2				0		0	2
20	<i>Lycalopex (Pseudalopex) culpaeus</i>								2				0		0	2
21	<i>Lycalopex (Pseudalopex) griseus</i>						0		2				0		0	2
22	<i>Mus musculus</i>						0			0			0		0	0
23	<i>Phyllotis amicus</i>						0			0			0		0	0
24	<i>Phyllotis limatus</i>						0		2				0		0	2
25	<i>Thylamys pallidior</i>						0			0	2				0	2
	Birds															
26	<i>Asthenes cactorum</i>						0	3					0		0	3
27	<i>Athene cunicularia</i>						0		2				0		0	2

28	<i>Chordeiles acutipennis</i>					0			0			0		0	0
29	<i>Columbina cruziana</i>					0	2					0		0	2
30	<i>Falco sparverius</i>					0			0			0		0	0
31	<i>Gallinula chloropus</i>					0			0			0		0	0
32	<i>Geositta crassirostris</i>					0	2					0		0	2
33	<i>Geositta peruviana</i>					0	2					0		0	2
34	<i>Leptasthenura striata</i>					0	2					0		0	2
35	<i>Myrtis fanny</i>					0	2					0		0	2
36	<i>Muscisaxicola maclovianus</i>					0			0			0		0	0
37	<i>Passer domesticus</i>					0			0			0		0	0
38	<i>Rhodopsis vesper</i>					0	2			2				0	4

Protection Status*:

CR= Critically endangered 6 points
 EN= Endangered 5 points
 VU= Vulnerable 4 points
 NT= Near threatened 3 points
 B= Low (Others) 2 points
 N= Not listed 0 points

Σ= Sensitivity value

1 - 5: Low

6 - 10: Medium

11 or higher: High

Species Distribution:

Local = (Endemic locally or to an EBA**) 3 points
 Regional = (Regional endemic in Andes or Coast) 2 points
 Widespread = (Across S. America or cosmopolitan) 0 points

Mobility:

Immobile = (restricted movement or in very short distance) 3 points
 Mobile = 0 points

Local Uses:

Permanent= 2 points
 Seasonal = 1 point
 None = 0 points

***Protection Status:** According IUCN (2006) or National Legislation (D.S. No. 034-2004-AG/D.S. No. 043-2005-AG)

****EBA:** Areas determined by Birdlife International, which includes at least 2 bird species with less than 50,000 km2 of known distribution range.

19.3.4 HABITAT SENSITIVITY ANALYSIS

Based on the information presented in Table 19.8, the Desert Scrub and the Columnar Cacti and Scrub habitat of the Coastal Bat Hills ELU meets the criteria for a High Sensitivity habitat due to the presence of one High Sensitivity plant species in each, and seven Medium Sensitivity plant species in the Columnar Cacti and Scrub habitat.

19.4 KEY ISSUES AND RECOMMENDATIONS

Physical Environment

Due to the arid climate and rare rain events, there is little risk of significant ARD, erosion, sedimentation, or instability issues.

Habitat and Species

The Columnar Cacti with Scrub habitat contains six Medium Sensitivity and one High Sensitivity plant species and two Medium Sensitivity lizard species presented by Table 19.8. All of these species could be properly managed with available techniques for plant translocation or replacement or fauna capture and relocation process.

The most practicable proposal is to replace the cacti and reestablish the shrubs by seed.

The long-snouted bat (*Platalina genovensium*) is a critically endangered species under Peruvian legislation. This bat depends upon the presence of reproductively mature (i.e., flowering) columnar cacti for its food source; thus, conservation efforts for this bat should focus on the protection of cactus habitat by replacement of lost plants cleared from the ROW.

A Pre-Clearance Survey should be undertaken immediately prior to construction clearing, grading and topsoil strip activities to identify any sensitive lizards (*Microlophus tigris* and *Phyllodactylus lepidopygus*), which are especially likely to be found in rocky areas of the Columnar Cacti habitat. The lizards should be moved to a safe area of same or similar habitat at a reasonable distance outside the zone of impact by construction activities.

Table 19.9. Key Issues and Recommendations - ELU 12

Issue	KP Reference	Recommendations	Reference
High and Medium Sensitivity Cacti (<i>Cleistocactus acanthurus</i> , <i>browningia candelaris</i> , <i>neoralmondia arequipensis</i>)	Cactus Habitat	Replace lost cacti by propagation from cutting.	ECOMP
Medium Sensitivity Shrubs and Sub-Shrubs (<i>Cnidoscolus basiacanthus</i> and <i>Ephedra Americana</i> , <i>loasa incana</i> and <i>orthopterygium huaucui</i>)	295+000 300+200 305+000	Use of native seeds from these species during construction.	ECOMP
Lizards (<i>Microlophus tigris</i> and <i>Phyllodactylus lepidoygus</i>)	ELU Wide	Pre-Clearance Survey to identify and relocate lizards from ROW prior to site clearing activities.	ECOMP

Source: Domus.

20.0 ELU 13: PISCO SAND PLAINS (KP 308+000 TO 332+940)

20.1 GENERAL DESCRIPTION

This ELU consists of sandy plains areas within the Pisco Sand Plains on the western edge of the Andes. Altitude ranges from 256m on the plains to 750 m in the lower foothills of the Andes. Given the very low rainfall and the scant development of soils, most of the ELU is devoid of vegetation, with the exception of areas with mat-forming bromeliads (*Tillandsia* spp.) or islands of vegetation in depressions with high watertables or standing water. This ELU includes the settlement of Bernales.

20.2 PHYSICAL CHARACTERISTICS

20.2.1 PRECIPITATION

The eastern sector near the foothills has an annual precipitation from 10 to 50 mm, while west of of KP 318+000, annual precipitation does not exceed 10 mm (Table 20.1).

Table 20.1. Estimated Peak and General Wet Season Precipitation Ranges - ELU 13

Estimated Precipitation			
Peak (January – March)		General (September-April)	
KP Range	Precipitation (mm)	KP Range	Precipitation (mm)
308+000 - 318+000	5 - 50	308+000 - 317+000	10 - 50
318+000 - 332+940	0 - 5	317+000 - 332+940	0 - 10

Source: ESIA Physical Baseline Maps 1.2-1 and 1.2-2.

20.2.2 GEOLOGY

From KP 308+000 to about KP 314+000, the ROW traverses Quaternary alluvium from the Seco River Basin. Between approximately KP 314+000 and 319+000, the ROW passes over monzonite intrusions that form a chain of steep hills, generally without thick covering of residue except at the toe of the slopes where there are thick colluvial desposits. These rocks are typically extremely hard below the depth of weathering. They present a moderate to high level of fracturing and moderate to intense weathering at the ground surface. Westward of KP 391+000, the landscape is dominated by Quaternary aeolian deposits, with areas of extensive dune fields.

Soils

The sandy or rocky substrates present in the Pisco Sand Plains ELU have undergone minimal soil development. There is no organically enriched topsoil horizon in these sandy alluvial and aeolian deposits. PH is moderately alkaline, with medium salt content in the subsoil, very low phosphorus content, and medium to high levels of potassium. Due to the absence of clays and very low organic matter content, cation exchange capacity (CEC) is low. Table 20.2 summarizes key characteristics of the surface horizon of the two profiles examined in ELU 13.

Table 20.2. Surface Horizon Characteristics - ELU 13

KP	pH	Surface horizon Depth (cm)	Organic matter	Fertility	Slope (%)
309+000	Moderately alkaline	20	Low	Low	2%
310+000	Moderately alkaline	50	Low	Low	5%

Source: Domus.

pH: Strongly acidic = Less than 5.5; Moderately acidic = 5.6 to 6.0; Slightly acidic = 6.1 – 6.5; Neutral = 6.6 - 7.0; Slightly alkaline = 7.1 – 7.8; Moderately alkaline = 7.9 to 8.4; Strongly alkaline = More than or equal to 8.5.

Surface horizon depth: Shallow = Less than 5 cm; Medium = 5 cm to 15 cm; Deep = More than 15 cm.

Organic matter: Low = Less than 2%; Medium = 2% to 4%; High = More than 4%.

Fertility based on Available Phosphorus: Low = Less than 7.0 ppm; Medium = 7.0 to 14.0 ppm; High = More than 14.0 ppm.

Waterbodies and Wetlands

The primary waterbodies in this Pisco Sand Plains ELU are isolated lagoons that occur in swales between sand dunes in the sector between KPs 326+000 and 332+000.

These wetlands and lagoons, some of are believed to be related to palaeochannels, appear to be fed by seepage from the Pisco River which flows roughly parallel to this sector some 3.5 km to the north.

Table 20.3. Principal Waterbody Crossings - ELU 13

Waterbody Type or Name	KP Mid-channel	Elevation (m)
Quebradas		
QUEBRADA	330+640.40	266.90

Source: Peru LNG Pipeline Project Alignment Sheets (Gulf Interstate Engineering, 2006).

Instability and Physical Risk

There is no risk to waterbodies or wetlands or other sensitive ecological receptors due to instability or physical risk of ROW sectors in ELU 13 due to the near absence of rainfall in the ELU.

The land surfaces within the Pisco Sand Plains ELU have been subject to aeolian and episodic fluvial deposition events throughout the Quaternary geologic period; thus the habitats and species in this ELU have evolved under these dynamic environmental conditions.

Infrastructure

The ESIA Project Description does not identify any additional infrastructure to be built in this ELU.

Infrastructure requirements such as camps and access roads are based on assumptions set out in the ESIA Project Description and are subject to change, depending on the requirements outlined in the Contractor's Plan of Work.

20.3 HABITATS AND SPECIES

20.3.1 HABITAT DISTRIBUTION

Table 20.4 presents habitat sequence throughout ELU 13 and Table 20.5 presents a summary with subtotals of each habitat.

Table 20.4. Habitat Sequence – ELU 13

Habitat Type*	Length (mt)	KP Start	KP Finish
Desert Barrens	4,770	308+000	312+770
Tillandsia mats	1,819	312+770	314+589
Desert Barrens	673	314+589	315+262
Tillandsia mats	3,896	315+262	319+158
Desert Barrens	11,424	319+158	330+582
Coastal Hydromorphic Islands	58	330+582	330+640
Desert Barrens	1,860	330+640	332+500
Cultivated Areas	440	332+500	332+940

Source: ESIA Biological Baseline Map 2-1 and Domus.

Table 20.5. Habitat Summary – ELU 13

Habitat Type	Length (m)	KP Start	KP Finish
Tillandsia mats	1,819	312+770	314+589
	3,896	315+262	319+158
Total	5,715	22.91%	
Desert Barrens	4,770	308+00	312+770
	673	314+589	315+262
	11,424	319+158	330+582
	1,860	330+640	332+500
Total	18,727	75.09%	
Coastal Hydromorphic Islands	58	330+582	330+640
Total	58	0.23%	
Cultivated Areas	440	332+500	332+940
Total	440	1.76%	
Total ELU 13:	24,940		

Source: ESIA Biological Baseline Map 2-1 and Domus.

20.3.2 HABITAT DESCRIPTIONS

Desert Barrens

These are expansive areas that are devoid of vegetation due to the extreme aridity of the climate and the inability of the sandy or rocky substrates to retain moisture necessary to promote plant growth. Nevertheless, these habitats still support specialized desert fauna, primarily lizards.

***Tillandsia* mats**

These are areas carpeted by mats of *Tillandsia latifolia* and *T. palacea*, which are sand-dwelling bromeliads or “air plants” which receive their moisture directly from fog and rainfall rather than rooting in the droughty sands. There is a formation of Tillandsias on Cerro Serpiente between KPs 315+000 to 320+000.

Coastal Hydromorphic Islands

There are various patches or islands of vegetation growing under the influence of localized depressions with groundwater seepage at the surface during all or part of the year. These small and isolated habitats are found among the sand dunes between KP 326+000 to KP 332+000. These habitats include zones of wetlands dominated by cattails (*Typha domingensis*) and zones of saltgrass (*Distichlis spicata*). Other zones are dominated by woody plants typical of floodplains such as *Tessaria integrifolia* and *Pluchea chingoyo*. From a floristic perspective, these habitats are of low value as their flora is composed of common widespread species and introduced elements such the reed *Phragmites australis*. However, they are of great importance to local populations of fauna.

Fauna

Pampas cat (*Leopardus pajeros*), was reported in this ELU (KP 329+000), as well as the montane guinea pig (*Cavia tschudii*) at Laguna Morón, and the mouse *Oryzomys xantheolus*. The Norwegian rat *Rattus norvegicus* is a common invasive pest in the area. A rodent not registered by the field team was the *Oligoryzomys arenalis*, species registered by ESIA.

Among the more notable birds, slender-billed finch (*Xenospingus concolor*) and coastal miners (*Geositta peruviana*) and were observed by the EFS Field Survey in this ELU. Miners are terrestrial nesting birds.

The slender-billed finch is an endemic element of coastal desert riparian and hydromorphic formations and is listed as near threatened by the IUCN and as vulnerable by the INRENA.

The Peruvian coastal endemic lizards, *Dicrodon heterolepis*, and *Microlophus thoracicus icae* and the gecko lizard *Phyllodactylus lepidopygus* were documented by the EFS Field Survey.

A native coastal fish observed in this ELU was the Green Terror *Aequidens rivulatus*.

Hydrobiology

The green terror (*Aequidens rivulatus*), a small but aggressive fish commonly marketed in the international aquarium trade, was found in the Morón and Lagunillas lagoon. This fish is native to the northern coast of Peru. However, invasive exotic species were also found in these lagoons. Tilapia (*Oreochromis niloticus*) were found in both Morón and Lagunillas, while guppies (*Poecilia reticulata*) were found in Morón only.

Table 20.6. Waterbodies Sampled – ELU 13

Station	Habitat	Waterbody	Name	Height (masl)	KP	Species
Hi-05	Costero	Laguna	Morón	282	329+600	<i>Aequidens sp.</i> <i>Oreochromis sp.</i>
Hi-06	Costero	Laguna	Lagunillas		329+000	<i>Aequidens sp.</i> <i>Oreochromis sp.</i>

20.3.3 SPECIES SENSITIVITY ANALYSIS

Table 20.7 shows the high and medium sensitivity species observed during the EFS Field Survey, based on the species sensitivity criteria presented in Section 7.1 of the EFS. 3 reptile species and one bird species were identified as Medium Sensitivity.

Table 20.7. Species Sensitivity Criteria - ELU 13

No	Species	Protection Status						Spatial Distribution			Local Use			Mobility		Σ
		CR	EN	VU	NT	L	N	Local	Regional	Widespread	Permanent	Seasonal	None	Immobile	Mobile	
	Plants															
1	<i>Bromus catharticus</i>						0			0			0	3		3
2	<i>Distichlis spicata</i>						0			0			0	3		3
3	<i>Phragmites australis</i>						0			0			0	3		3
4	<i>Pluchea chingoyo</i>						0			0	2			3		5
	<i>Tessaria integrifolia</i>						0							3		3
	<i>Tillandsia latifolia</i>						0		2					3		5
5	<i>Tillandsia paleacea</i>						0		2				0	3		5
6	<i>Typha domingensis</i>						0			0	2			3		5
	Fishes															
7	<i>Aequidens rivulatus</i>						0		2				0	3		5
8	<i>Oreochromis niloticus</i>						0			0	2			3		5
	<i>Poecilia reticulata</i>						0				2			3		5
	Reptiles															
9	<i>Dicrodon heterolepis</i>			4				3					0	3		10
10	<i>Microlophus thoracicus icae</i>						0	3					0	3		6
11	<i>Phyllodactylus lepidopygus</i>						0	3					0	3		6
	Mammals															
12	<i>Cavia tschudii</i>						0			0			0		0	0
13	<i>Conepatus chinga</i>						0			0			0		0	0
14	<i>Didelphis pernigra</i>						0			0			0		0	0
15	<i>Leopardus (Oreailurus) pajeros</i> (<i>L. colocoli garipepi</i>)						0		2				0		0	2
16	<i>Lycalopex (Pseudalopex) culpaeus</i>						0		2				0		0	2
17	<i>Lycalopex (Pseudalopex) griseus</i>						0		2				0		0	2
18	<i>Oryzomys xantheolus</i>						0		2				0		0	2
19	<i>Rattus norvegicus</i>						0			0			0		0	0
20	<i>Sturnella bellicosa</i>						0		2				0		0	2
21	<i>Thylamys pallidior</i>						0			0	2				0	2
	Birds															
22	<i>Butorides striata</i>						0			0			0		0	0

23	<i>Camptostoma obsoletum</i>					0			0			0		0	0
24	<i>Cathartes aura</i>					0			0			0		0	0
25	<i>Egretta thula</i>					0			0			0		0	2
26	<i>Falco sparverius</i>					0			0			0		0	0
27	<i>Fulica ardesiaca</i>					0			0			0		0	0
28	<i>Geositta peruviana</i>					0		2				0		0	2
29	<i>Hemispingus atropileus</i>					0		2				0		0	2
30	<i>Mimus longicaudatus</i>					0		2				0		0	2
31	<i>Myiotheretes striaticollis</i>					0		2				0		0	2
32	<i>Nycticorax nycticorax</i>					0			0			0		0	0
33	<i>Pardirallus sanguinolentus</i>					0			0			0		0	0
34	<i>Podiceps major</i>					0			0			0		0	0
35	<i>Sporophila simplex</i>					0		2				0		0	2
36	<i>Sturnella bellicosa</i>					0		2				0		0	2
37	<i>Volatinia jacarina</i>					0			0			0		0	0
38	<i>Xenospingus concolor</i>			4				2				0		0	6

Protection Status*:

CR= Critically endangered 6 points
 EN= Endangered 5 points
 VU= Vulnerable 4 points
 NT= Near threatened 3 points
 B= Low (Others) 2 points
 N= Not listed 0 points

Σ= Sensitivity value

1 - 5: Low
6 - 10: Medium
11 or higher: High

Species Distribution:

Local = (Endemic locally or to an EBA**) 3 points
 Regional = (Regional endemic in Andes or Coast) 2 points
 Widespread = (Across S. America or cosmopolitan) 0 points

Mobility:

Immobile = (restricted movement or in very short distance) 3 points
 Mobile = 0 points

Local
Uses:

Permanent= 2 points
 Seasonal = 1 point
 None = 0 points

***Protection Status:** According IUCN (2006) or National Legislation (D.S. No. 034-2004-AG/D.S. No. 043-2005-AG)

****EBA:** Areas determined by Birdlife International, which includes at least 2 bird species with less than 50,000 km2 of known distribution range.

20.3.4 HABITAT SENSITIVITY ANALYSIS

Based on the information presented in Table 20.7, the Coastal Hydromorphic Islands and Lagoons habitat of the Pisco Sand Plains ELU meets the criteria for a High sensitivity habitat.

While not containing any highly sensitive species, these habitats are considered to be highly sensitive due to their uniqueness, limited geographic distribution, presence of various medium sensitivity species, and loss of similar habitats in the region to agricultural conversion.

20.4 KEY ISSUES AND RECOMMENDATIONS

Waterbodies and Wetlands

The lagoons and hydromorphic vegetation complex in this ELU has been studied by Golder (2007) and it was determined that depth of the pipeline grade would not affect the groundwater sources that feed these and that no special construction management is required in these areas.

Nevertheless, the supply of surface water to the Morón Lagoon from the Lagunillas wetlands presently provided by the drainage should be interrupted as briefly as possible during the construction phase and restored completely during reinstatement.

Habitats and Ecosystems

A Pre-Clearance Survey should be undertaken immediately prior to construction clearing, grading and topsoil strip activities to identify any sensitive lizards that need to be relocated to safe areas outside the ROW (listed in Table 20.6).

The lizards will be moved to an area of same or similar habitat at a reasonable distance outside the zone of impact by construction activities.

Table 20.8. Key Issues and Recommendations - ELU 13

Issue	KP reference	Action	Reference

Lizard species	All habitats	Pre-Clearance survey to identify and relocate lizards from ROW prior to site clearance activities.	ECOMP
Waterbodies Moron Lagoon	326+000 -332+000	Minimise project footprint area (25 metres) where practicable. Erosion control devices to minimize sediment runoff beyond the RoW. Best practice pollution prevention and control measures to minimize risk of hydrocarbon contamination to surrounding habitat. Site-specific environmental training / refresher toolbox talks for Crew Supervisors and workers.	ECOMP
Birds – Slender-billed finch (<i>Xenospingus concolor</i>)	ELU-wide	Identify any nests during Pre-Clearance Survey if ROW site clearance during nesting season.	ECOMP

Source: EFS Field Work.

21.0 ELU 14: ICA-LIMA COASTAL PLAIN (KP 332+940 – 402+000)

21.1 GENERAL DESCRIPTION

The Ica-Lima Coastal Plain ELU includes the entire zone from the Pisco River Valley north to the LNG Plant at Pampa Melchorita. Despite absence of appreciable rainfall, there are extensive cultivated areas under irrigation, occasional crossings of rivers with narrow belts of riparian vegetation, scattered tillandsias, and unvegetated desert. This ELU is generally flat, with elevations ranging between approximately 125 and 368 m. This unit includes a diverse series of settlements of the Departments of Pisco and Lima.

21.2 PHYSICAL CHARACTERISTICS

Precipitation

Precipitation along the coastal desert plain is very low or sometimes nonexistent, with a typical maximum of 10 mm over the entire 'wet' season (September – April). However, on a decadal scale, occasional heavy rains may fall during El Niño meteorological events which result in precipitation levels considerably above the mean annual figure.

Table 21.1. Estimated Peak and General Wet Season Precipitation Ranges - ELU 14

KP Range	Estimated Precipitation (mm)	
	Peak (January – March)	General (September-April)
332+940 - 402+000	0-5	0-10

Source: ESIA Physical Baseline Maps 1.2-1 and 1.2-2.

Geology

The Ica-Lima Coastal Plain ELU is covered by a combination of Holocene-aged alluvium (floodplains of the Pisco, Matagente, and Chico rivers and the Topará stream), torrential deposits (gravels, cobbles, and subangular boulders) from episodic extreme flows, and aeolian deposits.

Soils

The sandy and coarser substrates of the coastal plain with very sparse vegetation cover and hydrological processes have undergone minimal soil development. With the exception of cultivated agricultural soils and narrow riparian zones in limited floodplain areas, there is no organically enriched topsoil horizon in these sandy alluvial and aeolian deposits.

Soils are affected by aeolian erosion and mainly influenced by sand dunes. These soils have neutral to alkaline characteristics.

Soils have low fertility based on phosphorus availability. In alkaline conditions the solubility of phosphate rock is low. The texture of Horizon A and Subsoil fluctuates from sandy to sandy loam so drainage will be very high. Organic matter and other nutrients are low.

Table 21.2 summarizes the key characteristics of the surface horizon of the four profiles examined in ELU 14.

Table 21.2. Surface Horizon Characteristics - ELU 14

KP	pH	Surface horizon Depth	Organic matter	Fertility	Slope (%)
334+000	Slightly alkaline	High	Low	High	5%
364+000	Slightly alkaline	High	Low	High	20%
380+000	Slightly alkaline	High	Low	Low	2%
390+000	Neutral	Medium	Low	Medium	2%

Source: Domus.

pH: Strongly acidic = Less than 5.5; Moderately acidic = 5.6 to 6.0; Slightly acidic = 6.1 – 6.5; Neutral = 6.6 - 7.0; Slightly alkaline = 7.1 – 7.8; Moderately alkaline = 7.9 to 8.4; Strongly alkaline = More than or equal to 8.5.

Surface horizon depth: Shallow = Less than 5 cm; Medium = 5 cm to 15 cm; Deep = More than 15 cm.

Organic matter: Low = Less than 2%; Medium = 2% to 4%; High = More than 4%.

Fertility based on Available Phosphorus: Low = Less than 7.0 ppm; Medium = 7.0 to 14.0 ppm; High = More than 14.0 ppm.

Waterbodies

The ROW crosses various rivers and streams in the Ica-Lima Coastal Plain ELU (Table 21.3), the largest being the Pisco River, whose active floodplain and channel area at

present lies approximately between KPs 334+382 and 335+114. All of these streams and rivers have highly seasonal flows, dependent on time of year and occasional storm events and have been historically affected by the development of irrigation agriculture throughout the ELU, which by abstraction has led to reduced mean discharges in the lower reaches of these watercourses.

Table 21.3. Principal Waterbody Crossings - ELU 14

Waterbody Type or Name	KP Mid-channel	Elevation (m)
Quebrada		
QUEBRADA	353+606.34	253.29
QUEBRADA	353+675.37	253.28
QUEBRADA	353+998.84	248.64
QUEBRADA	354+437.68	240.70
QUEBRADA	354+593.87	236.77
QUEBRADA	354+716.18	233.85
QUEBRADA	354+841.67	232.66
QUEBRADA	354+932.97	231.19
QUEBRADA	355+265.65	224.32
QUEBRADA	355+378.66	222.48
QUEBRADA	355+484.49	221.06
QUEBRADA	356+026.88	215.53
QUEBRADA	357+808.91	213.07
QUEBRADA	359+893.67	173.59
QUEBRADA	360+205.57	169.03
QUEBRADA SECA	371+800	176
QUEBRADA SECA	372+600	174
QUEBRADA SECA	375+750	184
QUEBRADA SECA	377+300	190
QUEBRADA	377+506.28	187.70

QUEBRADA	378+211.41	189.47
QUEBRADA	378+336.85	189.40
QDA. SECA	380+541.23	170.94
QUEBRADA	380+710.19	169.75
QUEBRADA	380+826.24	168.29
QUEBRADA	381+677.33	165.20
QUEBRADA	381+944.69	166.56
QUEBRADA	381+996.24	166.42
QUEBRADA	382+191.82	166.38
QDA. SECA	382+577.46	167.21
QDA. SECA	383+246.63	170.33
QDA. SECA	383+808.37	171.45
QDA. SECA	384+283.97	170.82
QUEBRADA	387+764.87	159.45
QDA CORRALES	389+077.24	128.14
QDA. TOPARA	389+437.86	126.68
Rivers		
PISCO	334+968.01	231.93
MATAGENTE	362+608.84	163.43
CHICO	364+486.74	153.66

Source: Peru LNG Pipeline Project Alignment Sheets (Gulf Interstate Engineering, 2006).

Instability and Physical Risk

There is no risk to waterbodies or wetlands or other sensitive ecological receptors due to instability or physical risk of ROW sectors in ELU 14 due to the near absence of erosion associated rainfall in the ELU. The land surfaces within the Pisco Sand Plains ELU have been subject to aeolian and episodic fluvial deposition events throughout the Quaternary geologic period and the habitats and species in this ELU have evolved under these dynamic environmental conditions.

Infrastructure

The ESIA does not identify any additional infrastructure to be built in this ELU although this could be subject to change, depending on the details to be developed by the Project for the construction programme.

21.3 HABITATS AND SPECIES

21.3.1 HABITAT DISTRIBUTION

The habitats of ELU 14 are listed in sequential order in Table 21.4, including the length of each habitat unit and associated start and finish ROW KPs. Table 21.5 presents habitat lengths over the ROW sorted by habitat type, with subtotals for each habitat.

Table 21.4. Habitat Summary – ELU 14

Habitat Type	Length (m)	KP Start	KP Finish
Cultivated Areas	1,757	332+940	334+697
Riparian Vegetation	386	334+697	335+083
Cultivated Areas	8,455	335+083	343+538
Desert Barrens	16,386	343+538	359+924
Cultivated Areas	2,539	359+924	362+463
Riparian Vegetation	152	362+463	362+615
Cultivated Areas	1,730	362+615	364+345
Riparian Vegetation	218	364+345	364+563
Cultivated Areas	3,071	364+563	367+634
Desert Barrens	4,502	367+634	372+136
Tillandsia Mats	113	372+136	372+249
Desert Barrens	2,832	372+249	375+082
Tillandsia Mats	727	375+082	375+809
Desert Barrens	1,414	375+809	377+222
Tillandsia Mats	1,285	377+222	378+507
Desert Barrens	1,483	378+507	379+990
Tillandsia Mats	1,201	379+990	381+191
Desert Barrens	7,944	381+191	389+135
Cultivated Areas	206	389+135	389+341
Riparian Vegetation	118	389+341	389+459
Desert Barrens	7,599	389+459	397+058
Tillandsia Mats	672	397+058	397+730
Desert Barrens	4,270	397+730	402+000

Source: ESIA Biological Baseline Map 2-1 and Domus.

Table 21.5. Habitat Summary – ELU 14

Habitat Type	Length (m)	KP Start	KP Finish
Desert Barrens	16,386	343+538	359+924
	4,502	367+634	372+136
	2,832	372+249	375+082
	1,414	375+809	377+222
	1,483	378+507	379+990
	7,944	381+191	389+135
	7,599	389+459	397+058
	4,270	397+730	402+000
Total	46,430	67.23%	
Cultivated Areas	1,757	332+940	334+697
	8,455	335+083	343+538
	2,539	359+924	362+463
	1,730	362+615	364+345
	3,071	364+563	367+634
	206	389+135	389+341
Total	17,758	25.71%	
Tillandsia Mats	113	372+136	372+249
	727	375+082	375+809
	1,284	377+222	378+507
	1,201	379+990	381+191
	672	397+058	397+730
Total	3,998	5.79%	
Riparian Vegetation	386	334+697	335+083
	152	362+463	362+615
	218	364+345	364+563
	118	389+341	389+459
Total	874	1.27%	
Total ELU 14:	69,060		

Source: ESIA Biological Baseline Map 2-1 and Domus.

21.3.2 HABITAT DESCRIPTIONS

Desert Barrens

About 67% of the ROW length in ELU 14 is desert, devoid of vegetation due to the extreme aridity of the climate and the inability of the sandy or rocky substrates to retain moisture necessary to promote plant growth and allow soil development. Nevertheless, these habitats still support very specialized fauna, primarily lizards, adapted to the harsh

desert environment. The desert habitat is occasionally interspersed with patches of tillandsias, and strips of riparian vegetation and cultivated areas beside sources of water such as rivers, streams, aquifers and oases.

Cultivated Areas

The availability of water from rivers draining the western slopes of the Andes has allowed for the development of irrigation-based agriculture in coastal Peru over the past 4,000 years. Cultivated areas cover approximately 25% of the length of the ROW in the Ica-Pisco Coastal Plain ELU. Despite the extensive transformation of the landscape and habitats, the cultivated areas still contain elements of native biodiversity, particularly in living fences, windbreaks, and vegetation-lined irrigation canals. The EFS Field Survey identified huarango trees (*Acacia macracantha*), a species listed by the INRENA as near threatened, in such microenvironments with this habitat type.

Tillandsia mats

Desert areas with concentrations of mat-forming bromeliads or “air plants” (*Tillandsia latifolia* and *Tillandsia palacea*) account for around 6% of the ROW in ELU 14. These mats provide habitats for small fauna including lizards.

Riparian Vegetation

Along the major watercourses, there are remnants of natural woody vegetation growing upon the banks and floodplains. The most common species in this habitat are the shrub *Baccharis salicifolia* and the small tree *Tessaria integrifolia*, both of which are widespread riparian species in South America. There are also individuals of the INRENA near threatened huarango tree (*Acacia macracantha*).

Key Fauna

Larger mammals observed by the EFS Field Survey include the Pampas cat (*Leopardus pajeros*) and two species *Lycalopex foxes*¹³. Peruvian miner (*Geositta peruviana*) were registered in this ELU. Miners are terrestrial nesting birds.

The Peruvian coastal endemic lizards *Ctenoblepharys adspersa*, *Dicrodon heterolepis*, and *Microlophus tigris* were documented by the EFS Field Survey, as well as the snake *Alsophis elegans*.

The ESIA suggested the presence of the pit viper *Bothrops roedingeri*, a species listed as endangered by the INRENA, based on the finding of a shed skin. Although not observed by the EFS Field Survey, the presence of this rare snake in ELU 14 should be considered

¹³ *Lycalopex culpaeus* and a second species which may be either *L. sechura*, which is documented as far south as Lima Department, or *L. griseus*, which is documented as far north as Arequipa Department. The identity of the foxes in Ica Department remains unsettled.

highly probable, especially in riparian habitats, as its documented range is from the Department of La Libertad to the Department of Arequipa.

Hydrobiology

The Pisco River has important populations of the Chagallo shrimp (*Cryphiops caementarius*), an economically important natural resource for local populations. These were observed by the EFS Field Survey in the Pisco River and also reported by local residents from the Chico and Matagente rivers (requires confirmation during wet season). Due to the high commercial value of this crustacean, the Peruvian Ministry of Production established legal open and closed seasons for this species through Ministerial Resolution N° 312-2006-PRODUCE. This species may be taken from April 1 through December 19, while it may not be taken, processed, transported, commercialized, or utilized between December 20 and March 31.

Eight individuals of *Cryphiops caementarius* were caught with a net from the canal offtake at the Murga bridge within a 20 minute span in a zone of the Pisco River with a depth of less than 30 cm. A local fisherman informed the EFS team that the shrimp increase in abundance mid-spring due to the migration of the shrimp towards the mouth of the river where they lay eggs in the nearshore marine environment. Egg laying is completed by mid-summer when the adults and new recruits return upstream to elevations of approximately 1,200 m in the Pisco river and its tributaries.

The fishes registered in the rivers of ELU 14 were the green terror (*Aequidens rivulatus*) and a catfish (*Trichomycterus rivulatus*).

Table 21.6. Waterbodies Sampled – ELU 14

Station	Habitat	Waterbody	Name	Height (masl)	KP	Species
Hi-01	Costero	Quebrada	Topará	113	389+400	
Hi-02	Costero	Río	Chico	164	364+500	<i>Trichomycterus sp.</i> <i>Poecilia sp.</i> <i>Oreochromis sp.</i>
Hi-03	Costero	Río	Matagente	192	362+500	<i>Trichomycterus sp.</i> <i>Poecilia sp.</i> <i>Oreochromis sp.</i>
Hi-04	Costero	Río	Pisco	240	334+800	<i>Aequidens sp.</i> <i>Oreochromis sp.</i> <i>Poecilia sp.</i>

21.3.3 SPECIES SENSITIVITY ANALYSIS

Table 21.7 shows the high and medium sensitivity species observed during the EFS Field Survey, based on the species sensitivity criteria presented in Section 7.1 of the EFS.

One High Sensitivity species (the Changello shrimp) is observed in the ELU which is listed as Vulnerable. There is 1 Medium Sensitivity fish species, *Trichomycterus rivulatus* which is of only local distribution and has a use throughout the year by local communities.

Additionally, there are 5 reptile species of Medium Sensitivity including three lizard species, a toad species and a snake species.

The huarango tree, *Acacia macracantha*, is also classified as Medium Sensitivity.

Table 21.7. Species Sensitivity Criteria - ELU 14

No	Species	Protection Status						Spatial Distribution			Local Use			Mobility		Σ
		CR	EN	VU	NT	L	N	Local	Regional	Widespread	Permanent	Seasonal	None	Immobile	Mobile	
	Plants															
1	<i>Acacia macracantha</i>				3					0	2			3		8
2	<i>Alternanthera halimifolia</i>						0			0			0	3		3
3	<i>Baccharis salicifolia</i>						0			0	2			3		5
4	<i>Boerhavia diffusa</i>						0			0	2			3		5
5	<i>Cynodon dactylon</i>						0			0	2			3		5
6	<i>Eriochloa</i> sp.						0			0			0	3		3
	<i>Tessaria integrifolia</i>						0			0			0	3		3
7	<i>Tillandsia latifolia</i>						0		2				0	3		5
8	<i>Tillandsia paleacea</i>						0		2				0	3		5
	Fishes and shrimps															
	<i>Aequidens rivulatus</i>						0		2		0		0	3		5
	<i>Cryphiops caementarius</i> ***			4					2			2		3		11
	<i>Oreochromis niloticus</i>						0			0		2		3		5
	<i>Poecilia reticulata</i>						0			0	2			3		5
	<i>Trichomycterus rivulatus</i>						0	3			2			3		8
	Reptiles and amphibians															
14	<i>Alsophis</i> sp.						0	3					0	3		6
15	<i>Alsophis elegans</i>						0			0			0	3		3
16	<i>Chaunus limensis</i>							3					0	3		6
17	<i>Ctenoblepharys adspersa</i>			4				3					0	3		10
18	<i>Dicrodon heterolepis</i>			4				3					0	3		10
19	<i>Microlophus tigris</i>						0	3			2		0	3		8
	Mammals															
20	<i>Cavia tschudii</i>						0			0			0		0	0
21	<i>Conepatus chinga</i>						0			0			0		0	0
22	<i>Leopardus (Oreailurus) pajeros</i>						0		2				0		0	2

25	<i>Lycalopex (Pseudalopex) culpaeus</i>					0		2				0		0	2
26	<i>Lycalopex (Pseudalopex) griseus</i>					0		2				0		0	2
27	<i>Mus musculus</i>					0			0			0		0	0
28	<i>Oryzomys xantheolus</i>					0		2				0		0	2
29	<i>Thylamys pallidior</i>					0			0	2				0	2
	Birds														
30	<i>Actitis macularius</i>					0			0			0		0	0
31	<i>Anas bahamensis</i>					0			0	2				0	2
32	<i>Ardea alba</i>					0			0			0		0	0
33	<i>Bubulcus ibis</i>					0			0			0		0	0
34	<i>Burhinus superciliaris</i>					0		2				0		0	2
35	<i>Butorides striata</i>					0			0			0		0	0
36	<i>Calidris alba</i>					0			0			0		0	0
37	<i>Cathartes aura</i>					0			0			0		0	0
38	<i>Chaetura pelagica</i>					0			0			0		0	0
39	<i>Charadrius vociferus</i>					0			0			0		0	0
40	<i>Coragyps atratus</i>					0			0			0		0	0
41	<i>Crotophaga sulcirostris</i>					0			0			0		0	0
42	<i>Dives warszewiczi</i>					0		2				0		0	2
43	<i>Egretta caerulea</i>					0			0			0		0	0
44	<i>Elaenia albiceps</i>					0		2				0		0	2
45	<i>Euscarthmus meloryphus</i>					0			0			0		0	0
46	<i>Falco sparverius</i>					0			0			0		0	0
47	<i>Gallinula chloropus</i>					0			0			0		0	0
48	<i>Geositta maritima</i>					0		2				0		0	2
49	<i>Geositta peruviana</i>					0		2				0		0	2
50	<i>Molothrus bonariensis</i>					0			0			0		0	0
51	<i>Muscigralla brevicauda</i>					0		2				0		0	2
52	<i>Myiophobus fasciatus</i>					0			0			0		0	0
53	<i>Parabuteo unicinctus</i>					0			0			0		0	0

54	<i>Petrochelidon rufocollaris</i>					0		2				0		0	2
55	<i>Pyrocephalus rubinus</i>					0			0			0		0	0
56	<i>Saltator striatipectus</i>					0			0			0		0	0
57	<i>Sicalis raimondii</i>					0		2				0		0	2
58	<i>Sporophila simplex</i>					0		2				0		0	2
59	<i>Sporophila peruviana</i>					0		2				0		0	2
60	<i>Sporophila telasco</i>					0		2				0		0	2
61	<i>Thaumastura cora</i>					0		2				0		0	2
62	<i>Tiaris obscurus</i>					0			0			0		0	0
63	<i>Tringa flavipes</i>					0			0			0		0	0
64	<i>Tyrannus melancholicus</i>					0			0			0		0	0
65	<i>Tyto alba</i>					0			0			0		0	0
66	<i>Zenaida meloda</i>					0		2				0		0	2

Protection Status*:

CR= Critically endangered 6 points
 EN= Endangered 5 points
 VU= Vulnerable 4 points
 NT= Near threatened 3 points
 B= Low (Others) 2 points
 N= Not listed 0 points

Σ= Sensitivity value

1 - 5: Low

6 - 10: Medium

11 or higher: High

Species Distribution:

Local = (Endemic locally or to an EBA**) 3 points
 Regional = (Regional endemic in Andes or Coast) 2 points
 Widespread = (Across S. America or cosmopolitan) 0 points

Mobility:

Immobile = (restricted movement or in very short distance) 3 points
 Mobile = 0 points

Local Uses:

Permanent= 2 points
 Seasonal = 1 point
 None = 0 points

***Protection Status:** According IUCN (2006) or National Legislation (D.S. No. 034-2004-AG/D.S. No. 043-2005-AG)

****EBA:** Areas determined by Birdlife International, which includes at least 2 bird species with less than 50,000 km² of known distribution range.

21.3.4 HABITAT SENSITIVITY ANALYSIS

Based on the information presented in Table 21.7 the Cultivated Areas of the Ica-Lima Coastal Plain ELU meet the criteria for Medium Sensitivity habitat due to the presence of four Medium sensitivity animal species. The Desert Barrens found in this ELU, meet the criteria for Medium Sensitivity habitat due to the presence of three Medium Sensitivity plant species. The Riparian Corridors habitat meets the criteria for a High sensitivity species due to the presence of one High Sensitivity animal species. The Pisco River supports a critical species from a socioeconomic perspective, the freshwater river shrimp *Cryphiops caementarius*, an important fishery species in local markets.

21.4 KEY ISSUES AND RECOMMENDATIONS

Waterbodies and Wetlands

Best practice crossing techniques and pollution prevention and control should be adopted to minimize turbidity and hydrocarbon impacts generated during construction on water quality. The channel morphology and bed characteristics should be restored post-construction and riparian vegetation should be restored during reinstatement.

Habitats and Species

Mature huarango trees (*Acacia macracantha*) and other riparian vegetation should be left in place to the extent possible. Alternatively, where trees must be cleared on the ROW, seeds should be collected from local huarango trees for the production of seedlings in a nursery for replanting during bioreinstatement.

Changallo shrimp *Cryphiops caementarius* is an economically important species, whose harvesting is regulated by national legislation. Construction of the Pisco River crossing should be scheduled to take place during the open, dry season for this species between April 1 and December 19, which avoid impacts to migrating and breeding and spawning shrimp during their peak reproductive season during the peak of the wet season (December to April).

A Pre-Clearance Survey should be undertaken immediately prior to construction clearing, grading and topsoil strip activities to identify any sensitive reptiles and amphibians including lizards, snakes and toads (listed in Table 21.7), which are especially likely to be found in association with semi-natural micro-habitats in Cultivated Areas such as field borders and along irrigation channels and riparian zones. These reptiles and amphibians will be moved to an area of same or similar habitat at a reasonable distance outside the zone of impact by construction activities. Snakes should be approached with extreme care and encouraged to move off the ROW without direct handling. Direct handling of

snakes should only ever be undertaken at any time on the ROW by a recognized snake handler who can competently identify and safely handle such reptiles.

Table 21.8. Key Issues and Recommendations - ELU 14

Issue	KP Reference	Recommendations	Reference
River and creek crossings	See Table 21.3	Ditch in dry season if possible using best practice crossing techniques to minimize turbidity.	ECOMP/RP
Lizards, Toads and Snakes	ROW	Pre-Clearance survey to identify and relocate from ROW prior to site clearance activities.	ECOMP
Cryphiops caementarius Changallo shrimp and Trichmycterus rivulatus	Pisco River	Ditch in dry season (April to December) using best practice techniques to minimize risk of turbidity and hydrocarbon contamination.	ECOMP
Native fish	Pisco, Matagente, and Chicho Rivers	Ditch in dry season (April to December) using best practice techniques to minimize risk of turbidity and hydrocarbon contamination.	ECOMP
Huarango trees (<i>Acacia macracantha</i>)	See Table 21.7	Collect seed, produce seedlings, plant during bioreinstatement if not possible to retain any trees within ROW during site clearance.	ECOMP/RP

Source: Domus.

22.0 CONCLUSIONS AND RECOMMENDATIONS

This section summarizes the findings of the Ecological Field Survey and provides recommendations for the Ecological Management Plan (ECOMP) and the Restoration Plan (RP).

The information surveyed in the field in November-December 2006 and its subsequent analysis reflects a finer and more specific level of information to that previously identified in the ESIA. The EFS was focused on identifying threatened, sensitive or economically important species that may be present in the ROW and to provide information that would allow the development of specific plans to protect and subsequently restore the ecology and biodiversity of the Row's direct area of influence.

22.1 IDENTIFICACION OF SENSITIVE HABITATS

Species Sensitivity

A key objective of the EFS was to identify the most sensitive elements and sectors of the RoW, building upon and validating the ESIA findings, in order to permit the development of the Pipeline Ecological Management Plan and the Pipeline Restoration Plan. The EFS was not intended to develop a new baseline study, thus the species lists are focused on sensitive elements and are not intended to be complete lists of species present in any given habitat type or landscape unit. For example, common, widespread, abundant species were not specifically addressed by the EFS. Also, the ESIA reports species observed at sampling points located within 3 to 7 km wide corridor, while the EFS focused on the ROW itself. Thus, the EFS findings are not intended to replace the ESIA baseline species data and they cannot be directly compared with the ESIA species data given the differences in the aims and methods of the EFS and ESIA.

Species sensitivity was determined for each species documented by the EFS Survey on the basis of four characteristics: 1) protected status, 2) geographic distribution, 3) use by local communities, and 4) mobility (ability to flee from a disturbance). Species were scored on these characteristics with a potential range of scores from 0 to 14.

The three categories were determined as follows:

High Sensitivity:

- ◆ Any species listed as either EN or CR by IUCN or INRENA **and** that is Immobile.
- ◆ Any other species with a score of 11 or higher.

Medium Sensitivity:

- ◆ Any species listed as either EN or CR by IUCN or INRENA **and** that is Mobile.
- ◆ Any species listed as either NT or VU by IUCN or INRENA **and** that is Immobile.
- ◆ Any other species with a score of from 6 to 10.

Low Sensitivity:

- ◆ Any species with a score less than or equal to 5.

Table 22.1 lists high and medium sensitivity species by Ecological landscape Unit.

Table 22.1 HIGH AND MEDIUM SENSITIVITY SPECIES BY ECOLOGICAL LANDSCAPE UNIT (ELU)

Species	Description	Level of Sensitivity
1. Apurimac River Valley Montane Forest Ecotone, KP 0+000 – 20+511		
<i>Phrynopus sp</i>	Frog	HIGH
<i>Polylepis pauta</i>	Quenual Tree	Medium
<i>Eleutherodactylus discoidalis</i>	Frog	Medium
<i>Proctoporus</i>	Lizard	Medium
<i>Tremarctos ornatus</i>	Spectacled Bear	Medium
<i>Agriornis ardicola</i>	Bird (Tyrant)	Medium
<i>Theristicus melanopis</i>	Bird (Ibis)	Medium

2. Campana Watershed, KP 20+511 – 25+115		
<i>Escallonia resinosa</i>	Shrub	Medium
<i>Myrosmodes sp.</i>	Bog Orchid	Medium
<i>Tecoma sambuxifolia</i>	Shrub	Medium
<i>Proctoporus sp.</i>	Lizard	Medium
<i>Theristicus melanopis</i>	Bird (Ibis)	Medium
3. Torobamba River Valley, KP 25+115 – 44+350		
<i>Corryocactus quadrangularis</i>	Cactus	HIGH
<i>Kageneckia lanceolata</i>	Shrub	HIGH
<i>Acacia macracantha</i>	Tree	Medium
<i>Ariestiguieta discolor</i>	Shrub	Medium
<i>Berberis flexuosa</i>	Shrub	Medium
<i>Echinopsos peruviana puquiensis</i>	Cactus	Medium
<i>Eriotheca vargasii</i>	Shrub	Medium
<i>Escallonia myrtilloides</i>	Shrub	Medium
<i>Escallonia resinosa</i>	Shrub	Medium
<i>Tecoma arequipensis</i>	Shrub	Medium
<i>Tecoma sumbucifolia</i>	Shrub	Medium
<i>Chanus spinulosus</i>	Toad	Medium
<i>Stenocercus aff. apurimacus</i>	Lizard	Medium
<i>Agriornis andicola</i>	Bird (Tyrant)	Medium
<i>Vultur gryphus</i>	Condor	Medium
4. Sillicasa Sierra, KP 44+350 – 56+738		
<i>Aaa Sp.</i>	Orchid	Medium
<i>Distichia muscoides</i>	Bog Moss	Medium

<i>Escallonia myrtilloides</i>	Shrub	Medium
<i>Myrosmodes sp.</i>	Bog Orchid	Medium
<i>Perezia coerulescens</i>	Herb	Medium
<i>Vultur gryphus</i>	Condor	Medium
5. Yucay River Valley, KP 56+783 – 74+199		
<i>Corryocactus quadrangularis</i>	Cactus	HIGH
<i>Berberis flexuosa</i>	Shrub	Medium
<i>Chaunus spinulosus</i>	Toad	Medium
<i>Cleistocactus morawetzianus</i>	Cactus	Medium
<i>Echinopsis peruviana spp. Puquiensis</i>	Cactus	Medium
<i>Escallonia myrtilloides</i>	Shrub	Medium
<i>Orestias sp.</i>	Killifish	Medium
<i>Trichomycterus rivulatus</i>	Andean catfish	Medium
<i>Liolaemus sp.</i>	Lizard	Medium
<i>Stenocercus fritti</i>	Lizard	Medium
<i>Telmatobius sp.</i>	Frog	Medium
<i>Vultur gryphus</i>	Condor	Medium
6. Huamanga-Visongo Watershed Divide, KP 74+199 – 103+970		
<i>Escallonia myrtilloides</i>	Shrub	Medium
<i>Parastrephia quadrangularis</i>	Shrub	Medium
<i>Orestias sp.</i>	Killifish	Medium
<i>Liolaemus sp.</i>	Lizard	Medium
<i>Telmatobius sp.</i>	Frog	Medium
<i>Leopardus (oreailurus) jacobitus</i>	Mountain Cat	Medium
<i>Vicugna vicugna</i>	Vicuna	Medium

7. Vinchos River Valley, KP 103+970 – 117+388		
<i>Echinopsis peruviana ssp. Puquiensis</i>	Cactus	Medium
<i>Escallonia myrtilloides</i>	Shrub	Medium
<i>Oroya peruviana</i>	Cactus	Medium
<i>Trichomycterus rivulatus</i>	Andean catfish	Medium
8. Apacheta High Sierras, KP 117+388 – 162+137		
<i>Berberis sp.</i>	Bush	Medium
<i>Ephedra Americana</i>	Bush	Medium
<i>Escallonia myrtilloides</i>	Shrub	Medium
<i>Oroya peruviana</i>	Cactus	Medium
<i>Perezia coerulensis</i>	Herb	Medium
<i>Perezia pinnatifida</i>	Herb	Medium
<i>Ribes sp.</i>	Plant	Medium
<i>Liolaemus cf. melanogaster</i>	Lizard	Medium
<i>Liolaemus melanogaster</i>	Lizard	Medium
<i>Leopardus (oreailurus) jacobitus</i>	Mountain Cat	Medium
<i>Vicugna vicugna</i>	Vicuna	Medium
<i>Asthenes dorbignyi (huancavelica)</i>	Bird (Canastero)	Medium
<i>Theristicus melanopsis</i>	Bird (Ibis)	Medium
<i>Vultur gryphus</i>	Condor	Medium
9. Pampas-Palmitos River Basins, KP 162+137 – 195+050		
<i>Perezia coerulescens</i>	Herb	Medium
<i>Distachia muscoides</i>	Bog Moss	Medium
<i>Liolaemus sp.</i>	Lizard	Medium
<i>Leopardus (oreailurus) jacobitus</i>	Mountain Cat	Medium

<i>Vicugna vicugna</i>	Vicuna	Medium
<i>Asthenes dorbignyi (huancavelica)</i>	Bird (Canastero)	Medium
10. Huaytara High Plains and Ridges, KP 195+050 – 249+538		
<i>Perezia coerulescens</i>	Herb	Medium
<i>Liolaemus sp. (ramirez)</i>	Lizard	Medium
<i>Liolaemus cf. polystictus</i>	Lizard	Medium
<i>Vicuna vicugna</i>	Vicuna	Medium
<i>Asthenes dorbignyi (huancavelica)</i>	Bird (Canastero)	Medium
11. Pisco-Ica Watershed Divide, KP 249+538 – 272+181		
<i>Chersodoma arequipensis</i>	Shrub	HIGH
<i>Senecio tovari</i>	Cactus	Medium
<i>Liolaemus sp.</i>	Lizard	Medium
<i>Microlophus affitigris</i>	Lizard	Medium
12. Coastal Bat Hills, KP 272+181 – 308+000		
<i>Cleistocactus acanthurus</i>	Cactus	HIGH
<i>Browningia candelaris</i>	Cactus	Medium
<i>Cridoscolus basiacanthus</i>	Herb	Medium
<i>Ephedra Americana</i>	Shrub	Medium
<i>Loasa incana</i>	Shrub	Medium
<i>Neoralmundia arequipensis</i>	Cactus	Medium
<i>Orthopterygium huaucui</i>	Tree	Medium
<i>Microlophus tigris</i>	Lizard	Medium
<i>Phyllodactylus lepidopygus</i>	Gecko Lizard	Medium
13. Pisco Sand Plains, KP 308+000 – 332+940		
<i>Dicrodoa heterolepis</i>	Lizard	Medium

<i>Microlophus thoracicusicae</i>	Lizard	Medium
<i>Phyllodactylus lepidopygus</i>	Gecko Lizard	Medium
<i>Xenospingus concolor</i>	Bird (Finch)	Medium
14. Ica-Lima Coastal Plain, KP 332+940 – 408+000		
<i>Cryphiops caementarius</i>	Shrimp	HIGH
<i>Acacia macracantha</i>	Tree	Medium
<i>Trichomycterus rivulatus</i>	Andean catfish	Medium
<i>Alsopphis sp.</i>	Snake	Medium
<i>Chaunus limensis</i>	Toad	Medium
<i>Ctenblepharys adspersa</i>	Lizard	Medium
<i>Dicrodon heterolepis</i>	Lizard	Medium
<i>Microlophus tigris</i>	Lizard	Medium

Source: Ecological Field Survey

The sensitivity of the species analyzed is summarized in Table 22.2 by taxonomic group.

Table 22.2. Species Sensitivities by Taxonomic Group

Group	Low	Medium	High	Total
Plants	83	25	4	112
Crustaceans	0	0	1	1
Fish	2	5	0	7
Amphibians	2	5	0	7
Reptiles	4	17	0	21
Birds	218	4	0	222
Mammals	32	3	0	35

All	341	59	5	405

Sensitive Habitats

According to the ESIA, Vol. II-B, p. 6-51,

"...the most sensitive RoW segments are:

- Kp 0+000 to Kp 10+000. This corresponds to the eastern watershed.
- Kp 55+000 to Kp 75+000: This corresponds to the two end points of the study area (high sensitivity) as well as the two intermediate segments with medium sensitivity. This is mostly in the Acocros cultivated area.
- Kp 115+000 to Kp 120+000: Corresponds to the Vinchos River cultivated area.
- Kp 120+000 to Kp 200+000: Corresponds to high-Andean zone 4, between the Vinchos River and Taccracocha Lake. This includes grass formations, grazing lands, sedge swamps, and lakes.
- Kp 245+000 to Kp 250+000: Corresponds to the last segment of the puna before descending towards the Western watersheds near Huaytará.

Therefore, the most sensitive ecosystems are the eastern watersheds, cultivated areas, and the puna area (particularly high-Andean zone 4)."

The total length of the "most sensitive ecosystems" as identified by the ESIA is 120 km, which is equivalent to 29.8% of the RoW length.

A comparison of the ESIA findings against the EFS follows:

- Kp 0+000 to Kp 10+000. Corresponds to the portions of Apurimac Valley Upper Montane Forest Ecotone and the Campana Sierra. Considered to be of Medium Sensitivity by EFS.
- Kp 55+000 to Kp 75+000: Corresponds almost entirely to the Yucay River Valley (KP 56+800 to Kp 74+000). EFS considers the Resinous Scrub habitat in this sector to be of High Sensitivity.
- Kp 115+000 to Kp 120+000: Corresponds to the western portion of the Vinchos River Valley and a small portion of the easternmost Apacheta High Sierras. Considered to be of Medium Sensitivity by EFS.
- Kp 120+000 to Kp 200+000: Corresponds to Apacheta High Sierras, Pampas-Palmitos River Basins, and a portion of the easternmost Huaytará High Plains and Ridges. It does not include the Vinchos River Valley. It does include the Taccracocha Lake area; however, the lake itself is located well beyond the direct area of influence of the RoW. This includes tussock and sward-forming

- grasslands and peat bogs. Considered to be of Medium Sensitivity by the EFS. Does not include habitats known to be inhabited by the white-bellied cinclodes.
- Kp 245+000 to Kp 250+000: Corresponds to the last segment of the high Andean grasslands (Huaytará High Plains and Ridges) and the first 500 m of the mixed scrublands of the Pisco-Ica Watershed Divide southwest of the town of Huaytará. The grasslands are not considered to be sensitive by the EFS; however, the mixed scrubland from KP 245+000 and westward are considered to be of High Sensitivity.

Based on the EFS findings, the most sensitive ecosystems are, in general terms, the dry forest river valleys of the Apurimac and Mantaro basins in the easternmost section of the RoW, the western Andean scrublands and cactus formations, the hydromorphic habitat islands of the Pisco sand plains, and the riverine ecosystems of the coastal plain in the westernmost section of the RoW.

The three major differences between the ESIA and EFS findings on sensitive ecosystems or habitats are that:

- 1) The ESIA considers the sector from KP 120+000 to KP 200+000 to be highly sensitive while the EFS find this zone to be largely of medium sensitivity,
- 2) The ESIA considers the sector from KP 249+500 to KP 300+000 to be of medium sensitivity and the sector for KP+300+000 to 308+000 to be of low sensitivity, while the EFS finds the sector from KP 249+500 to 308+000 to be of high sensitivity, and
- 3) The ESIA considers the sector from KP 325+000 to KP 335+000 to be of low sensitivity, while the EFS finds the sector from 326+000 to 332+000 to be largely of high sensitivity.

Table 22.3. Medium and High Sensitivity Habitats by Ecological Landscape Unit according to the EFS

ELU	HABITAT TYPES	HABITAT SENSITIVITY	RoW Length (m)
1. Apurimac River Valley Montane Forest Ecotone	Upper Montane Forest	Medium	4,495
	Tussock Grassland	Medium	3,321
2. Campana Sierra	Peat Bog	Medium	1,834
	Sward-forming Grassland	Medium	6,318
3. Torobamba River	Cultivated Areas	High	7,902

Valley	Dry Deciduous Forest	Medium	651
	Thorny Scrub	High	6,238
4. Sillaccasa Sierra	Tussock Grassland	Medium	10,333
5. Yucay River Valley	Thorny Scrub	Medium	171
	Resinous Scrub	High	1,630
	Yucay River	Medium	26
6. Huamanga Vischongo Watershed Divide	Tussock Grassland	Medium	27,246
7. Vinchos River Valley	Cultivated Areas	Medium	12,074
8. Apacheta High Sierras	Scarcely Vegetated High Andean Areas	Medium	21,083
	Sward-forming Grassland	Medium	17,481
	Tussock Grassland	Medium	6,900
9. Pampas Palmitos River Basins	Tussock Grassland	Medium	11,741
10. Huaytará High Plains and Ridges	Scarcely Vegetated High Andean Areas	Medium	3,599
	Sward-forming Grassland	Medium	16,127
	Tussock Grassland	Medium	33,616
11. Pisco Ica Watershed Divide	Mixed Scrub	High	17,910
	Thorny Scrub	High	4,590
12. Coastal Bat Hills	Desert Scrub	High	15,924
	Columnar Cacti and Scrub	High	20,076
13. Pisco Sand Plains	Hydromorphic Islands and Lagoons	High	4,800*
14. Ica-Lima Coastal Plain	Cultivated Areas	Medium	18,197
	Desert Barrens	Medium	46,430

	Riverine Corridors	High	875

*Distance of sector where RoW passes near or crosses hydromorphic island and lagoon habitats. Actual length of such habitats traversed by RoW is approximately 274 m.

Table 22.4 summarizes the distribution of habitat sensitivity categories over the length of the RoW, showing that 19.9% of the RoW length falls under the High Sensitivity category.

Table 22.4 Habitat Sensivity Category Summary

Sensitivity	Length (m)	Percent
Low	80,412	20.0
Medium	241,643	60.1
High	79,945	19.9
Total	402,000	100.0

The EFS categorizes 19.9% of the RoW within the most sensitive category, versus 29.8% in the “most sensitive” category in the ESIA.

Low and Medium Sensitivity Habitats require best practice ecological management procedures that comply with all applicable ESIA commitments, the ECOMP and RP. In addition, site-specific measures apply to High Sensitivity Habitats as described by the ECOMP and RP.

The designation of High Sensitivity Habitat Type means that the specified area is a habitat type within which the EFS has verified the presence of either at least on High Sensitivity Species or at least two medium sensitivity animal species or at least three medium sensitivity plant species. Applying the precautionary principal, this designation requires that the Project take special care to identify the location of sensitive elements within the habitat type and develop appropriate mitigations for these specific locations prior to the start of construction.

In accordance with IFC Performance Standard 1, in areas of High Sensitivity Habitat, no project activities will be implemented unless the following requirements are met:

- There are no measurable adverse impacts on the ability of the critical habitat to support the established population of species or the functions of the critical habitat

- There is no reduction in the population of any recognized critically endangered or endangered species
- Mitigation measures are implemented to achieve no net loss of biodiversity where feasible, which may include but are not limited to actions such as post-operation restoration of habitats, offset of losses through the creation of ecologically comparable area(s) that is managed for biodiversity, and compensation to direct users of biodiversity.

The EFS High Sensitivity Habitats are summarized briefly below:

1. Torobamba River Valley Cultivated Areas. Despite extensive land clearing for intensive cultivation, there are patches and corridors of native vegetation between the fields that contain listed and endemic species typical of dry forests and scrublands of the Apurimac Dry Forest System. Among these species are the endangered cactus *Corryocactus quadrangularis* and the critically endangered rosaceous shrub *Kageneckia lanceolata*.
2. Torobamba River Valley Thorny Scrub. Higher up the valley slopes, patches of thorny scrub harbor the critically endangered rosaceous shrub *Kageneckia lanceolata* and other sensitive dry forest and scrub plants, as well as the endangered white-tailed shrike tyrant, a bird of the flycatcher family.
3. Yucay River Valley Resinous Scrub. The dry Yucay River Valley contains patches of native vegetation belonging to the Mantaro Dry Forest System, including populations of the endangered cactus *Corryocactus quadrangularis* and the vulnerable cactus *Echinopsis peruviana puquiensis*.
4. Pisco-Ica Watershed Divide Mixed and Thorny Scrub. The upper slopes of the western Andes which drain to the Pacific Ocean support highly adapted plant species such as the critically endangered composite shrub *Chersodoma arequipensis* and the regional endemic *Aequatorium tovarii*. A possible new lizard species of the genus *Microlophus* was found by the EFS in high elevation mixed scrub. Also, these habitats may support populations of the endangered rufous-breasted warbling finch, as documented by the ESIA.
5. Coastal Bat Hills Desert Scrub and Columnar Cacti. The lower desert slopes of the Andean foothills support sparse yet diverse vegetation with various threatened and endemic species of cacti and shrubs, including the endangered *Cleistocactus acanthurus*. This habitat supports populations of the critically endangered long-snouted bat (*Platalina genovensium*), a species that feeds exclusively on the pollen and nectar of night-blooming cacti.
6. Pisco Sand Plains Hydromorphic Islands and Lagoons. Among the sand dunes south of the lower Pisco River, there are small oases of wetland vegetation, often surrounding small permanent waterbodies such as the Bernal and Morón lagoons. These unusual habitat islands support fauna that could not otherwise survive in the surrounding desert environment. For example, the vulnerable slender-billed finch, an endemic coastal desert bird that nests only in

hydromorphic thickets and riparian areas, was observed in these habitats. While not containing any highly sensitive species, these habitats are considered to be highly sensitive due to their uniqueness, limited geographic distribution, presence of various medium sensitivity species, and loss of similar habitats in the region to agricultural conversion.

7. Ica-Lima Coastal Plain Riverine Corridors. The coastal plain of south-central Peru is traversed by various highly seasonal rivers and streams. The natural vegetation along these streams was formerly a dense riparian woodland and thicket, but these have largely been lost with the development of irrigated agriculture in the narrow river valleys. Only small fragments of these habitats remain. The rivers themselves have been affected by agriculture and urbanization. Nevertheless, the Pisco River supports a critical species from a socioeconomic perspective, the freshwater river shrimp *Cryphiops caementarius*, an important fishery species with an important contribution to the local economy.

22.2 CONCLUSIONS AND RECOMMENDATIONS RELATING TO THE ECOMP

The ECOMP should address all of the key issues and recommendations of the EFS, as well as the ESIA commitments relating to ecology and biodiversity.

Plant relocation and salvaging

Protected plant species identified within the RoW and that should be considered for either relocation, salvaging or replacement, where practicable, prior to construction are listed in Table 22.5.

Table 22.5 Protected Plants Identified along RoW by EFS

Family	Scientific Name	Type of Plant	Category	ELU Habitat
Asteraceae	<i>Aristeguietia discolor</i>	Shrub	NT*	Torobamba River Valley Cultivated Areas
	<i>Chersodoma arequipensis</i>	Subshrub	CR	Pisco-Ica Watershed Divide

				Thorny Scrub
	<i>Parastrephia quadrangularis</i>	Shrub	VU	Huamanga-Vischongo Watershed Divide Tussock Grassland
	<i>Perezia coerulescens</i>	Herb	VU	Sierra Sillaccasa Sward-forming Grassland Apacheta High Sierra Sward-forming Grassland Huaytará High Plains and Ridges Sward-forming Grassland
	<i>Perezia pinnatifida</i>	Herb	VU	Apacheta High Sierras Sward-forming Grassland Pampas-Palmitos River Basins Sward-forming Grassland
Bignoniaceae	<i>Tecoma arequipensis</i>	Shrub	VU	Torobamba River Valley Dry Deciduous Forest Torobamba River Valley Resinous Scrub
	<i>Tecoma sambucifolia</i>	Shrub	NT	Torobamba River Valley Thorny Scrub Torobamba River Valley

				Cultivated Areas
Cactaceae	<i>Browningia candelaris</i>	Cactus	VU	Coastal Bat Hills Desert Scrub Coastal Bat Hills Columnar Cacti and Scrub
	<i>Cleistocactus acanthurus</i>	Cactus	EN	Coastal Bat Hills Desert Scrub Coastal Bat Hills Columnar Cacti and Scrub
	<i>Corryocactus quadrangularis</i>	Cactus	EN	Torobamba River Valley Cultivated Areas Yucay River Valley Resinous Scrub
	<i>Echinopsis peruviana puquiensis</i>	Cactus	VU	Yucay River Valley Resinous Scrub; Vinchos River Valley Cultivated Areas
Euphorbiaceae	<i>Cnidoscolus basiacanthus</i>	Herb	VU	Coastal Bat Hills Columnar Cacti and Scrub

Ephedraceae	<i>Ephedra americana</i>	Subshrub	NT	Apacheta High Sierra Sward-forming Grassland Coastal Bat Hills Columnar Cacti and Scrub
Fabaceae	<i>Acacia macracantha</i>	Tree	NT	Ica-Lima Coastal Plain Cultivated Areas Ica-Lima Coastal Plain Riparian Vegetation Torobamba River Valley Cultivated Areas
Glossuraliaceae	<i>Escallonia myrtilloides</i>	Shrub	EN	Yucay River Valley Thorny Scrub Huamanga-Vischongo Watershed Divide Tussock Grassland Vinchos River Valley Tussock Grassland Vinchos River Valley Resinous Scrub Apacheta High Sierra Tussock Grassland

	<i>Escallonia resinosa</i>	Shrub	VU	Torobamba River Valley Thorny Scrub Torobamba River Valley Cultivated Areas
Orchidaceae	<i>Myrosmodes</i> sp.	Bog Orchid	NT	Campana Watershed Peat Bogs Sillaccasa Sierra Peat Bogs
Rosaceae	<i>Kageneckia lanceolata</i>	Shrub	CR	Torobamba River Valley Thorny Scrub
	<i>Polylepis pauta</i>	Tree	NT	Apurimac Valley Montane Forest Ecotone Upper Montane Forest

*IUCN listing only.

Further studies will be required to determine the specific situation of these species along the RoW, including numbers, distribution and where it is practicable to undertake salvage activities either by direct transplanting or by propagation from cuttings and seeds.

Fauna Relocation

The sensitive species of fauna either confirmed or with potential presence on the RoW are listed in Table 22.6.

Table 22.6 Protected fauna (animal) species with potential presence in RoW based on ESIA and EFS findings.

Scientific Name	Common Name	Category	ELU Habitats
<i>Chaunus spinulosus</i>	Warty toad	NT	Torobamba River Valley Cultivated Areas Torobamba River Valley Dry Deciduous Forest
<i>Ctenoblepharys adspersa</i>	Lizard	VU	Ica-Lima Coastal Plain Desert Barrens Ica-Lima Coastal Plain Tillandsia Mats
<i>Dicrodon heterolepis</i>	Lizard	VU	Pisco Sand Plains Desert Barrens Ica-Lima Coastal Plain Desert Barrens Ica-Lima Coastal Plain Riparian Vegetation
<i>Microlophus tigris</i>	Lizard	NT	Coastal Bat Hills Columnar Cati and scrub Ica-Lima Coastal Plain Desert Barrens
<i>Bothrops pictus</i>	Pit Viper	VU	Ica-Lima Coastal Plain Columnar Cacti and Scrub
<i>Bothrops roedingeri</i>	Pit Viper	EN	Ica-Lima Coastal Plain Columnar Cacti and Scrub
<i>Agriornis andicola</i>	White-tailed shrike-tyrant	EN	Campana Watershed Tussock Grassland Torobamba River Valley Thorny Scrub
<i>Asthenes huanacavelicae</i>	Pale-tailed canastero	VU	Apacheta High Sierras Scarcely Vegetated High Andean Area

Scientific Name	Common Name	Category	ELU Habitats
			Tussock Grassland Pampas-Palmitos River Basins Scarcely Vegeated High Andean areas Tussock Grassland Huaytará High Plains and Ridges Tussock Grassland Sward-forming Grassland
<i>Cinclodes palliatus</i>	White-bellied cinclodes	CR	Apacheta High Sierras Peat Bog
<i>Podiceps occipitalis</i>	Silvery grebe	NT	Sillaccasa Sierra Peat Bog
<i>Poospiza rubecula</i>	Rufous-breasted warbling finch	EN	Pisco-Ica Watershed Divide Mixed and Thorny Scrub
<i>Theristicus melanopis</i>	Black-faced ibis	VU	Apurimac River Valley Forest Ecotone Peat Bogs Campana Watershed Peat Bog Apacheta High Sierras Peat Bog
<i>Vultur gryphus</i>	Andean condor	EN	Torobamba River Valley Resinous Scrub Sillaccasa Sierra Sward forming Grassland Tussock Grassland Yucay River Valley Thorny Scrub Apacheta High Sierras

Scientific Name	Common Name	Category	ELU Habitats
			Scarcely Vegetated High Andean Areas Sward-forming Grassland
<i>Xenospingus concolor</i>	Slender-billed finch	VU	Pisco Sand Plains Hydromorphic Islands
<i>Lama guanicoe cacsilensis</i>	Guanaco	EN	Huamanga-Vischongo Watershed Divide, Apacheta High Sierras, Pampas-Palmitos River Basins and Huaytará High Plains and Ridges Tussock Grassland Sward forming Grassland
<i>Vicugna vicugna</i>	Vicuña	NT	Huaytará High Plains and Ridges Tussock Grassland Sward-forming Grassland
<i>Puma concolor</i>	Puma	NT	Apurimac River Valley Montane Forest Ecotone Sward-forming grassland Torobamba River Valley Resinous Scrub Dry Deciduous Forest Siliccasa Sierra Tussock Grassland Huamanga-Vischongo Watershed Divide Tussock Grassland Apacheta High Sierras Scarcely Vegetated High Andean Areas
<i>Leopardus jacobitus</i>	Andean	EN	Pampas-Palmitos River Basin

Scientific Name	Common Name	Category	ELU Habitats
	mountain cat		Scarcely Vegetated High Andean Areas Apacheta High Sierras Scarcely Vegetated High Andean Areas Sward-forming Grassland Huamanga-Vischongo Watershed Divide Tussock Grassland
<i>Tremarctos ornatus</i>	Spectacled bear	EN	Apurimac River Valley Forest Ecotone Upper Montane Forest
<i>Amorphochilus schnablii</i>	Smoky bat	VU	Coastal Bat Hills Columnar Cacti and Scrub
<i>Tomopeas rarus</i>	Blunt-eared bat	CR	Coastal Bat Hills Columnar Cacti and Scrub
<i>Platalina genovensium</i>	Long-snouted bat	CR	Coastal Bat Hills Columnar Cacti and Scrub

Of the listed species, only the low-mobility amphibians and reptiles such as lizards, toads, frogs and snakes are unlikely to flee from the RoW during clearing activities and these should be identified and relocated immediately prior to the start of construction where observed as part of the Pre-Clearance Survey. Other high mobility species observed during the EFS such as the Andean cat, puma, spectacled bear and birds such as the condor and vulture are highly likely to readily move away from the area of construction disturbance and will therefore unlikely be significantly affected by construction. Camelids, particularly the vicuna which is found in high grassland puna areas between approximately KP 75 and 250 and of socio-economic as well as ecological sensitivity should receive special management measures to avoid or minimize any impacts during construction.

Noise monitoring should be undertaken at a number of sites as set out in the ESIA to determine any impacts on white-bellied cinclodes, pale-tailed canastero, the rufous-breasted warbling finch and slender-billed finch during the nesting season and efforts

should be taken to identify any live nests which may occur as part of the Pre-Clearance Survey.

The EFS has also identified a number of additional medium sensitivity species, which because of their low mobility and inability to escape intrusive construction activities will require relocation from the RoW prior to site clearance. These are listed in Table 22.7.

Protection of sensitive aquatic habitats such as watercourses, swamps, bogs and marshes (bofadelas) should be attained by design and implementation of pollution prevention and erosion control best practices during the construction phase minimizing the risk of contamination by sediment and hydrocarbons and acid rock drainage. Crossing of the Pisco River should be undertaken outside the rainy season to minimize the impacts on the changello shrimp population in this waterbody and crossing of all waterbodies should adopt best practice techniques to minimize the mobilization of sediment and downstream turbidity in the channel.

Bogs are one of the most sensitive habitats crossed by the ROW and are frequently occurring in several ELUs particularly the highland areas. Special techniques such as turf and topsoil strip and storage during construction, erosion controls and strict control of the working area should be adopted to preserved materials that will be critical to longterm reinstatement after completion of construction and prevent the widening of the project footprint beyond the approved area. Preservation and biorestorement of these areas should be dependent on species translocation where practicable prior to construction and seed and cutting collection and propagation to enable the disturbed area to return as closely as possible to its original species diversity as quickly as reasonably possible.

Table 22.7 Low-mobility endemic animal species that may require capture and relocation from RoW

Scientific Name	Type of Animal	Habitats
<i>Chaunus limensis</i>	Toad	Ica-Lima Coastal Plain Cultivated Areas Riparian Vegetation
<i>Eleutherodactylus</i> sp.	Andes frog	Apurimac River Valley Montane Forest Ecotone Upper Montane Forest
<i>Phrynopis</i> sp.	Andes frog	Apurimac River Valley Montane Forest Ecotone Upper Montane Forest

Scientific Name	Type of Animal	Habitats
<i>Telmatobius</i> sp.	Water frog	Sillaccasa Sierra Waterbodies Huamanga-Vischongo Watershed Divide Waterbodies
<i>Proctoporus</i> sp.	Lizard	Apurimac River Valley Montane Forest Ecotone Upper Montane Forest Tussock Grassland Sward-forming Grassland Campana Watershed Tussock Grassland Sward-forming Grassland
<i>Liolaemus</i> spp.	Lizards	All Tussock Grassland, Sward-forming Grassland, Scarcely Vegetated High Andean Areas for each ELU where they occur
<i>Microlophus</i> aff. <i>tigris</i>	Lizard	Pisco-Ica Watershed Divide Mixed Scrub
<i>Stenocercus</i> spp.	Lizards	Torobamba River Valley – all habitats within this ELU Yucay River Valley – all habitats within this ELU

22.3 CONCLUSIONS AND RECOMMENDATIONS RELATING TO THE PRP

Revegetation

Regeneration of the vegetation cover to restore original localized biodiversity, promote ground and soils stability and minimize erosion risk should be a combination of a natural regeneration process from the native seed bank in the soil and assisted regeneration by additional broadcast or hand seeding and planting of new shrubs, bushes and trees where practicable to replace those lost during site clearance activities where translocation is not possible.

Seed and Cutting Collection for Nurseries Creation

In the case of shrubs and bushes with deep roots and trees, seed and cutting collection programs should be carried out for the creation of nurseries, managed by local communities, which will provide seedlings for the revegetation process during the biorestitution phase after the completion of construction. A large variety of progenitor plants should be included to ensure the genetic variability of populations.

Nursery Maintenance

During the construction phase, nurseries should be preserved in order to have nursery plants for the revegetation programs, to ensure its continuity in case a larger process is needed, and to ensure the transference of the generated technology for future processes.

Seeding

Native species should be used wherever practicable using species representative of the ROW and surrounding habitats. When naturalized species use is required in the absence of native species or in high risk erosion areas where an accelerated process of revegetation cover is required to protect the ROW and which cannot be achieved by native species, strict control rules should be established in order to avoid that they become invasive and that they are representative of and compatible with the habitats on and surrounding the RoW.

Physical issues

The most sensitive areas regarding erosion processes and geologic instability are dominated by the steep slopes of very sheer hills with superficial soils and with granite outcrops that may require blasting or excavation with machinery that will demand considerable geo-engineering for the stabilization and the biorestore alone will be a small complement to these engineering works where possible.

The depth and the quality of the topsoil and its preservation and protection during the construction phase will be important factors in the biorestore process.

In areas with high and moderate slopes, biorestore will play a very important role and the measures will depend on the conditions of structure and fertility of the soil at the particular location, since most of the assessed soils are from low to medium fertility levels and very few have high fertility.

The most restrictive factors are low phosphorus availability in most of the soils, followed by low organic matter content. These increase in cultivated areas.

In areas of greatest erosion and mass wasting risk such as steep slopes with thin and infertile topsoils and close to sensitive waterbodies, fertilizer application should be considered on a very localized basis to enhance the rate and extent of revegetation and hence promote ground protection and stabilization. The use of carefully selected faster growing naturalized species should also be considered in these locations. Fertilizer should not be used in wetland and bog habitats where a localized change in the pH of the soil and water could affect these delicate habitats and compromise acid-tolerant plant species.

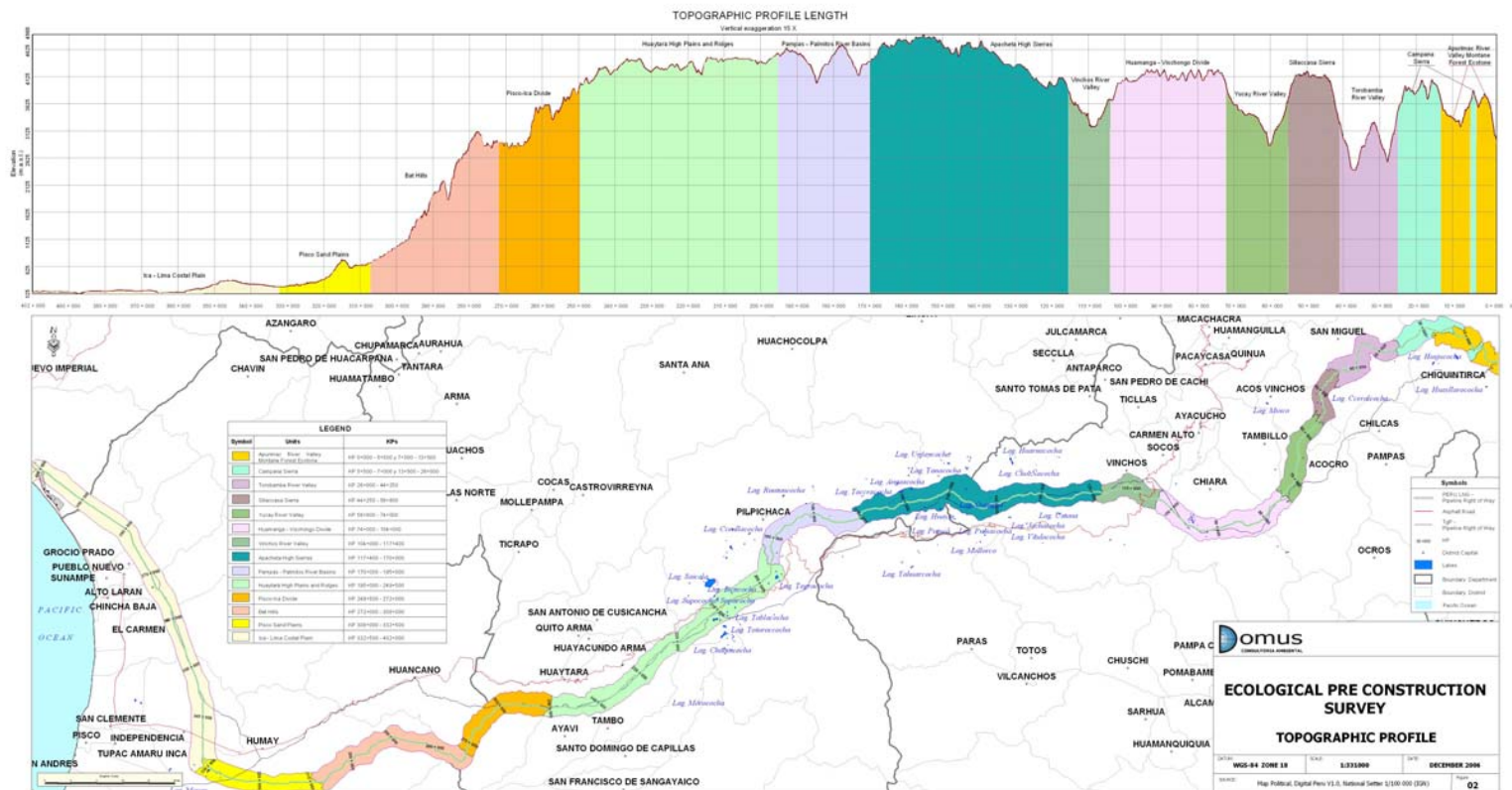
Hydroseeding should also be considered on a very localized scale in the highest risk areas such as steep, erodible slopes and close to major rivers, where it is practicable to undertake this measure.

Other biorestore measures such as organic applications from mulching (hay/straw) to enhance soil fertility and structure, compost or manure and jute matting should be considered in risk areas.

23.0 APPENDICES

23.1 CARTOGRAPHY

Figure 23.1.1 Topographic Profile of the ROW



23.2 METHODOLOGY

23.2.1 Vegetation

23.2.1.1 Team Organization

The Vegetation Team was formed by 4 Field Survey Groups, each composed of a specialist and a local assistant. Each group covered a specific segment of the ROW, dividing their activities according to the physiographic conditions of the 402 km and the resources to be evaluated. The team collected not only flora information but also physical information as to complement the information of the soil evaluators. Soil and plant samples were collected as needed. (Note: the vegetation and ornithology groups worked and traveled together in the field).

23.2.1.2 Data Recording

In order to achieve with the EFS objectives, data obtained were focused on the identification of sensitive habitats for within and adjacent to the ROW. The focus was to determine the sites which support plant species considered important because of their conservation status as listed by 2006 IUCN Red List and the Peruvian DS N° 043-2006-AG (the INRENA list of threatened plant species), as well as the sites with high value of floral diversity or presence of endemic species.

Prior to the field evaluation, data from previous studies performed within the area were used to prepare documents to facilitate the identification of species and habitats in the field:

- Photo gallery of threatened species considered by the IUCN and the DS N°043-2006-AG, as well as endemic species suspected to be present within the area.
- Preliminary map of habitats that offer important environmental services (i.e., wetlands)
- Preliminary map of habitats with high value of floral diversity.

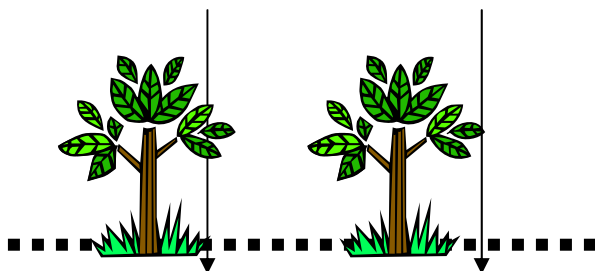
For the quantitative description of habitat types along the pipeline ROW, community sampling and plant specimen collection were performed in the area. The sampling consisted of a total of 30 50-m transects. In case of trees and shrubs, 4-m wide transects where all individuals from all the species present in the area were registered. The approximate coverage and phenology was also registered. In addition, "point

quadrat" method was used to determine the number of hits of each species with the help of a "needle" that goes from the soil to the highest part of the vegetation. This method offers an indirect measure of the biomass (repeated cover). A point was sampled each meter along the transect in areas with only herbaceous species.

"Point-Quadrat" Method

The point-quadrat is a method that was designed at the beginning to obtain the values of the frequency variable (presence-absence) in herb and bush communities. Later it was used to obtain cover data (projected area on the soil covered by plants). However, this method shows to be very useful generating "repeated cover" values that are calculated from the number of times a plant touches a "needle" ("zero" width and "infinite" length in theory). So the number of times the plant hits the needle will depend not only on the simple cover but also on the size and volume of the plant foliage becoming an indirect and non-destructive measure of the biomass. So that the repeated cover values has a high correlation with the ones of the biomass.

The following explains how the data was obtained:



As it can be observed, in the first case the needle hits the shrub three times and the herbaceous plant once. In the second case, the needle hits the shrub only once and does not touch any herbaceous cover. So the value for the first case is 4 and 1 for the second. For this study, 50 equally-spaced location points for the needles were used in a 50-m linear transect.

The plant species and the number of hits with the needle were registered in each point. The sum of values in the 50 points for each species was considered as the abundance measure ("repeated cover"). This measure was used to calculate the diversity indicators and the percentage of abundance (having as the total sum the number of hits in the 50 points of all the plant species). The following measures were calculated:

$P1a$ = Number of hits between needle 1 and the species a.

$\Sigma Pa = (P1a + P2a + \dots + P50a) =$ Total Sum of hits between the needles and the species a.

$\Sigma P = (\Sigma Pa + \Sigma Pb + \dots) =$ Total Sum of hits between needles and species.

Percentage of Abundance of species a = $(\Sigma Pa / \Sigma P) \times 100$

23.2.1.3 Sampling

A visual search of all plant species suspected to be present in the study area was performed separating every collection and/or record by location and type of vegetation.

A photographic record of the representative areas of each type of vegetation by sampling locations will be also performed, as well as a photographic record of the most important plant species (because its abundance, peculiarity, visual value, etc.).

Interviews applied to locals were made about the location of important species and the way they use those species.

Botanical samples were collected from plants with flowers and fruits, when possible. The specimens were preserved with 96% alcohol in botanical presses and later transported to Lima for their identification and donation to the herbaria of the San Marcos and La Molina universities.

23.2.2 Ornithology

23.2.2.1 Team Organization

The Ornithology Team consisted of 4 field groups which collectively covered nearly the entire length of the ROW to record the information on threatened or endemic birds present. These groups also made opportune observations of other faunal groups to complement the existing data and areas not covered by the Herpetology and Mammalogy teams.

23.2.2.2 Data Recording

During the evaluation, the following data were collected: day, starting time, final time and observer. Species were recorded as they were observed in the field. In the same census, all birds species encountered, visually or heard were registered according to the following data: species, number of individuals seen, habitat in which it was seen, place where it was seen, special remarks if any. In addition, all the species captured by means of mist nets were registered taking into account the following information: species, number of individuals, habitat and capture location special remarks if any.

The design of the study focused on the presence of rare species and habitat specialists, because common species adapt themselves easily to environmental changes and their presence could not be affected even though there is a strong environmental change. On the other side, rare species and specialists generally need a special adaptation with respect of any specific resource.

23.2.2.3 Sampling

In order to complete the total lists of birds for each site, mist nets were placed at 16 sites to complete censuses, and all individuals registered were released. In rapid evaluations such as the present EFS, mist nets provide little qualitative data for comparisons; however, they do provide important information on the presence of species which are not easily observed. More time would be required for each site to provide meaningful quantitative data.

23.2.3 Herpetology

23.2.3.1 Team Organization and Evaluated sites

The Herpetology Team consisted of two field groups. Highly sensitive areas identified from the Biological Sensitivity Map of the Environmental and Social Impact Study. The two groups of evaluators collected information in detail about habitats characteristics and species composition.

In some zones, these groups worked together with the Hydrobiology groups due to the habitat characteristics (mainly amphibians). Morning and evening inspections were carried out along transects. Voucher specimens were collected and sent for identification to the San Marcos University Natural History Museum.

Table 23.2.1. Herpetology Sampling Points

Sampling Points	Progressive	Habitat Type
1	397+500	Tillandsia Mat
2	389+300	Resinous Scrub/Cultivated Area
3	361+500	Thorny Scrub
4	334+700	Resinous Scrub
5	329+600	Coastal Hydromorphic Islands
6	329+000	Thorny Scrub
7	308+000	Tillandsia Mat
8	298+000	Columnar Cacti And Scrub
9	260+500	Desert Scrub
10	255+000	Mixed Scrub
11	251+000	Mixed Scrub
12	227+000	Tussock Grassland
13	217+000	Tussock Grassland
14	216+000	Scarcely Vegetated High Andean Areas
15	210+000	Sward-Forming Grassland
16	202+000	Sward-Forming Grassland
17	199+500	Scarcely Vegetated High Andean Areas
18	191+000	Peat Bog

Sampling Points	Progressive	Habitat Type
19	185+000	Tussock Grassland
20	164+000	Peat Bog
21	160+000	Scarcely Vegetated High Andean Areas
22	156+000	Peat Bog
23	154+000	Scarcely Vegetated High Andean Areas
24	146+000	Scarcely Vegetated High Andean Areas
25	137+000	Tussock Grassland
26	122+000	Sward-Forming Grassland
27	116+000	Resinous Scrub/Cultivated Area
28	114+000	Resinous Scrub
29	92+000	Peat Bog
30	74+500	Tussock Grassland
31	73+400	Eucalyptus Plantation
32	57+000	Thorny Scrub
33	56+500	Tussock Grassland
34	49+000	Sward-Forming Grassland
35	47+500	Tussock Grassland
36	46+500	Tussock Grassland
37	45+500	Tussock Grassland
38	45+000	Tussock Grassland

Sampling Points	Progressive	Habitat Type
39	44+000	Resinous Scrub
40	42+500	Resinous Scrub
41	41+000	Resinous Scrub
42	40+500	Dry Deciduous Forest
43	40+000	Cultivated Area
44	39+000	Thorny Scrub
45	38+800	Cultivated Area
46	37+000	Thorny Scrub
47	36+000	Cultivated Area
48	33+000	Thorny Scrub
49	32+000	Cultivated Area
50	31+500	Cultivated Area
51	30+700	Thorny Scrub
52	30+500	Thorny Scrub
53	27+000	Thorny Scrub
54	25+500	Tussock Grassland
55	25+000	Tussock Grassland
56	23+000	Sward-Forming Grassland
57	22+000	Peat Bog/Sward-Forming Grassland
58	21+500	Sward-Forming Grassland
59	19+000	Sward-Forming Grassland

Sampling Points	Progressive	Habitat Type
60	17+000	Tussock Grassland
61	15+500	Sward-Forming Grassland
62	15+000	Sward-Forming Grassland
63	12+000	Tussock Grassland
64	11+500	Sward-Forming Grassland
65	7+500	Upper Montane Forest
66	7+000	Upper Montane Forest/Tussock Grassland
67	1+500	Upper Montane Forest
68	1+000	Upper Montane Forest

23.2.3.2 Data Recording

The study design was based on general observations and collections using the Visual Encounter Surveys (VES) method (Crump & Scott 1994), which consists on walking on an area or habitat searching for animals, during a specific time. This method among others is used to measure the species composition and determine their richness and abundance.

Points for study had been select using the ESIA information and available cartography. In the sampling points, transects were established around various habitats and micro-habitats. Transects will be traveled during the night with the help of headlamps after an inspection of the area was done during the day. Geographic coordinates and altitude were registered by means of a GPS. The height above ground were recorded for all individuals observed or captured, as well as the type of substrate or refuge where the specimen was found.

Standardized VES field forms were used to collect information about each specimen, and they were hand collected. Amphibians and reptile were put into plastic or cloth bags. Measures taken were snout-cloaca length (SVL) and the length of reptiles' tails with a

1.0 Mixed Scrub Vernier. Diagnostic photographs from the ventral, dorsal and lateral regions were taken, as well as general habit photographs.

23.2.3.3 Specimen Collection

Vouch specimens of amphibian specimens were euthanized with Orajel (anesthetic) or its equivalent. Reptile specimens were euthanized with Ketalar and then they were fixed in Formalin at 10% and preserved in alcohol at 70%. Tissue samples (muscles and/or liver) of every species were collected and preserved in ethanol at 95%. The identification photos were encoded with field specimen numbers in the photographic register.

23.2.4 MAMMALS

23.2.4.1 Team Organization and Evaluated Sites

The Mammals groups traveled along with the Herpetology groups and focused on the sampling localities listed in Table N° 4 below.

Table 23.2.2. Mammals Sampling Points

Sampling Points	KP	Habitat Type
1	389+300	Resinous Scrub, Cultivated Area
2	362+500	Resinous Scrub
3	329+800	Coastal Hydromorphic Islands
4	308+500	Desert Barrens
5	304+300	Columnar Cacti And Scrub
6	298+500	Columnar Cacti And Scrub
7	297+500	Columnar Cacti And Scrub
8	253+000	Mixed Scrub
9	230+000	Sward-Forming Grassland
10	229+000	Tussock Grassland
11	201+000	Sward-Forming Grassland
12	186+500	Tussock Grassland
13	163+000	Scarcely Vegetated High Andean Areas
14	133+000	Sward-Forming Grassland
15	103+000	Tussock Grassland

16	92+200	Peat Bog
17	85+500	Peat Bog
18	72+000	Cultivated Area
19	71+000	Cultivated Area
20	62+500	Resinous Scrub/Cultivated Area
21	57+000	Thorny Scrub
22	56+000	Tussock Grassland
23	40+500	Dry Deciduous Forest
24	29+000	Cultivated Area
25	11+500	Sward-Forming Grassland
26	10+500	Upper Mountain Forest
27	10+200	Upper Mountain Forest
28	4+500	Cultivated Area
29	2+000	Upper Montane Forest

23.2.4.2 Data Recording

On each evaluation tract, transects were implemented. Within each transect, trap lines for small mammals were placed. Walkthroughs in the habitats previously identified on the base cartography were carried out for direct sightings of large and medium mammals with the help of binoculars. Transects was searched for indirect evidence of species such as tracks, burrows, scat, and skulls from owl pellets will be searched for. Locals were interviewed about the current and historical presence of mammal species in each zone, as well as uses for each species mentioned, with the aid of photos from specialized guidebooks. To the extent possible, photographic evidence was obtained to support observations.

Each transect was identified with GPS coordinates of endpoints and vertices. A photographic record of the dominant plant communities was also be obtained.

23.2.4.3 Specimen Collection

Following the procedures of Voss and Emmons (1996), 130 TOMCAT traps were placed in the afternoon to collect small mammals at each sampling locality and were checked the following morning.

Animals captured in the TOMCAT traps were measured, weighed and prepared to be fixed with Formalin at 10% and preserved with alcohol at 75%, following the procedures of Nagorsen and Peterson (1980).

Bats were captured for identification in mist nests set up at each sampling locality. Representative specimens of morphospecies that unidentified in the field were euthanized and preserved (as described above).

Collected specimens were identified at the Mammalogy Department laboratory of the UNMSM Natural History Museum. To accomplish the identification, inspection of skulls and external characters, as well as the use of specialized keys, a comparison between captured specimens and the museum collections will be necessary. The extraction and cleaning of skulls were done previously with the help of *Dermestes* larvae. Biological material from the samples were deposited in the Mammals Collection of the San Marcos Natural History Museum.

23.2.5 Hydrobiology

23.2.5.1 Evaluated Sites

Compared to terrestrial environments, aquatic ecosystems are often more sensitive to disturbance of their habitat because of the connectivity of their environment. Thus, 22 sampling stations have been determined through out the study area (Table N° 5). Twenty five percent of the stations correspond to lentic environments (lakes or lagoons) and the remained to lotic environments (rivers and streams). The selection criteria include permanent aquatic bodies as well as the ones that could be refuge for endemic and native species, in the high Andean zones for fish (*Astroblepus*, *Orestias* and *Trichomycterus*), and in the coastal areas for aquatic invertebrates (*Cryphiops caementarius*).

Table 23.2.3. Hydrobiology Sampling Points

Sampling Point	KP	Description
1	389+400	Q. Topará
2	364+500	R. Chico
3	362+500	R. Matagente
4	334+800	R. Pisco
5	329+600	L. Morón
6	329+000	Lagunillas
7	241+000	B. Taccra
8	224+000	Q. TaSward-forming Grasslandampa

9	212+200	Q. Canya
10	211+500	L. Quisacocha
11	209+500	R. Leche Leche
12	201+000	Q nn
13	186+500	R. Pampas
14	175+500	Q. Pichjahuasi
15	173+800	Q. Huayco Corral
16	162+000	B. Yuarilla
17	156+000	L. Yanacocha
18	149+500	Q. Antacocha
19	145+500	B. Yanacancha
20	136+700	L. Challhuacocha
21	135+000	B. Soyusoytu
22	110+500	R. Vinchos
23	110+00	Q. Urpaypampa
24	95+500	L. Choquehuacgra
25	92+200	B. Chaquicocha
26	85+500	B. Acchacruz Orcco
27	80+800	B. Carimayo
28	71+000	Q. Jatunchancara
29	62+500	Q. Afluente
30	62+500	Q. Huayco
31	62+500	R. Yucay
32	53+200	B. Nina Orcco
33	51+200	L. Nina Orcco
34	49+500	Q. Soccosmayo
35	48+800	L. Yanacocha
36	39+000	R. Torobamba
37	30+000	Q. Uras
38	29+000	Q. Yanacaca
39	22+700	Q. Campana
40	17+000	L. Yanapacha
41	14+500	B. Cochas
42	10+000	R. Sachapampa
43	0+500	Q. Collpa R.
44	0+000	Alfarpampa

23.2.5.2 Data Recording

A field form was designed for the characterization of the physical structure of each of the sampling stations. This form was useful to ensure the comparability of the hydrobiological community structures evaluated.

Information such as type of environment, area, and associated vegetation was specified in the form mentioned above. A portable multiparameter measuring device (YSI 85) and a pH meter was used to register field parameters (temperature, conductivity, pH and dissolved oxygen). This information is relevant to know how these parameters are associated to the type of existing fauna.

23.2.5.3 Sampling

23.2.5.3.1 Benthos Evaluation

In the lotic and lentic environments, there are habitats associated to either hard substrates (boulders, stones, and gravel) or soft substrates (silts, clay, and sand), and habitats formed by aquatic vegetation (macrophytes, algal, and allochthonous material). The communities that have a wide diversity of aquatic macro-invertebrates on its riverside or environments entirely under water were evaluated with a 0,1 m² Surber net which has a 500 µm mesh. In each sampling station, a sample from each habitat was collected and put into a plastic bag with 10% Formalin neutralized with borax. Each sample was labeled with its corresponding identification label, specifying the date, sampling station and sample type. Benthos samples were determined taxonomically by the Entomology Laboratory of the Universidad Nacional Agraria La Molina.

23.2.5.3.2 Fish Evaluation

Fish evaluation were take place in lotic environments within 100-m transects. Specimens were collected by an electric discharge device and put into 10-l plastic containers, so specialists could select any to later identification. Every specimen selected for identification was measured (mm) and weighed (g) in situ, the rest were returned to their natural environment. Then they were immersed in 10% Formalin neutralized with borax, labeled individually, and sent to Lima for their identification at the Ichthyology Department of the Natural History Museum - UNMSM.

In the lentic environments with depths of 50 cm or greater, a 0.5-inch-mesh cast net was used instead of an electric discharge device. 10 casts were carried out for each sampling station. The specimens captured will be determined and evaluated in situ, except those that could not be identified. They were immersed in Formalin neutralized with borax at 10%, labeled individually and sent to the Ichthyology Department of the Natural History Museum – UNMSM for their identification.

In the lentic environments with water levels of less than 50 cm, the electric device for fish capture was used.

Specimens weighing more than 200 g were injected with Formalin at 10% before putting them into the collection bags.

23.2.6 SOILS

23.2.6.1 Team Organizationa and Evaluated Sites

Two soils groups collect samples and described soils at pre-selected sites along the ROW corridor at locations listed in Table N° 5 below. Areas with agriculture (crops and plantations) and livestock production activities (pastures and natural rangelands), coastal wetlands, shrublands, and peat bogs were differentiated in order to have the information about the different uses of the soil.

Table 23.2.4. Soils Sampling Points

Sampling Point	Progressive	Number of samples
1	380+000	4
2	364+000	4
3	353+000	3
4	334+000	4
5	310+000	2
6	309+000	4
7	290+000	3
8	260+000	4
9	256+000	4
10	251+000	4
11	227+000	4
12	225+000	1
13	220+000	1
14	215+000	1
15	210+000	1
16	205+000	1
17	200+000	3
18	195+000	1
19	190+000	1
20	187+000	2

21	185+000	1
22	180+000	1
23	175+000	6
24	175+000	1
25	170+000	1
26	165+000	1
27	160+000	1
28	155+000	1
29	150+000	1
30	145+000	1
31	140+000	1
32	135+000	1
33	134+000	1
34	131+000	3
35	130+000	1
36	120+000	1
37	117+000	1
38	116+000	2
39	114+000	1
40	111+000	1
41	108+000	1
42	105+000	3
43	104+000	3
44	102+000	1
45	100+000	2
46	99+000	1
47	96+000	1
48	93+000	1
49	90+000	1
50	88+000	1
51	87+000	1
52	84+000	1
53	81+000	1
54	78+000	1
55	75+000	1
56	73+000	1
57	72+000	1
58	69+000	1

59	66+000	1
60	63+000	2
61	61+000	5
62	59+000	1
63	53+000	2
64	50+000	1
65	47+000	1
66	46+000	2
67	45+000	1
68	44+000	5
69	41+000	5
70	35+000	2
71	32+000	1
72	31+000	4
73	30+000	2
74	29+000	4
75	28+000	1
76	21+000	2
77	15+000	1
78	8+000	1
79	5+000	1
80	0+500	1

23.2.6.2 Data Recording

Data collected by each group of specialists in the field included topography, stoniness, gradients, soil fauna, erosion, drainage, riverside stability, slopes, etc.

23.2.6.3 Sampling

In the Andean sector, samples were taken every 10 km, with 2 samples in 2 positions at 2 depths of 0-10 cm and 10-30 cm. Samples taken exceed 150, more than 4 for each 10-km portion and 2 sites and at 2 depths (0-20 and 20-40 cm) were taken more or less every 20 km.

Apparent density was measured to estimate compaction and calculate nutrients reserves. Characterization analysis included texture, pH, salts, carbonates, organic matter content, available phosphorus, available potassium, cation exchange capacity, and exchangeable cations such as calcium, magnesium, potassium, and sodium.

23.3 REFERENCES

23.3.1 General

Peruvian normative:

- D.S. 034-2004-AG. Categorización de Especies Amenazadas de Fauna Silvestre.
- D.S. 043-2005-AG. Categorización de Especies Amenazadas de Flora Silvestre.

23.3.1 Botany

Alverson, W. S., B. A. Whitlock, R. Nyffeler, C. Bayer, & D. A. Baum. 1999. Phylogeny of the core Malvales: evidence from ndhF sequence data. *American Journal of Botany* 86: 1474–1486.

ANGIOSPERM PHYLOGENY GROUP. 2003. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. *Botanical Journal of the Linnean Society*, 2003, 141:399–436.

Armesto J. J., C. Smith-Ramirez & R. Rozzi. 2001. Conservation strategies for biodiversity and indigenous people in Chilean forest ecosystems. *Journal of The Royal Society of New Zealand* 31(4):865-877.

Baum, D., S.D. Smith, A. Yen, W.S. Alverson, R. Nyffeler, B.A. Whitlock & R.L. Oldham. 2004. Phylogenetic relationships of Malvaceae (Bombacoideae and Malvoideae; Malvaceae sensu lato) as inferred from plastid DNA sequences. *American Journal of Botany* 91:1863-1871.

Brack A. 1986. Ecología de un país Complejo. En: *Gran Geografía del Perú. Naturaleza y Hombre*. Volumen II, Pp. 175-319. ManferJuan Mejía Baca, Barcelona, España.

Comisión Nacional Forestal de México. Sin año. *Dodonaea viscosa*. SIRE-Paquetes tecnológicos. Comisión Nacional Forestal de México.

Gentry, A. H. 1992. Bignoniaceae - Part II (Tribe Tecomeae). In: Organization for Flora Neotropica, ed., Fl. Neotrop. Monogr. 25(2):284.

IUCN 2006. 2006 IUCN Red List of Threatened Species. <www.iucnredlist.org>. Downloaded on 8 December 2006.

Kessler, M. & A. N. Schmidt-Lebuhn. 2006. Taxonomical and distributional notes on *Polylepis* (Rosaceae). Org. Divers. Evol. 6, Electr. Suppl. 1: 1 - 10 (2006)

León, B.; J. Roque, C. Ulloa, N. Pitman, P. M. Jørgensen y A. Cano. (en prensa). El libro rojo de las plantas endémicas del Perú. Rev. peru. biol. Número especial 13(2).

Legislación peruana (D.S. 043-2006-AG), Aprueban categorización de flora silvestre.

Linares-Palomino, R. 2004. Los Bosques Tropicales Estacionalmente Secos: II. Fitogeografía y Composición Florística. *Arnaldoa* 11(1):103-138.

Ministerio de Ambiente, Vivienda y Desarrollo Territorial de Colombia. 2003. Restauración de Ecosistemas a partir del Manejo de la Vegetación: Guía Metodológica. Ministerio de Ambiente, Vivienda y Desarrollo Territorial de Colombia, Bogotá.

Porter, M. 1970. The genus *Dodonaea* (Sapindaceae) in the Galápagos Islands. Occasional papers of the California Academy of Sciences 81:1-4.

Ramos, C. 2002. Producción de hojarasca en *Dodonaea viscosa* (Sapindaceae) un mecanismo que facilita la sucesión primaria. *Acta Biológica Colombiana* 7(1):53-56.

Reynel, C., Pennington, R., Pennington, T., Flores, C. y Daza, A. 2006. Árboles útiles del Ande Peruano. Una guía de identificación, ecología y propagación de las especies de la Sierra y los Bosques Montanos en el Perú. Herbario de la Facultad de

- Ciencias Forestales de la Universidad Nacional Agraria – La Molina, Royal Botanic Gardens Kew, Royal Botanic Gardens Edingburgh e ICRAF. 466 p.
- Romoleroux, K. 2004. The genus *Lachemilla* (Rosaceae) in the northern Andes of South America. *Lyonia* 7(1):21-32.
- Stadler-Kaulich, N. 2004. Un Ensayo de Agroforestería Sucesional en el Valle de Cochabamba, Bolivia. *Zonas Áridas* 8:63-68.
- Tate, J. A.; J. Fuertes Aguilar, S. J. Wagstaff, J. C. La Duke, T. A. Bodo Slotta & B. B. Simpson. 2005. Phylogenetic relationships within the tribe Malveae (Malvaceae, subfamily Malvoideae) as inferred from ITS sequence data. *American Journal of Botany* 92(4): 584 - 602.
- University of Hawai at Manoa. 2001. *Dodonaea viscosa*. Hawaiian Native Plant Propagation Database. <http://www2.hawaii.edu/~eherring/hawnprop/dod-visc.htm> (Last updated: 18 September 2001, Revised: 3 December 2006).
- USDA, ARS, National Genetic Resources Program. Germplasm Resources Information Network - (GRIN) [Online Database]. National Germplasm Resources Laboratory, Beltsville, Maryland. <http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?105263> (8 December 2006)
- Weberbauer A. 1945. El Mundo Vegetal de los Andes Peruanos. Estación Experimental Agrícola de La Molina, Lima, 776 pp.
- Weigend, M.; E. Rodríguez & C. Arana. 2006. The relict forest of Northwest Peru and Southwest Ecuador. In: M. Weigend, E. Rodríguez & C. Arana (comps.) Los bosques relictos del Noroeste de Perú y Suroeste de Ecuador, Número especial Revista Peruana de Biología 12 (2): 185-194.
- Weigend, M.; A. Cano & E. Rodríguez. 2006. New species and new records of the flora in Amotape-Huancabamba Zone: Endemics and biogeographic limits. In: M. Weigend, E. Rodríguez & C. Arana (comps.) Los bosques relictos del Noroeste de Perú y Suroeste de Ecuador, Número especial Revista Peruana de Biología 12 (2):249-274.
- Williams, T. 2002. America's largest weed. *Audubon* 104:24-31.

23.3.3 Herpetology

- Carrillo de Espinoza, N. & J. Icochea. 1995. Lista Taxonómica preliminar de los reptiles vivientes del Peru. Publicaciones del Museo de Historia Natural, UNMSM, (A) 49: 1-27.
- Cei, J. 1993. Reptiles del noroeste, nordeste y este de la Argentina. Herpetofauna de las selvas Subtropicales, Puna y Pampas. Museo Regionale di Science Naturali. Monografía XIV.
- Crump, M. y L. Scott. 1994. Visual Encounter Survey. En: Measuring and Monitoring Biological Diversity, Standard Methods for Amphibians. Heyer, W. R., Donnelly, M.A., McDiarmid, R.W., Hayek, L.A.C. y Foster M.S. (Eds). Smithsonian Institution Press (Washintong, D. C.). 364 pp.
- Doan, T. y T. Castoe. 2005. Phylogenetic taxonomy of the Cercosaurini (Squamata: Gymnophthalmidae), with new genera for species Neusticurus and Proctoporus. Zoological Journal of the Linnean Society, 143: 405-416.
- Duellman, W. y T. Fritts. 1972. A taxonomic review of the southern Andean marsupial frogs (Hylidae: Gastrotheca). Occasional Papers of the Museum of Natural History Museum the University of Kansas, Lawrence, Kansas 9: 1-37.
- Duellman, W. y A. Veloso. 1977. Phylogeny of Pleurodema (Anura: Leptodactylidae): A Biogeographic model. Occasional Papers of the Museum of Natural History Museum the University of Kansas, Lawrence, Kansas 64: 1-46.
- Duellman, W. 1978. Two new species of Eleutherodactylus (Anura: Leptodactylidae) from the Peruvian Andes. Transactions of the Kansas Academy of Science 81: 65-71.
- Duellman, W. y A. Salas. 1991. Annotated checklist of amphibians and reptiles of Cusco Amazónico, Perú. Occas. Pab. Mus. Nat. Hist. Univ. Kansas 143:1-13
- Duellman, W. y J. Pramuk. 1999. Frogs of the genus Eleutherodactylus (Anura: Leptodactylidae) in the Andes of northern Peru. Scientific Papers of the Museum of Natural History Museum the University of Kansas 13: 1-78.

El Peruano. 2004. D.S. N°034-2004-AG. p 276853 – 276856.

Etheridge, R, y R. Espinoza. 2000. A semi-annotated bibliography and taxonomy of the Liolaeminae (Squamata:Iguania:Tropiduridae).
<http://www.sci.sdsu.edu/etheridge/>

FANPE 1996. Diversidad Biológica del Perú: Zonas prioritarias para su conservación. Ed. L. Rodríguez. Ministerio de Agricultura, Instituto Nacional de Recursos Naurales.

Fritts, T. 1974. A Multivariate Evolutionary Analysis of the Andean Iguanid Lizard of the genus *Stenocercus*. San Diego Society of Natural History Memoir 7: 1-89.

Gallardo, J. 1987. Anfibios argentinos: Guía par su identificación. Librería Agropecuaria S. A.

Köhler, G. y E. Lehr. 2004. Comments on *Euspondylus* and *Proctoporus* (Squamata: Gymnophthalmidae) from Peru, with description of three new species and a key to the Peruvian species. *Herpetologica* 60: 501-518.

Laurent, R. 1998. New forms of lizards of the subgenus *Eulaemus* of the genus *Liolaemus* (Reptilia: Squamata: Tropiduridae) from Perú and northern Chile. *Acta Zoológica Lilloana* 44(1): 1-26.

Lavilla, E. y I. De la Riva. Prólogo. En Estudios de las ranas andinas de los géneros *Telmatobius* y *Bratrachophrynus*. Eds. Lavilla, E. O. and De la Riva, I. Asociación Herpetológica Española, Valencia 7.

Lehr, E. 2002. Amphibien und Reptilien in Perú. Natur und Tier Verlag, Münster. 208 pp.

Lehr, E. 2006. Taxonomic status of some species of peruvian *Phrynosoma* (Anura: Leptodactylidae), with the description of a new species from the Andes of southern Peru. *Herpetologica* 62: 331-347.

Lynch, J. 1989. Intrageneric relationships of mainland *Eleutherodactylus* (Leptodactylidae). I. A review of the frogs assigned to the *Eleutherodactylus discoidalis* species group. *Milwaukee Public Museum Contributions in Biology and Geology*, 79: 1-25.

- Lips, K. R., J. K. Reaser, B. E. Young, and R. Ibáñez. 2001. Amphibian monitoring in Latin America: a protocol manual / Monitoreo de Anfibios en América Latina: Manual de protocolos. SSAR Herpetological Circular No. 30, 116 pp.
- Péfaur, J. y W. Duellman. 1980. Community structure in high Andean herpetofaunas. Transactions of the Kansas Academy of Sciences 83(2): 45-65
- Pefaur, J., P. Jiménez, E. López y A. Núñez. 1978. Distribución y clasificación de los reptiles de Arequipa, Perú. Bull. Inst. Fr. Et. And. 7:129-139.
- Pineda, E. and G. Halffter. 2003. Species diversity and habitat fragmentation: frogs in a tropical montane landscape in Mexico. Biological Conservation : 1-10
- Pramuck, J y F. Kadivar. 2003. A new species of Bufo (Anura: Bufonidae) from southern Ecuador. Herpetologica 59: 270-283.
- Rodríguez, L.O., J.H. Córdova y J. Icochea. 1993. Lista preliminar de los anfibios del Perú. Publicaciones del Museo Historia Natural UNMSM (A) 45: 1-22.
- Rodríguez, L. 1996. Áreas prioritarias para la conservación de anfibios en el Perú. En Diversidad Biológica del Perú, zonas prioritarias para su conservación. FAMPE, 1996.
- Rodríguez, L. y J. Cadle. 1990. A preliminary overview of the herpetofauna of Cosha Cashu, Manu National Park, Perú. In: Gentry, A (ed) Four Neotropical Rainforest. Yale, New Haven.
- Rueda-Almonacid, J., J. Lynch, y A. Amézquita. (Eds.). 2004. Libro rojo de anfibios de Colombia. Serie de libros rojos de especies amenazadas de Colombia. Conservación Internacional Colombia, Instituto de Ciencias Naturales-Universidad Nacional de Colombia, Ministerio de Medio Ambiente. Bogotá, Colombia. 384 pp.
- Schlaepfer, M. y T. Gavin 2001. Edges effect on lizards and frog in tropical forest fragment. Conservation Biology 15 (4): 1079-1089.
- Sinsch, U. 1986. Anfibios de la sierra central del Perú. Una clave de identificación para adultos y larvas. Boletín de Lima, (45): 23-32.

Vellard, J. 1955. Estudios sobre batracios andinos. III. Los Telmatobius del grupo jelskii. Memorias del Museo de Historia Natural 4: 1-28.

Vellard, J. 1959. Estudios sobre batracios andinos. V. El género Bufo. Memorias del Museo de Historia Natural 8: 1-48.

Vellard, J. 1960. El género Pleurodema en los Andes peruanos. Memorias del Museo de Historia Natural 10: 1-12.

Walsh, 2005. Estudio de Impacto Ambiental y Social del proyecto de transporte de gas natural por ducto de Ayacucho a la planta de licuefacción. Preparado para Perú LNG.

Young, B. E., S. N. Stuart, J. S. Chanson, N. A. Cox, and T. M. Boucher. 2004. Disappearing Jewels: The Status of New World Amphibians. Appendix 3. Comprehensive List of Species. Nature Serve, Arlington, Virginia.

<http://www.embl-heidelberg.de/~uetz/LivingReptiles.html>

<http://research.amnh.org/herpetology/amphibia/index.php>

<http://amphibiaweb.org/>

<http://redlist.org/>

23.3.4 Mammalogy

Brewer, S.W. and M. Rejmanek. 1999. Small rodents as significant dispersers of tree seeds in a Neotropical forest. Journal of Vegetation Science 10:165-174.

Cabrera, A. y Yepes, J. 1960. South American mammals. Historia Natural, Buenos Aires.

Carthew S. M. R. L. Goldingay 1997 Non-flying mammals as pollinators. Trends in Ecology and Evolution 12: 104-108

Cat specialist group .2004. Oreailurus jacobita. IUCN.

CITES 2006. Appendices I, II y III . < <http://www.cites.org/eng/app/appendices.shtml>>

Fleming, T. H. y Sosa, V. J. 1994. Effects of nectarivorous and frugivorous mammals on reproductive success of plants. Journal of Mammalogy. 75(4):845-851.

Greene, H.W. (1988). Species richness in tropical predators. In Almeda, F. and Pringle, C.M. (eds), Tropical rainforests. Calif. Acad. Sci. and AAAS Pacific Division, San Francisco. Pp. 259-280.

Herskovitz, P. 1962. Evolution of Neotropical Cricetinae rodents (Muridae) with special reference to the Phyllotinae Group. Fieldiana Zoology 46: 524.

IUCN. 2006. *2006 IUCN Red List of Threatened Species*. <www.iucnredlist.org>.

Janson, C.H.; Terborgh, J.; Emmons, L.H. 1981. Non-flying mammals as pollinating agents in the Amazonian forest. Biotropica 13 (suppl.): 1-6.

Myers, 1990. A review of the *Boliviensis* Group of *Akodon* (Muridae: Sigmodontinae), with emphasis on Peru and Bolivia. Miscellaneous Publication Museum of Zoology, University of Michigan 177: 1-104.

Pearson, O. 1982. Distribución de pequeños mamíferos en el altiplano y los desiertos del Perú. Zoología Neotropical. Actas del VIII Congreso Latinoamericano de Zoología (P. Salinas, Ed.) Merida, Venezuela, 263 – 284.

Pearson, O. 1972. New information on ranges and relationships within the rodent Genus Phyllotis in Peru and Ecuador. Journal of mammalogy, 53 (4): 677 – 686.

Perú LNG, 2005. Estudio de Impacto ambiental y social del proyecto de transporte de gas natural por ducto de Ayacucho a la planta de licuefacción. Volumen II B, Línea Base Biológica, Walsh Perú S.A. Proyecto N° PET – 1239.

Redford, K.H. and Eisenberg, J.F. 1992. Mammals of the Neotropics, Vol. 2: the southern cone. Univ. Chicago Press, Chicago

- Rodríguez, L. (Ed.). 1996. Diversidad Biológica del Perú. Zonas Prioritarias para su Conservación. Proyecto FAMPE, GTZ-INRENA. Ministerio de Agricultura. INRENA.
- Seidensticker, J. 1991b. Pumas. Pp 130-137 in J. Seidensticker and S. Lumpkin, eds. *Great cats*. Merehurst, London.
- Vilá, B.L. y Cassini, M.H., 1994. Time allocation during the reproductive season in vicuñas. *Ethology*, 97: 226-235.
- Voss, R.S. y L.H. Emmons. 1996. Mammals diversity in neotropical lowland rainforest: A preliminary assessment. *Bull. Am. Mus. Nat. Hist.* 230: 1-115.
- Yensen E. y K.L. Seymour. 2000. *Oreailurus jacobita*. *Mammalian Species* 644: 1-6.
- Yahner, R.H. & Smith, H.R. (1991) Small mammal abundance and habitat relationships on deciduous forested sites with different susceptibility to gypsy moth defoliation. *Environmental Management*, 15, 113–120.
- Wilson, D. E., and D. M. Reeder (eds). 2005. *Mammal species of the World*. Johns Hopkins University Press, 2,142 pp. (Available from Johns Hopkins University Press, 1-800-537-5487 or (410) 516-6900 <http://www.press.jhu.edu/>)

23.3.5 Ornithology

- Barrio, J. 2002. Evaluación Rápida de la Avifauna, Presencia de Mamíferos, y Prioridades de Conservación en el Parque Nacional Huascarán. Reporte Técnico para el Plan Maestro del Parque Nacional Huascarán. Instituto de Montaña, Huaraz, Perú.
- Domus Consultoría Ambiental S.A.C. 2005. Determinación de Índices Medioambientales por Medio del Monitoreo de Aves en el Área de Influencia de la Mina Antamina. Domus Consultoría Ambiental S.A.C., Lima, Perú.
- Domus Consultoría Ambiental S.A.C. 2006. Determinación de Índices Medioambientales por Medio del Monitoreo de Aves en el Área de Influencia de la Mina Antamina: segundo año. Domus Consultoría Ambiental S.A.C., Lima, Perú.

Fjeldsø, J. 1987. Birds of relict forests in the high Andes of Peru and Bolivia. Technical report from the Polylepis forest expedition of the Zoological Museum, 1987, with some preliminary suggestions for habitat preservation. Zoological Museum, University of Copenhagen, Denmark.

Fjeldsø, J. 1993. The avifauna of the Polylepis woodlands of the Andean highlands: the efficiency of basing conservation priorities on patterns of endemism. Bird Conservation International, 3: 37-55.

Frimer, O., & Moller-Nielsen, S. 1989. The status of Polylepis forests and their avifauna in Cordillera Blanca, Peru. Technical report from an inventory in 1988, with suggestions for conservation management. Zoological Museum, University of Copenhagen, Denmark.

23.3.6 Hydrobiology

Flury, B & H. Riedwyl. 1990. Multivariate Statistics: A Practical Approach. Chapman and Hall. London UK. 296 p.

Krebs, C. 1985. Ecología: Estudio de la Distribución y Abundancia. Editorial Harla. México

Krebs, C. 1989. Ecological Methodology. Harper & Row, Publishers. New York. 654 p.

Magurran, A. 1987. Diversidad Ecológica y su Medición. Ediciones Vedral. Barcelona, España. 200 p.

Maldonado, J; A, Ortega; Usma, J; G. Galdís; F. Villa; L, Vásquez; S, Prada y C. Ardilla. 2006. Peces de los Andes de Colombia: Guía de Campo. Instituto de Investigación de Recursos Biológicos Alexander Von Humboldt. Bogotá, Colombia. 346 p.

Margalef, R. 1974. Ecología. Ediciones Omega. Barcelona, España.

Odum, E. 1971. Ecología. Editorial Interamericana. México.

Parenti, L. 1984. A Taxonomic Revision of the Andean Killifish Genus *Orestias* (Cyprinodontiformes, Cyprinodontidae). Bulletin of the American Museum of Natural History. Vol. 178: Article 2. New York. 212 p.

23.3.7 Soils

Brady, N. 1990. The Nature and Properties of soils. 10ma edición. MacMillan Publishing Company.

Estrada J. y R. Bazan. 1970 Análisis de Suelos y Plantas. Facultad de Agronomía-Departamento de Suelos.

Havlin J, J. Beaton, S. Tisdale And W. Nelson. 1999 Soil Fertility and Fertilizar. Prentice Hall. New Jersey.

Marschner Horst 1995 Mineral Nutrition of Higher Plants. Academic Press. London. New York

Mengel K. y E. Kirkby 2000 Principios de Nutrición Vegetal. Internacional Potash Institute. Basel. Switzerland

Rengel Zdenko 1999. Mineral Nutrition of Crops: Fundamental Mechanisms and Implications. Food Products Press, New York.London. Oxford

Troeh F. and L. Thompson. 1993. Soils and Soil Fertility. 5ta Edición University Press. Ocford. Iowa State University.

23.4 ACROMYMS AND GLOSSARY

Table 23.4.1. ACRONYMS

English	Spanish	Description
RP	PBR	Restoration Plan
CMP	PMC	Contractor Management Plan
ELU	UPE	Ecological Landscape Unit
ECOMP	PME	Ecological Management Plan
ESIA	EIA	Environmental and Social Impact Assessment
ESMP	PMSA	Environmental and Social Management Plan
ESS	SES	Ecological Sensitive Sectors
GIS	SIG	Geographical Information System
MLU	UMP	Micro Landscape Unit
ROW	DDV	Right of Way

Table 23.4.2. GLOSSARY

English	Spanish	Description
ABANDONMENT	ABANDONO	It is the phase of a hydrocarbons activity in which the necessary measures are applied to correct any environmental adverse condition happened as consequence of operation activities. And to implement the necessary restoration works to turn the area to its natural state or to create appropriate conditions for its new use. Generally the actions for abandonment are developed under an Abandonment Plan that is part of the the management documents of a project. This Plan includes measures to avoid adverse impacts to the environment produce by solid, liquid and gaseous waste that can appear subsequently.
AGGREGATE	AGREGADOS	A group of primary soil particles that cohere to each other more strongly than to other surrounding particles.
ALLUVIAL	ALUVIAL	Sediments deposited by running water of streams and rivers. It may occur on terraces well above present streams, on the present flood plains or deltas, or as a fan at the base of a slope.
AMPHIBIAN	ANFIBIOS	A vertebrate animal of the Class Amphibia. Amphibia are a taxon of animals that include all tetrapods and four-legged vertebrates that do not have amniotic eggs, are ectotherms, and generally spend part of their time on land.
AQUATIC	ACUÍCOLA	Pertaining to water, living or growing in water, taking place in water
BAT	MURCIÉLAGO	A mainly nocturnal mammal, capable of sustained flight, with membranous wings that extend between the fingers and limbs. Order Chiroptera. It is guided in the darkness by the echoes of the ultrasound it emits; it is nocturnal and passes the day hanging with its head down; there are about 900 species, of very different sizes. Most of the bats are insectivorous, but there are also frugivorous and ichthyovorous. They are important for the dispersion of seeds and the control of insects.
BIRD	AVES	A warm-blooded egg-laying vertebrate animal of a class distinguished by the possession of feathers, wings, and a beak, typically able to fly.

English	Spanish	Description
PEAT BOG	BOFEDAL	Bog of moor or of Andean puna, created by the agricultural irrigation practices and the drinking trough practices in the soil. Characteristic of the Andean topography and hydrology.
BULK DENSITY	DENSIDAD APARENTE	The mass of dry soil (105°C) per unit volume.
BUSH	ARBUSTO	Perennial plant which has woody stems and branches and ranges in height from very low to the size of a small tree. Shrub.
CAMELID	CAMÉLIDO	Mammal of a family (Camelidae) comprising the camels together with the llama and its relatives.
COLLUVIAL	COLUVIAL	Pertaining to material or processes associated with transportation and/or deposition by mass movement (direct gravitational action) and local, unconcentrated runoff on side slopes and/or at the base of slopes. Rock detritus and soil accumulated at the foot of a slope.
COLLUVIAL	COLUVIAL	Rock detritus and soil accumulated at the foot of a slope.
DECIDUOUS	CADUCIFOLIO	Characteristic of a tree or shrub that sheds its leaves annually.
EDAPHOLOGY	EDAFOLOGÍA	Soil science.
EROSION	EROSIÓN	The wearing away of the land surface by rain or irrigation water, wind, ice, or other natural or anthropogenic agents that abrade, detach and remove geologic parent material or soil from one point on the earth's surface and deposit it elsewhere, including such processes as gravitational creep and so-called tillage erosion.
FISH	PEZ	Type of cold-blooded aquatic animal with fins and scales.
FULVIC ACID	ACIDO FULVICO	The pigmented organic material that remains in solution after removal of humic acid by acidification.
GULLY	CÁRCAVA	(also gully) A channel resulting from erosion and caused by the concentrated but intermittent flow of water usually during and immediately following heavy rains.
HERPETOLOGY	HERPETOLOGÍA	Science that studies the reptiles.

English	Spanish	Description
HORIZON	HORIZONTE	A layer of soil or soil material approximately parallel to the land surface and differing from adjacent genetically related layers in physical, chemical, and biological properties or characteristics such as color, structure, texture, consistency, kinds and number of organisms present, degree of acidity or alkalinity.
HYDROBIOLOGY	HIDROBIOLOGÍA	The biological study of bodies of water, is the science of life and life processes in water.
HYDROSEEDING	HIDROSIEMBRA	The technique of spraying a slurry of seeds, tackifier, mulch and fertilizer on bare ground (often steeply sloping) to hold soil in place while awaiting germination of a ground cover.
IUCN (International Union For Conservation of Nature And Natural Resources, The World Conservation Union)	UICN	International conservation institution that annually elaborates the IUCN Red List of Threatened Species. This list provides taxonomic, conservation status and distribution information on taxa that have been globally evaluated using the IUCN Red List Categories and Criteria. This system is designed to determine the relative risk of extinction, and the main purpose of the IUCN Red List is to catalogue and highlight those taxa that are facing a higher risk of global extinction (i.e. those listed as Critically Endangered , Endangered and Vulnerable). The IUCN Red List also includes information on taxa that are categorized as Extinct or Extinct in the Wild ; on taxa that cannot be evaluated because of insufficient information (i.e. are Data Deficient); and on taxa that are either close to meeting the threatened thresholds or that would be threatened were it not for an ongoing taxon-specific conservation programme (i.e. are Near Threatened).
LANDSLIDE	DESLIZAMIENTO	A general term for a mass movement landform and a process characterized by moderately rapid to rapid (greater than 30 cm per year) downslope transport, by means of gravitational stresses, of a mass of rock and regolith that may or may not be water saturated.
MAMMAL	MAMÍFERO	Member of the class Mammalia (class of warm-blooded vertebrate animals the female of which secrete milk to feed their young and characterized by a covering of hair on their bodies).
MASS MOVEMENT	MOVIMIENTO EN MASA	Dislodgement and downslope transport of soil and rock material as a unit under direct gravitational stress. The process includes slow displacements such as creep and solifluction, and rapid

English	Spanish	Description
		movements such as landslides, rock slides, and falls, earthflows, debris flows, and avalanches. Agents of fluid transport (water, ice, air) may play an important, if subordinate role in the process.
MECHANICAL RESISTANCE	RESISTENCIA MECÁNICA	The force applied to a soil with a penetrometer which determine the soil resistance and is giving in kg/cm ² .
PLAIN	PLANO	A flat, undulating, or even rolling area, larger or smaller, that includes few prominent hills or valleys, that usually is at low elevation in reference to surrounding areas, and that may have considerable overall slope and local relief.
QUENUAL	QUEÑUAL	Quenuales are relict forest formations, with predominance of tree genus <i>Polylepis</i> .
REPTILE	REPTIL	A cold-blooded vertebrate animal of a class (Reptilia) that includes snakes, lizards, crocodiles, turtles, and tortoises, typically having a dry scaly skin and laying soft-shelled eggs on land.
ROCKS	ROCAS	Hard material formed by minerals.
SEEDLING	PLANTÓN	Young tree or plant; plant or tree grown from a seed.
SHRUBLAND	MATORRAL	Shrubland is a habitat type dominated by woody shrubs. A shrub is a perennial woody plant that branches at ground level to form several stems.
SILT	LIMO	Fine particles of sand and other earthy matter which are carried and deposited by water.
SOIL ORGANIC MATTER	MATERIA ORGÁNICA DEL SUELO	The organic fraction of the soil exclusive of undecayed plant and animal residues.
SPAWN	DESOVAR	Reproduce, produce eggs in large numbers (about aquatic animals); bring forth, give rise to, generate.
TAXON (PL. TAXA)	TAXÓN (PL. TAXA)	Categorical classification. Taxa is a grouping of organisms given a formal taxonomic name such as species, genus, family, etc.
TERRACE	TERRAZA	(i) A step-like surface, bordering a stream or shoreline, that represents the former position of a flood plain, lake, or sea shore. (ii) A raised, generally horizontal strip of earth and/or

English	Spanish	Description
		rock constructed along a hill on or nearly on a contour to make land suitable for tillage and to prevent accelerated erosion. (iii) An earth embankment constructed across a slope for conducting water from above at a regulated flow to prevent accelerated erosion and to conserve water.
TILLANDSIA	TILLANDSIA	Large genus of epiphytic or terrestrial sparse-rooting tropical plants usually forming dense clumps or pendant masses.
TOPSOIL	CAPA ARABLE	Topsoil is the uppermost layer of soil, usually the top 15-20 cm. It has the highest concentration of organic matter and microorganisms, and is where most of the Earth's biological soil activity occurs. Plants generally concentrate their roots in, and obtain most of their nutrients from this layer. Topsoil can be measured as the depth from the surface to the first densely packed soil layer known as hardpan.
TREE	ÁRBOL	A woody perennial plant typically with a single stem or trunk growing to a considerable height and bearing lateral branches.
WETLAND	HUMEDAL	Area of land that has wet soil (such as a marsh or bog). Are sensitive and in general, legally protected areas.
XEROPHYTIC	XERÓFITO	A plant adapted for life and growth with a limited water supply.

23.5 PHOTOGRAPHIC GALLERY

ELU 1: Apurimac River Valley (KP 00+000 – 20+511)



Figure 1. Plantations of *Polylepis pauta*.



Figure 2. Mist net set in Montane Forest, 10 m far from the river that goes to SP3.



Figure 3. Sachapampa River, KP 10+000.



Figure 4. *Proctoporus sp.* KP 7+500



Figure 5. *Proctoporus sp.* in KP 15+000

ELU 2: Campana Watershed (KP 20+511 – 25+115)



Figure 1. Peat bogs in Campana Creek, KP 25+000.



Figure 2. View of Campana KP 21+511



Figure 4. *Lagidium peruanum* "Vizcacha" observed over a stone in thorny scrub

ELU 3: Torobamba River Valley (KP 25+115 – 44+448)



Figure 1. Thorny scrub, KP 33+000



Figure 2. Pati tree, *Eriotheca vargasii* in KP 40+000



Figure 3. Hummingbird *Lesbia luna*, captured in KP 30+000



Figure 4. Thorny Scrub in Patibamba, KP 34+000

ELU 4: Sillaccasa Sierra (KP 44+448 – 56+783)



Figure 1. View of Yanacocha lagoon, Kp 48+800



Figure 2. *Echinopsis peruviana* subsp. *puquiensis*, KP 45+000



Figure 3. View of Nina Orcco lagoon Kp 51+200



Figure 4. *Pleurotalis* sp. over the ROW, Kp 45+000

ELU 5: Yucay River Valley (KP 56+783 – 74+199)



Figure 1 Yucay River Valley, KP 67+000



Figure 2. *Cleistocactus morawetzianus*. KP 63+000



Figure 3. *Telmatobius sp*, KP 73+400



Figure 4. View of Yucay River KP 62+500

ELU 6: Huamanga-Vischongo Divide (KP 74+199 to 103+970)



Figure 1. Puna Scrubland in Huamanga-Vischongo Divide, KP 75+000.



Figure 2. *Austrocylindropuntia floccosa* "Huaracco quisqa", Kp 100+700



Figure 3. *Geossita tenuirostris*, KP 102+000.



Figure 4. *Liolaemus sp.*, captured in the KP 92+000

ELU 7: Vinchos River Valley (KP 103+970 – 117+388)



Figure 1. Vinchos River Valley, KP 110+000.



Figure 2. *Austrocylindropuntia floccosa*, *Austrocylindropuntia subulata* and *Oroya peruviana* KP 110+000



Figure 3. *Diglossa bruneiventris* , KP 112+000.



Figure 4. *Metriopelia ceciliae*. KP 112+000

ELU 8: Apacheta High Sierras (KP 117+388 – 162+137)



Figure 1. View of Ranracancha, KP 120+000.



Figure 2. *Ephedra americana* between *Opuntia floccosa* KP 120+000



Figure 3. *Liolaemus sp.*, KP 160+000.



Figure 4. *Pleurodema marmorata*. KP Churiac 146+000

ELU 9: Pampas-Palmitos River Basins (KP 162+137 – 195+050)



Figure 1. View of Pampas River Kp 186+500



Figure 2. Matas de *Opuntia Flocosa* in the ROW kp 175+00



Figure 3. View of Huayco Corral Creek Kp 173+800



Figure 4. *Liolemus sp.* Observed over stone taking sunshine Kp 185+000

ELU 10: Huaytará High Plains and Ridges (KP 195+050 – 249+538)



Figure 1. Camelids grazing in Kp 201+000



Figure 2. View of Taccra Pet bog ,Kp 241+000

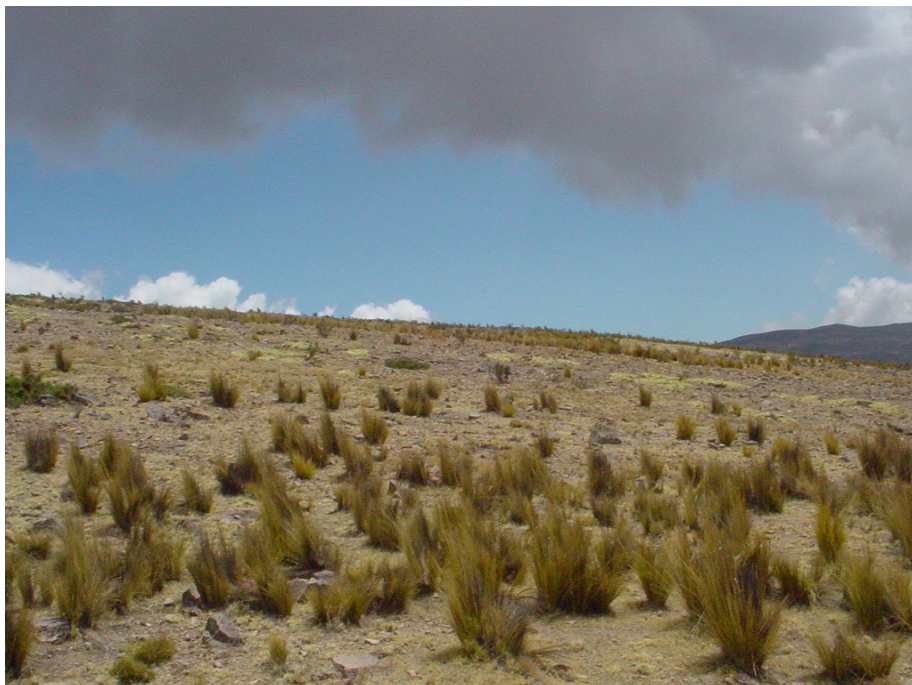


Figure 3. Puna Scrubland in Taccra, KP 227+000



Figure 4. *Liiolemus sp.* KP 227+000

ELU 11: Pisco-Ica Divide (KP 249+538+000 to 272+181)



Figure 1. *Senecio tovarii*, KP 261+300.



Figure 2. *Microlophus aff. tigris* Captured in , KP 255+000



Figure 3. Mixed Scrub habitat in the KP 255+000.



Figure 4. *Lupinus aff. mutabilis*. KP 252+000

ELU 12: Coastal Bat Hills (KP 272+181 to 308+000)



Figure 1. *Armatocereus procerus* in the KP 301+000.



Figure 2. *Leptasthenura striata* captured in KP 299+500



Figure 3. *Neoraimondia arequipensis*, KP 305+000.



Figure 4. *Microlophus tigris*. KP 298+000

ELU 13: Pisco Sand Plains (KP 308+000 to 332+940)



Figure 1. Tillandsial de *Tillandsia palacea* in the KP 310+000.



Figure 2. Moron Lagoon in the desert Pisco Sand Planis KP 329+600



Figure 3. *Microlophus thoracicus*, KP 329+000.



Figure 4. *Myiophobus fasciatus* nest, KP 329+000

ELU 14: Ica-Lima Coastal Plain (KP 332+940 – 402+000)



Figure 1. *Acacia macracantha* in the KP 390+800.



Figure 2. View of Pisco River KP 334+800



Figure 3. *Dicrion heterolepis* KP 329+000.



Figure 4. *Cryphiops caementarius* captured in KP 334+800

23.6 LIST OF SPECIES REPORTED BY EFS FIELD SURVEY

Table 23.6.1 Species Sensitivity

	Grp	Species	KP reference	Protection Status						Spatial Distribution			Local Use			Mobility		Σ
				CR	EN	VU	NT	L	N	Local	Reg.	Wide.	Perm.	Seas.	None	Inmob.	Mob.	
1	b	<i>Actitis macularius</i>	335+200									0			0		0	0
2	b	<i>Aeronautes andecolus</i>	62+150 67+400 82+000 94+900									0			0		0	0
3	b	<i>Aglaeactis cupripennis</i>	40+100 72+500 76+500									0			0		0	0
4	b	<i>Agriornis andicola</i>	17+000 21+650 27+000 30+000			4					2				0		0	6
5	b	<i>Agriornis montanus</i>	62+150 67+400									0			0		0	0
6	b	<i>Amazilia amazilia</i>	76+500									0			0		0	0
7	b	<i>Amazilia chionogaster</i>	40+100								2				0		0	2
8	b	<i>Ampelion rubrocristatus</i>	03+400									0			0		0	0
9	b	<i>Anairetes flavirostris</i>	40+100 72+500 109+000									0			0		0	0
10	b	<i>Anairetes parulus</i>	03+400 12+600									0			0		0	0
11	b	<i>Anairetes reguloides</i>	109+100								2				0		0	2
12	b	<i>Anas bahamensis</i>	365+250 397+900 389+500									0	2				0	2
13	b	<i>Anas flavirostris</i>	21+650 42+550 94+900 103+600 163+400 171+000 176+100									0			0		0	0
14	b	<i>Anas puna</i>	88+250 94+900								2			1			0	3
15	b	<i>Anisognathus igniventris</i>	03+400									0			0		0	0
16	b	<i>Anthus bogotensis</i>	204+900									0			0		0	0
17	b	<i>Anthus furcatus</i>	82+000 94+900								2				0		0	2
18	b	<i>Aratinga mitrata</i>	05+000								2				0		0	2

19	b	<i>Ardea alba</i>	335+200								0			0		0	0
20	b	<i>Asthenes cactorum</i>	299+200						3					0		0	3
21	b	<i>Asthenes huancavelicae</i>	136+600 141+300 176+100 192+070 204+800 212+700 218+400 223+400			4			3					0		0	7
22	b	<i>Asthenes humilis</i>	98+300							2				0		0	2
23	b	<i>Asthenes modesta</i>	122+100 135+250 178+600 180+300 190+100 221+850								0			0		0	0
24	b	<i>Asthenes ottonis</i>	154+600						3					0		0	3
25	b	<i>Asthenes sp.</i>	12+200 35+000 51+200 61+600							2				0		0	2
26	b	<i>Asthenes virgata</i>	25+200						3					0		0	3
27	b	<i>Asthenes wyatti</i>	132+200							2				0		0	2
28	b	<i>Athene cunicularia</i>	286+000 299+200							2				0		0	2
29	b	<i>Attagis gayi</i>	136+600 152+800 163+400 171+000 218+400								0			0		0	0
30	b	<i>Basileuterus coronatus</i>	25+100								0			0		0	0
31	b	<i>Basileuterus luteoviridis</i>	02+450								0			0		0	0
32	b	<i>Bolborhynchus orbygnesi</i>	05+000 62+150								0		1			0	1
33	b	<i>Buarremon torquatus</i>	26+100								0			0		0	0
34	b	<i>Bubulcus ibis</i>	334+600 363+000 365+250 397+900 389+500								0			0		0	0
35	b	<i>Burhinus superciliaris</i>	362+100							2				0		0	2
36	b	<i>Buteo leucorrhous</i>	135+200								0			0		0	0
37	b	<i>Buteo magnirostris</i>	125+400								0			0		0	0
38	b	<i>Buteo poecilochrous</i>	130+000							2				0		0	2
39	b	<i>Buteo polyosoma</i>	192+070 204+800 252+700								0			0		0	0
40	b	<i>Buthraupis montana</i>	00+500								0			0		0	0
41	b	<i>Butorides striata</i>	316+120 329+800 334+600 365+250								0			0		0	0

			397+900 389+500														
42	b	<i>Calidris alba</i>	389+600							0			0		0	0	
43	b	<i>Calidris bairdii</i>	239+000							0			0		0	0	
44	b	<i>Calidris melanotos</i>	212+200							0			0		0	0	
45	b	<i>Camptostoma obsoletum</i>	315+200							0			0		0	0	
46	b	<i>Carduelis atrata</i>	67+400						2				0		0	2	
47	b	<i>Carduelis magellanica</i>	62+150 67+400 72+500 76+500 109+000 114+300 118+600							0			0		0	0	
48	b	<i>Catamenia analis</i>	62+150 67+400 76+500 109+000 114+300							0			0		0	0	
49	b	<i>Catamenia inornata</i>	67+400 109+000							0			0		0	0	
50	b	<i>Cathartes aura</i>	316+120 329+800 363+000 365+250 389+500 397+900							0			0		0	0	
51	b	<i>Chaetura pelagica</i>	362+500							0			0		0	0	
52	b	<i>Charadrius vociferus</i>	390+100							0			0		0	0	
53	b	<i>Chloephaga melanoptera</i>	130+000 136+600 163+400						2		2				0	4	
54	b	<i>Chloephaga melanoptera</i>	21+650 42+550 88+250 171+000 176+100 204+800 218+400						2		2				0	4	
55	b	<i>Chordeiles acutipennis</i>	295+100							0			0		0	0	
56	b	<i>Cinclodes atacamensis</i>	82+000 88+250						2				0		0	2	
57	b	<i>Cinclodes fuscus</i>	76+500 82+000 88+250 103+600 114+300 118+600						2		2				0	4	
58	b	<i>Cinclus leucocephalus</i>	40+100						2				0		0	2	
59	b	<i>Circus cinereus</i>	86+200							0			0		0	0	
60	b	<i>Coeligena violifer</i>	05+000							0			0		0	0	
61	b	<i>Colaptes atricollis</i>	251+800						2				0		0	2	

62	b	<i>Colaptes rupicola</i>	40+100 67+400 88+250 103+600 109+000 114+300 118+600 121+400 204+800 224+000 250+200							0			0		0	0
63	b	<i>Colibri coruscans</i>	40+100							0	2				0	2
64	b	<i>Columba livia</i>	60+000							0			0		0	0
65	b	<i>Columbina cruziana</i>	305+600						2				0		0	2
66	b	<i>Conirostrum cinereum</i>	59+800						2				0		0	2
67	b	<i>Contopus cinereus</i>	11+500							0			0		0	0
68	b	<i>Coragyps atratus</i>	395+400							0			0		0	0
69	b	<i>Cranioleuca albicapilla</i>	05+000 15+800 21+650 27+000 30+000					3					0		0	3
70	b	<i>Crotophaga ani</i>	05+200 40+100 334+600							0			0		0	0
71	b	<i>Crotophaga sulcirostris</i>	334+600							0			0		0	0
72	b	<i>Diglossa brunneiventris</i>	109+000							0			0		0	0
73	b	<i>Diglossa cyanea</i>	02+100							0			0		0	0
74	b	<i>Diuca speculifera</i>	72+800						2				0		0	2
75	b	<i>Dives warszewiczi</i>	341+200						2				0		0	2
76	b	<i>Egretta caerulea</i>	335+200							0			0		0	0
77	b	<i>Egretta thula</i>	327+800							0			0		0	0
78	b	<i>Elaenia albiceps</i>	334+600 363+000 365+250 389+500 397+900						2				0		0	2
79	b	<i>Eriocnemis sapphiropygia</i>	05+000						2				0		0	2
80	b	<i>Euphonia lanirostris</i>	02+400							0			0		0	0
81	b	<i>Euscarthmus meloryphus</i>	395+200							0			0		0	0
82	b	<i>Falco femoralis</i>	30+000 40+100 250+200							0			0		0	0
83	b	<i>Falco sparverius</i>	30+000 40+100 103+600 109+000 286+000 299+200 316+120 329+600 334+600 363+000 365+250							0			0		0	0

84	b	<i>Fulica ardesiaca</i>	329+800								0			0		0	0
85	b	<i>Gallinago andina</i>	46+600							2				0		0	2
86	b	<i>Gallinula chloropus</i>	260+100 395+200								0			0		0	0
87	b	<i>Geositta crassirostris</i>	286+000							2				0		0	2
88	b	<i>Geositta cunicularia</i>	103+600							2				0		0	2
89	b	<i>Geositta maritima</i>	389+400							2				0		0	2
90	b	<i>Geositta peruviana</i>	299+200 316+400 329+600 334+800 353+500 363+000 389+500 397+900							2				0		0	2
91	b	<i>Geositta punensis</i>	88+250 121+400							2				0		0	2
92	b	<i>Geositta saxicolina</i>	94+900 121+400							2				0		0	2
93	b	<i>Geositta tenuirostris</i>	224+000							2				0		0	2
94	b	<i>Geranoaetus melanoleucus</i>	30+000 40+100 56+900 114+300 130+000 176+100 224+000 252+700								0			0		0	0
95	b	<i>Glaucidium jardinii</i>	40+100							2				0		0	2
96	b	<i>Haplochelidon andecola</i>	185+200 187+500 193+300							2				0		0	2
97	b	<i>Hemispingus atropileus</i>	312+200							2				0		0	2
98	b	<i>Hemispingus superciliaris</i>	16+100								0			0		0	0
99	b	<i>Hirundo rustica</i>	84+700								0			0		0	0
100	b	<i>Iridosornis analis</i>	03+200							2				0		0	2
101	b	<i>Knipolegus aterrimus</i>	40+100								0			0		0	2
102	b	<i>Larus serranus</i>	103+600 163+400								0			0		0	0
103	b	<i>Leptasthenura striata</i>	286+000 299+200							2				0		0	2
104	b	<i>Leptotila verreauxi</i>	112+000								0			0		0	0
105	b	<i>Lesbia nuna</i>	40+100 109+000							2		2				0	4
106	b	<i>Lessonia oreas</i>	130+400 135+600 165+400 168+200							2				0		0	2
107	b	<i>Lophonetta specularioides</i>	42+550								0			0		0	0
108	b	<i>Margarornis squamiger</i>	03+200								0			0		0	0

109	b	<i>Mecocerculus stictopterus</i>	154+200							0			0		0	0
110	b	<i>Merganetta armata</i>	176+100							0			0		0	0
111	b	<i>Metallura aeneocauda</i>	00+300					3					0		0	3
112	b	<i>Metallura phoebe</i>	114+300						2		2				0	4
113	b	<i>Metallura tyrianthina</i>	45+200							0			0		0	0
114	b	<i>Metriopelia aymara</i>	118+600						2				0		0	2
115	b	<i>Metriopelia ceciliae</i>	109+000						2				0		0	2
116	b	<i>Metriopelia melanoptera</i>	63+100							0			0		0	0
117	b	<i>Mimus longicaudatus</i>	325+400						2				0		0	2
118	b	<i>Molothrus bonariensis</i>	395+200							0			0		0	0
119	b	<i>Muscigralla brevicauda</i>	335+600						2				0		0	2
120	b	<i>Muscisaxicola albifrons</i>	221+100						2				0		0	2
121	b	<i>Muscisaxicola albilora</i>	23+000							0			0		0	0
122	b	<i>Muscisaxicola alpinus</i>	225+400						2				0		0	2
123	b	<i>Muscisaxicola cinereus</i>	82+000 118+600						2				0		0	2
124	b	<i>Muscisaxicola maclovianus</i>	290+200							0			0		0	0
125	b	<i>Muscisaxicola maculirostris</i>	82+000 109+000							0			0		0	0
126	b	<i>Muscisaxicola rufivertex</i>	118+600						2				0		0	2
127	b	<i>Myiarchus tuberculifer</i>	18+900							0			0		0	0
128	b	<i>Myioborus miniatus</i>	15+200							0			0		0	0
129	b	<i>Myioborus ornatus</i>	00+250						2				0		0	2
130	b	<i>Myiophobus fasciatus</i>	392+400							0			0		0	0
131	b	<i>Myiotheretes striaticollis</i>	329+600						2				0		0	2
132	b	<i>Myrtis fanny</i>	286+000 299+200						2				0		0	2

133	b	<i>Nothoprocta ornata</i>	30+000 40+100 56+900 192+070 250+200 252+700								2				0		0	2
134	b	<i>Nothoprocta pentlandii</i>	30+000 42+550 56+900 176+100								2				0		0	2
135	b	<i>Notiochelidon flavipes</i>	05+200								2				0		0	2
136	b	<i>Notiochelidon murina</i>	40+100								2				0		0	2
137	b	<i>Nycticorax nycticorax</i>	192+070 316+120 329+800									0			0		0	0
138	b	<i>Ochthoeca frontalis</i>	112+200								2				0		0	2
139	b	<i>Ochthoeca leucophrys</i>	40+100 109+000								2				0		0	2
140	b	<i>Ochthoeca oenanthoides</i>	192+070								2				0		0	2
141	b	<i>Ochthoeca rufipectoralis</i>	05+200								2				0		0	2
142	b	<i>Oreonympha nobilis</i>	27+000 30+000 62+150 110+000							3					0		0	3
143	b	<i>Oreopholus ruficollis</i>	160+300									0			0		0	0
144	b	<i>Oreotrochilus estella</i>	40+100 121+400								2				0		0	2
145	b	<i>Oreotrochilus melanogaster</i>	16+300 171+000							3					0		0	3
146	b	<i>Oxyura ferruginea</i>	42+550								2				0		0	2
147	b	<i>Parabuteo unicinctus</i>	363+000									0			0		0	0
148	b	<i>Pardirallus sanguinolentus</i>	316+120 329+800									0			0		0	0
149	b	<i>Passer domesticus</i>	295+200									0			0		0	0
150	b	<i>Patagioenas fasciata</i>	05+000									0			0		0	0
151	b	<i>Patagioenas maculosa</i>	40+100								2				0		0	2
152	b	<i>Patagioenas plumbea</i>	05+000									0			0		0	0
153	b	<i>Patagona gigas</i>	40+100									0			0		0	0
154	b	<i>Petrochelidon pyrrhonota</i>	145+400									0			0		0	0
155	b	<i>Petrochelidon rufocollaris</i>	350+600								2				0		0	2

156	b	<i>Phalcoboenus megalopterus</i>	21+650 30+000 40+100 56+900 121+400 130+000 136+600 152+800 163+400 171+000 176+100 192+070 204+800 218+400 224+000 250+200 252+700								0			0		0	0
157	b	<i>Pheucticus aureoventris</i>	27+200 57+800								0			0		0	0
158	b	<i>Phrygilus alaudinus</i>	85+500								0			0		0	0
159	b	<i>Phrygilus erythronotus</i>	15+200							2				0		0	2
160	b	<i>Phrygilus fruticeti</i>	104+700								0			0		0	0
161	b	<i>Phrygilus plebejus</i>	25+500 55+800 125+100 130+000 144+150 150+500 167+700 174+800 215+400 218+500 226+100								0			0		0	0
162	b	<i>Phrygilus punensis</i>	109+000							2				0		0	2
163	b	<i>Phrygilus unicolor</i>	25+500 55+800 129+700 144+150 150+500 167+700 174+800 215+400 218+500 226+100								0			0		0	0
164	b	<i>Plegadis ridgwayi</i>	21+650 152+800								0			0		0	0
165	b	<i>Podiceps major</i>	316+120 329+800								0			0		0	0
166	b	<i>Podiceps occipitalis</i>	42+550							2				0		0	2
167	b	<i>Polioptila rufipennis</i>	58+300							2				0		0	2
168	b	<i>Polynonimus caroli</i>	135+400							2				0		0	2
169	b	<i>Poospiza caesar</i>	27+000 30+000						3					0		0	3
170	b	<i>Poospiza hispaniolensis</i>	27+200							2				0		0	2
171	b	<i>Progne tapera</i>	12+800								0			0		0	0
172	b	<i>Psilopsiagon aurifrons</i>	12+800								0			0		0	0
173	b	<i>Pterophanes cyanocephalus</i>	112+500							2				0		0	2
174	b	<i>Pygochelidon cyanoleuca</i>	05+200 12+400								0			0		0	0

175	b	<i>Pyrocephalus rubinus</i>	394+700								0			0		0	0
176	b	<i>Rhodopsis vesper</i>	286+000 299+200							2		2				0	4
177	b	<i>Rollandia rolland</i>	40+100								0			0		0	0
178	b	<i>Saltator aurantirostris</i>	27+200 62+600								0			0		0	0
179	b	<i>Saltator striatipectus</i>	395+200								0			0		0	0
180	b	<i>Schizoeaca sp.</i>	05+200						3					0		0	3
181	b	<i>Schizoeaca vilcabambae</i>	05+200						3					0		0	3
182	b	<i>Scytalopus parvirostris</i>	02+300							2				0		0	2
183	b	<i>Scytalopus sp.</i>	40+100							2				0		0	2
184	b	<i>Sicalis luteola</i>	122+800 129+100 177+200 210+100								0			0		0	0
185	b	<i>Sicalis olivascens</i>	177+200								0			0		0	0
186	b	<i>Sicalis raimondii</i>	395+100							2				0		0	2
187	b	<i>Sicalis sp.</i>	105+200								0			0		0	0
188	b	<i>Sicalis uropygialis</i>	63+900 121+100 133+500 153+400 177+200 205+100 220+000 226+900								0			0		0	0
189	b	<i>Sporophila luctuosa</i>	08+900								0			0		0	0
190	b	<i>Sporophila peruviana</i>	385+600							2				0		0	2
191	b	<i>Sporophila simplex</i>	329+800 334+800							2				0		0	2
192	b	<i>Sporophila telasco</i>	385+600							2				0		0	2
193	b	<i>Stelgidopteryx andecola</i>	215+000							2				0		0	2
194	b	<i>Streptoprocne zonaris</i>	122+200								0			0		0	0
195	b	<i>Sturnella bellicosa</i>	314+800							2				0		0	2
196	b	<i>Synallaxis azarae</i>	02+300								0			0		0	0
197	b	<i>Synallaxis unirufa</i>	12+800							2				0		0	2
198	b	<i>Thaumastura cora</i>	335+400							2				0		0	2
199	b	<i>Theristicus melanopis</i>	16+500 21+650 130+000			4				2				0		0	6

200	b	<i>Thinocorus orbignyianus</i>	136+600 171+000 204+800 218+400 224+000 250+200 252+700								0	2				0	2
201	b	<i>Thlypopsis ruficeps</i>	02+300							2				0		0	2
202	b	<i>Thraupis bonariensis</i>	109+000								0			0		0	0
203	b	<i>Thraupis cyanocephala</i>	107+200 112+000								0			0		0	0
204	b	<i>Tiaris obscurus</i>	335+400								0			0		0	0
205	b	<i>Tringa flavipes</i>	400+300								0			0		0	0
206	b	<i>Tringa melanoleuca</i>	150+200								0			0		0	0
207	b	<i>Troglodytes aedon</i>	109+000								0			0		0	0
208	b	<i>Troglodytes solstitialis</i>	05+100								0			0		0	0
209	b	<i>Turdus chiguanco</i>	05+200 28+100 61+500								0			0		0	0
210	b	<i>Turdus fuscater</i>	05+200								0			0		0	0
211	b	<i>Turdus serranus</i>	111+300								0			0		0	0
212	b	<i>Tyrannus melancholicus</i>	335+400								0			0		0	0
213	b	<i>Tyto alba</i>	335+200								0			0		0	2
214	b	<i>Upucerthia jelskii</i>	130+100 132+800 152+600 174+400 179+500							2				0		0	2
215	b	<i>Vanellus resplendens</i>	21+650 121+400 136+600 152+800 163+400 204+800 218+400 224+000 250+200 252+700							2				0		0	2
216	b	<i>Vireo leucophrys</i>	12+400								0			0		0	0
217	b	<i>Volatinia jacarina</i>	309+500								0			0		0	0
218	b	<i>Vultur gryphus</i>	42+550 48+500 49+000 56+900 151+000 152+800	5							0			0		0	5
219	b	<i>Xenospingus concolor</i>	329+600	5						2				0		0	7
220	b	<i>Zenaida auriculata</i>	40+100								0			0		0	0
221	b	<i>Zenaida meloda</i>	400+300					0		2				0		0	2
222	b	<i>Zonotrichia capensis</i>	109+000								0			0		0	0
223	c	<i>Cryphiops</i>	334+800				4	0		2		2			3		11

		<i>caementarius</i>															
224	f	<i>Aequidens rivulatus</i>	328+700 329+700 334+900					0		2				0	3		5
225	f	<i>Astroblepus</i> sp.	62+200 62+500					0			0	2			3		5
226	f	<i>Oncorhynchus mykiss</i>	09+700 13+050 14+500 148+800 155+800					0				2			3		5
227	f	<i>Oreochromis niloticus</i>	329+000 329+600 364+500 362+500 334+800					0			0	2			3		5
228	f	<i>Orestias</i> sp.	62+500 95+800 62+500					0		2		2		0	3		7
229	f	<i>Poecilia reticulata</i>	364+500 362+500 334+800					0			0	2			3		5
230	f	<i>Trichomycterus rivulatus</i>	62+200 110+000 364+500 363+000					0	3			2		0	3		8
231	ha	<i>Chaunus limensis</i>	334+100 362+500						3					0	3		6
232	ha	<i>Chaunus spinulosus</i>	38+900 40+200 40+450			3		0			0			0	3		6
233	ha	<i>Eleutherodactylus</i> aff. <i>discoidealis</i>	01 + 500						3					0	3		6
234	ha	<i>Gastrotheca marsupiata</i>	18+900 21+500 25+300 26+000 40+100 56+500							2				0	3		5
235	ha	<i>Phrynopus</i> sp.	01 + 500						3					0	3		6
236	ha	<i>Pleurodema marmorata</i>	40+250 48+300 155+800								0			0	3		3
237	ha	<i>Telmatobius</i> sp.	73+400 92+000		4				3					0	3		10
238	hr	<i>Alsophis elegans</i>	364+500					0			0			0	3		3
239	hr	<i>Alsophis</i> sp.	389+300						3					0	3		6
240	hr	<i>Ctenoblepharys adspersa</i>	397+500 397+900		4				3					0	3		10
241	hr	<i>Dicrodon heterolepis</i>	329+000 329+600 389+500 362+500 389+500		4				3					0	3		10
242	hr	<i>Liolaemus</i> cf. <i>melanogaster</i>	159+700 136+700					0	3					0	3		6
243	hr	<i>Liolaemus</i> cf. <i>polystictus</i>	199+500 202+000 209+300 210+000 217+000 216+000 210+000 227+000					0	3					0	3		6

244	hr	<i>Liolaemus cf. walkeri</i>	25+500 45+000 47+500 56+500						0		2				0	3		5
245	hr	<i>Liolaemus cf. williamsi</i>	202+000 216+000						0	3					0	3		6
246	hr	<i>Liolaemus melanogaster</i>	160+000 146+000						0	3					0	3		6
247	hr	<i>Liolaemus sp. 1</i>	73+400						0	3					0	3		6
248	hr	<i>Liolaemus sp. 2</i>	185+000						0	3					0	3		6
249	hr	<i>Liolaemus sp. 3</i>	227+000 217+000 210+000						0	3					0	3		6
250	hr	<i>Liolaemus walkeri</i>	25+300 40+250 56+500 122+400						0		2				0	3		5
251	hr	<i>Microlophus aff. tigris</i>	259+800 254+900							3	2				0	3		8
252	hr	<i>Microlophus thoracicus icae</i>	329+000 329+600						0	3					0	3		6
253	hr	<i>Microlophus tigris</i>	298+800 299+200 304+900 389+500				3				2				0	3		8
254	hr	<i>Phyllodactylus lepidopygus</i>	304+900						0	3					0	3		6
255	hr	<i>Proctoporus sp.</i>	01+600 06+500 07+000 11+500 15+150 21+500 24+800						0	3					0	3		6
256	hr	<i>Stenocercus aff. apurimacus</i>	30+700 37+000 37+500 40+000 40+500 41+000						0	3					0	3		6
257	hr	<i>Stenocercus frittsi</i>	61+800							3					0	3		6
258	hr	<i>Tachymenis peruviana</i>	12+000 15+000 30+500						0			0			0	3	0	3
259	m	<i>Abrothrix jelskii</i>	21+700									0			0		0	0
260	m	<i>Akodon cf. juninensis</i>	33+000 48+000						0	3					0		0	3
261	m	<i>Akodon cf. torques</i>	12+200 40+150								2				0		0	2
262	m	<i>Akodon subfuscus</i>	28+500						0		2				0		0	2
263	m	<i>Artibeus lituratus</i>	40+150						0			0			0		0	0
264	m	<i>Auliscomys pictus</i>	21+700						0		2				0		0	2
265	m	<i>Calomys sorellus</i>	21+700 40+150 44+500 48+000						0	3					0		0	3
266	m	<i>Calomys lepidus</i>	62+500									0			0		0	0

267	m	<i>Cavia tschudii</i>	298+000 304+900 329+800 363+000					0			0			0		0	0
268	m	<i>Conepatus chinga</i>	14+200 33+000 63+000 103+000 186+400 253+000 297+000 298+000 304+900 329+800 362+000 363+000 389+000					0			0			0		0	0
269	m	<i>Desmodus rotundus</i>	40+150 63+000					0			0			0		0	0
270	m	<i>Didelphis pernigra</i>	298+000 304+900 329+800					0			0			0		0	0
271	m	<i>Histiotus</i> sp.	40+150 295+800					0		2				0		0	2
272	m	<i>Lagidium peruanum</i>	14+200 132+600 253+000					0	3			2				0	5
273	m	<i>Leopardus jacobitus</i>	103+000 132+600 154+000 163+100		5					2				0		0	7
274	m	<i>Leopardus pajeros</i>	103+000 132+600 253+000 329+800 363+000					0		2				0		0	2
275	m	<i>Lycalopex culpaeus</i>	28+500 33+000 40+150 48+000 63+000 71+000 186+400 230+000 253+000 298+000 304+900 329+800 363+000							2				0		0	2
276	m	<i>Lycalopex</i> cf. <i>griseus</i>	297+000 298+000 304+900 329+800 363+000							2				0		0	2
277	m	<i>Mus musculus</i>	298+000 363+000					0			0			0		0	0
278	m	<i>Mustela frenata</i>	103+000 132+600 253+000								0			0		0	0
279	m	<i>Odocoileus virginianus</i>	4+000 40+150 103+000 132+600								0			0		0	0
280	m	<i>Oligoryzomys</i> cf. <i>destructor</i>	18+300 107+300								0			0		0	0
281	m	<i>Oryzomys xantheolus</i>	329+800 363+000 389+300							2				0		0	2
282	m	<i>Phyllotis amicus</i>	107+300 253+000 298+000								0			0		0	0
283	m	<i>Phyllotis</i> cf. <i>xanthopygus posticalis</i>	14+200 28+500 63+000 103+000					0	3			2				0	5

284	m	<i>Phyllotis limatus</i>	298+900 299+000 304+900					0		2				0		0	2
285	m	<i>Phyllotis magister</i>	250+100 253+000								0			0		0	0
286	m	<i>Phyllotis xanthopygus posticalis</i>	200+000 253+000					0	3			2				0	5
287	m	<i>Puma concolor</i>	14+200 40+150 44+000 48+000 103+000 132+600			3					0			0		0	3
288	m	<i>Rattus norvegicus</i>	329+800					0			0			0		0	0
289	m	<i>Sturnella bellicosa</i>	314+800							2				0		0	2
290	m	<i>Sturnira erythromos</i>	39+800								0			0		0	0
291	m	<i>Thylamys pallidior</i>	103+000 132+600 253+000 298+000 304+900 329+800 363+000								0	2				0	2
292	m	<i>Tremarctos ornatus</i>	04+000		5					2		2				0	9
293	m	<i>Vicugna vicugna</i>	103+000 201+000 227+100 230+000		5						0	2				0	7
294	m	<i>Vicugna vicugna</i>			5						0	2				0	7
295	p	<i>Aa</i> sp.	48+800					0	3					0	3		6
296	p	<i>Acacia macracantha</i>	39+250 334+900 391+000			3					0	2			3		8
297	p	<i>Aciachne</i> cf. <i>acicularis</i>	85+400 141+150 165+800 170+690 171+200 204+000					0			0			0	3		3
298	p	<i>Aciachne pulvinata</i>	48+300 85+400					0		2				0	3		5
299	p	<i>Agave americana</i>	39+250					0			0	2			3		5
300	p	<i>Alternanthera halimifolia</i>	299+000 334+900					0			0			0	3		3
301	p	<i>Ariestiguetia discolor</i>	35+000			3				2				0	3		8
302	p	<i>Armartocereus procerus</i>	299+000					0		2				0	3		5
303	p	Asteraceae sp.	135+900					0			0			0	3		3
304	p	<i>Astragalus</i> sp.	165+800					0			0			0	3		3
305	p	<i>Atriplex peruviana</i>	279+000					0		2				0	3		5
306	p	<i>Austrocylindropuntia floccosa</i>	25+000 36+700 79+000 109+800 122+800 165+800 170+690 171+200					0			0			0	3		3
307	p	<i>Austrocylindropuntia</i>	63+000 109+800					0		2				0	3		5

		<i>subulata</i>															
308	p	<i>Austrocylindropuntia subulata</i>						0	2				0	3		5	
309	p	<i>Azorella</i> sp.	76+200					0		0			0	3		3	
310	p	<i>Baccharis odorata</i>	36+700 56+900 171+200					0	2				0	3		5	
311	p	<i>Baccharis salicifolia</i>	334+900					0		0	2			3		5	
312	p	<i>Baccharis tricuneata</i>	56+900					0	2				0	3		5	
313	p	<i>Berberis flexuosa</i>	36+700 56+900					0	3				0	3		6	
314	p	<i>Boerhavia coccinea</i>	299+000					0		0	2			3		5	
315	p	<i>Boerhavia difusa</i>	334+900					0		0	2			3		5	
316	p	<i>Bromus catharticus</i>	328+900					0		0			0	3		3	
317	p	<i>Browningia candelaris</i>	281+000			4			2					3		9	
318	p	<i>Bulnesia retama</i>	305+000					0	2				0	3		5	
319	p	<i>Calamagrostis</i> cf. <i>vicunarum</i>	77+500 85+400					0		0	2			3		5	
320	p	<i>Calamagrostis vicunarum</i>	48+800					0		0	2			3		5	
321	p	<i>Cardionema</i> sp.	76+200					0		0			0	3		3	
322	p	<i>Castilleja</i> sp.	22+350					0		0	2			3		5	
323	p	<i>Chersodoma arequipensis</i>	259+100	6					3			2		3		14	
324	p	<i>Cleistocactus acanthurus</i>	299+000 300+000 301+000		5				3			2		3		13	
325	p	<i>Cleistocactus morawetzianus</i>	62+900					0	3				0	3		6	
326	p	<i>Cnidioscolus basiacanthus</i>	299+000			4				2			0	3		9	
327	p	<i>Corryocactus quadrangularis</i>	35+000 62+900		5				3				0	3		11	
328	p	<i>Croton ruizianus</i>	259+100					0	2				0	3		5	
329	p	<i>Cuphea</i> sp.	40+250					0	2				0	3		5	
330	p	<i>Cynodon dactylon</i>	334+900					0		0	2			3		5	
331	p	<i>Dasyphyllum ferox</i>	36+700					0	2				0	3		5	
332	p	<i>Delostoma lobbii</i>	36+700					0		0			0	3		3	
333	p	<i>Dissanthelium</i> sp.	122+800					0		0	2			3		5	
334	p	<i>Distichia muscoides</i>	48+300 48+800 141+150 149+700 171+200					0		0		1		3		4	
335	p	<i>Distichlis spicata</i>	328+900					0		0			0	3		3	

336	p	<i>Dodonaea viscosa</i>	36+700 40+250					0			0	2			3		5
337	p	<i>Dunalia spinosa</i>	36+700 259+100					0		2				0	3		5
338	p	<i>Echinopsis peruviana puquiensis</i>	62+900 109+800		4				3					0	3		10
339	p	<i>Ephedra americana</i>	122+800 295+000 299+000				3			2				0	3		8
340	p	<i>Erigeron</i> sp.	85+400					0			0			0	3		3
341	p	<i>Eriochloa</i> sp.	334+900					0			0			0	3		3
342	p	<i>Eriotheca vargasii</i>	40+000					0	3					0	3		6
343	p	<i>Erodium cicutarium</i>	259+100					0			0			0	3		3
344	p	<i>Escallonia myrtilloides</i>	37+000 55+000 56+900 88+350 112+500 116+100 118+700		4					2					3		9
345	p	<i>Escallonia resinosa</i>	28+000 35+000		4					2					3		9
346	p	<i>Euphorbia</i> sp.	40+250					0			0			0	3		3
347	p	<i>Gamochaeta</i> sp.	76+200					0			0			0	3		3
348	p	<i>Gentiana sedifolia</i>	85+400					0			0			0	3		3
349	p	<i>Gomphichis</i> sp.	04+000 09+000 27+214					0		2				0	3		5
350	p	<i>Hypochaeris</i> sp.	85+400					0			0			0	3		3
351	p	<i>Hypochaeris taraxacoides</i>	22+350					0		2				0	3		5
352	p	<i>Jarava</i> sp.	76+200					0			0	2			3		5
353	p	Juncaceae sp.	122+800					0			0			0	3		3
354	p	<i>Juncus</i> cf. <i>bufonius</i>	76+200					0			0			0	3		3
355	p	<i>Junellia juniperina</i>	259+100					0		2				0	3		5
356	p	<i>Kageneckia lanceolata</i>	36+700	6						2				0	3		11
357	p	<i>Lachemilla diplophylla</i>	22+350					0		2				0	3		5
358	p	<i>Lachemilla pinnata</i>	22+350 48+800 76+200 85+400 122+800 135+900 165+800 170+690 171+200					0		2				0	3		5
359	p	<i>Lantana</i> sp.	40+250					0			0			0	3		3
360	p	<i>Loasa incana</i>	299+000					0	3					0	3		6
361	p	<i>Luzula racemosa</i>	22+350 48+255					0				2			3		5
362	p	<i>Lysipomia</i> sp.	76+200					0			0			0	3		3
363	p	<i>Muhlenbergia</i> sp.	77+500 85+400					0				2			3		5

364	p	<i>Myrosmodes</i> sp.	22+240 48+800				3			3						3		9
365	p	<i>Neoraimondia arequipensis</i>	295+000 299+000						0	3					0	3		6
366	p	<i>Novenia acaulis</i>	76+900						0		2				0	3		5
367	p	<i>Oncidium</i> sp.	04+000 09+000						0		2				0	3		5
368	p	<i>Oreithales integrifolia</i>	76+200 77+500						0			0			0	3		3
369	p	<i>Oreomyrrhis andicola</i>	76+200						0		2				0	3		5
370	p	<i>Oroya peruviana</i>	105+100 118+700 122+800						0	3		0			0	3		6
371	p	<i>Orthopterygium huaucui</i>	299+000						0	3					0	3		6
372	p	<i>Parastrephia quadrangularis</i>	101+800 103+700						0	3					0	3		6
373	p	<i>Peperomia</i> sp.	76+900						0			0			0	3		3
374	p	<i>Perezia coerulensis</i>	48+800 118+700 122+800 170+690 204+000			4			0		2				0	3		9
375	p	<i>Perezia pinnatifida</i>	135+900 140+300			4					2				0	3		9
376	p	<i>Phragmites australis</i>	329+800						0			0			0	3		3
377	p	<i>Plantago rigida</i>	22+350 48+300 141+150 149+700 170+690						0		2				0	3		5
378	p	<i>Plantago tubulosa</i>	77+500 85+400						0			0			0	3		3
379	p	<i>Plettkea</i> sp.	165+800						0		2				0	3		5
380	p	<i>Pleurothallis</i> sp.	04+000 09+000 42+880						0		2					3		5
381	p	<i>Pluchea chingoyo</i>	329+800						0			0	2			3		5
382	p	Poaceae sp. 1	122+800 137+000 141+000 150+000 166+000						0			0			0	3		3
383	p	Poaceae sp. 2	76+200 76+900 85+400						0			0			0	3		3
384	p	<i>Polylepis pauta</i>	04+000 09+000				3					0	2			3		8
385	p	<i>Pycnophyllum molle</i>	140+300									0	2			3		5
386	p	<i>Ranunculus flagelliformis</i>	22+350						0			0		1		3		4
387	p	<i>Ranunculus praemorsus</i>	48+800						0			0		1		3		4
388	p	<i>Ribes</i> sp.	118+700						0	3				1		3		7
389	p	<i>Schinus molle</i>	36+700 40+250						0			0	2			3		5
390	p	<i>Scirpus americanus</i>	48+300						0			0	2			3		5

391	p	<i>Scirpus cf. rigidus</i>	76+200						0			0	2			3		5
392	p	<i>Senecio</i> sp.	171+200						0			0	2			3		5
393	p	<i>Senecio tovari</i>	259+100						0	3			2			3		8
394	p	<i>Solanum</i> sp.	259+100						0			0			0	3		3
395	p	<i>Stelis</i> sp.	04+000 09+000						0		2					3		5
396	p	<i>Stenomesson incarnatum</i>	259+100						0		2				0	3		5
397	p	<i>Tecoma arequipensis</i>	40+250			4					2			1		3		10
398	p	<i>Tecoma sambucifolia</i>	29+000 33+000 35+000 36+700				3				2			1		3		9
399	p	<i>Tillandsia latifolia</i>	397+800						0		2				0	3		5
400	p	<i>Tillandsia paleacea</i>	308+200 348+600						0		2				0	3		5
401	p	<i>Tiquilia paronychioides</i>	299+000						0		2				0	3		5
402	p	<i>Typha domingensis</i>	329+800 328+900						0			0	2			3		5
403	p	Valerianaceae sp.	170+690						0			0			0	3		3
404	p	<i>Viola pygmaea</i>	77+500 85+400						0		2				0	3		5
405	p	<i>Werneria nubigena</i>	76+200						0			0			0	3		3
406	p	<i>Werneria pygmaea</i>	48+300 48+800						0		2				0	3		5

23.7 HABITAT SENSITIVITY CRITERIA

Table 23.7.1. Medium and High Sensitive Habitats

GROUP	SPECIES	KP	SPECIES SENSITIVITY	ELU	HABITAT TYPES	HABITAT SENSITIVITY
Plants	<i>Pleurothallis</i> sp.	004+000 009+000	Medium	1. Apurimac River Valley Montane Forest Ecotone	Upper Montane Forest	Medium
Plants	<i>Polylepis pauta</i>	004+000 009+000	Medium			
Amphibians	<i>Phrynopus</i> sp.	001+500	Medium			
Amphibians	<i>Eleutherodactylus</i> aff. <i>discoidalis</i>	001+500	Medium			
Reptiles	<i>Proctoporus</i> sp.	007+000 011+500	Medium			
Reptiles	<i>Proctoporus</i> sp.	001+500 007+500	Medium		Tussock Grassland	Medium
Mammalogy	<i>Tremarctos ornatus</i>	003+000	Medium		Sward-forming Grassland	Medium
Reptiles	<i>Proctoporus</i> sp.	015+500 021+500	Medium			
Birds	<i>Agriornis andicola</i>	017+000	Medium			
Birds	<i>Theristicus melanopis</i>	016+500	Medium			
Plants	<i>Castilleja</i> sp.	022+350	Medium	2. Campana Watershed	Peat Bog	Medium
Plants	<i>Hypochaeris taraxacoides</i>	022+350	Medium			
Plants	<i>Lachemilla diplophylla</i>	022+350	Medium			
Plants	<i>Plantago rigida</i>	022+350	Medium			
Plants	<i>Luzula racemosa</i>	022+350	Medium			
Birds	<i>Theristicus melanopis</i>	022+500	Medium			
Plants	<i>Corryocactus quadrangularis</i>	035+000	High	3. Torobamaba River Valley	Cultivated Areas	High
Plants	<i>Kageneckia lanceolata</i>	038+000	High			

Plants	<i>Acacia macracantha</i>	040+000	Medium			
Plants	<i>Ariestiguetia discolor</i>	035+000	Medium			
Plants	<i>Eriotheca vargasii</i>	040+000	Medium			
Plants	<i>Escallonia resinosa</i>	035+000	Medium		Dry Deciduous Forest	Medium
Plants	<i>Tecoma arequipensis</i>	040+000	Medium			
Plants	<i>Tecoma sambucifolia</i>	029+000	Medium			
Plants	<i>Tecoma sambucifolia</i>	035+000	Medium			
Amphibians	<i>Chaunus spinulosus</i>	038+900	Medium			
Reptiles	<i>Stenocercus</i> aff. <i>apurimacus</i>	037+500 037+700 040+000	Medium			
Plants	<i>Tecoma arequipensis</i>	040+250	Medium			
Amphibians	<i>Chaunus spinulosus</i>	040+200 040+450	Medium			
Reptiles	<i>Stenocercus</i> aff. <i>apurimacus</i>	040+500	Medium			
Plants	<i>Kageneckia lanceolata</i>	036+700	High		Thorny Scrub	High
Plants	<i>Escallonia myrtilloides</i>	037+000	Medium			
Plants	<i>Escallonia resinosa</i>	028+000	Medium			
Plants	<i>Tecoma arequipensis</i>	040+250	Medium			
Plants	<i>Tecoma sambucifolia</i>	036+700	Medium			
Reptiles	<i>Stenocercus</i> aff. <i>apurimacus</i>	030+700 037+000	Medium			
Birds	<i>Agriornis andicola</i>	027+000	Medium			
Birds	<i>Oreonympha nobilis</i>	027+000	Medium			
Plants	<i>Aa</i> sp.	050+000	Medium	4. Sillaccasa Sierra	Tussock Grassland	Medium
Plants	<i>Escallonia myrtilloides</i>	055+000	Medium			
Plants	<i>Myrosmodes</i> sp.	048+800 050+000	Medium			
Plants	<i>Perezia coerulescens</i>	050+000	Medium	5. Yucay River Valley	Resinous Scrub	High
Plants	<i>Corryocactus quadrangularis</i>	062+500	High			
Plants	<i>Cleistocactus morawetzianus</i>	062+900 063+000	Medium			

Reptiles	<i>Stenocercus fritti</i>	062+900	Medium			
Plants	<i>Echinopsis peruviana subsp. puquiensis</i>	062+900	Medium			
Aquatic Fauna	<i>Astroblepus</i> sp.	062+500	Medium		Yucay River	Medium
Aquatic Fauna	<i>Trichomycterus rivulatus</i>	062+500	Medium			
Plants	<i>Escallonia myrtilloides</i>	088+400	Medium	6. Huamanga Vischongo Watershed Divide	Tussock Grassland	Medium
Plants	<i>Parastrephia quadrangularis</i>	101+800	Medium			
Amphibians	<i>Telmatobius</i> sp.	092+000	Medium			
Reptiles	<i>Liolaemus</i> sp. 1	092+000	Medium			
Mammals	<i>Leopardus jacobitus</i>	103+000	Medium			
Mammals	<i>Vicugna vicugna</i>	103+000	Medium	7. Vinchos River Valley	Cultivated Areas	Medium
Plants	<i>Echinopsis peruviana subsp. puquiensis</i>	109+800	Medium			
Plants	<i>Escallonia myrtilloides</i>	116+100 116+300	Medium			
Plants	<i>Oroya peruviana</i>	105+200	Medium			
Birds	<i>Metallura phoebe</i>	114+300	Medium			
Birds	<i>Oreonympha nobilis</i>	110+000	Medium	8. Apacheta High Sierras	Scarcely Vegetated High Andean Areas	Medium
Plants	<i>Perezia pinnatifida</i>	140+300 141+000	Medium			
Plants	<i>Plantago rigida</i>	141+150	Medium			
Reptiles	<i>Liolaemus</i> cf. <i>melanogaster</i>	160+000	Medium			
Reptiles	<i>Liolaemus melanogaster</i>	160+000 146+000	Medium			
Birds	<i>Asthenes dorbignyi (huancavelicae)</i>	141+300	Medium			
Mammals	<i>Leopardus jacobitus</i>	132+600 154+000 163+100	Medium		Sward-forming Grassland	Medium
Plants	<i>Ephedra americana</i>	122+800	Medium			
Plants	<i>Escallonia myrtilloides</i>	118+700	Medium			
Plants	<i>Oroya peruviana</i>	122+800 118+700	Medium			
Plants	<i>Perezia coerulensis</i>	122+800 118+700	Medium			
Plants	<i>Perezia pinnatifida</i>	135+900, 137+000	Medium			

Reptiles	<i>Liolaemus cf. melanogaster</i>	136+700	Medium		Tussock Grassland	Medium
Birds	<i>Theristicus melanopis</i>	127+500	Medium			
Plants	<i>Ribes sp.</i>	118+700	Medium			
Plants	<i>Escallonia myrtilloides</i>	118+700	Medium			
Plants	<i>Oroya peruviana</i>	118+100 123+000	Medium			
Plants	<i>Perezia coerulensis</i>	118+700 122+800	Medium			
Plants	<i>Perezia pinnatifida</i>	135+900	Medium			
Reptiles	<i>Liolaemus cf. melanogaster</i>	137+000	Medium			
Birds	<i>Asthenes dorbignyi (huancavelicae)</i>	136+600	Medium			
Mammals	<i>Leopardus jacobitus</i>	132+600, 154+000, 163+100	Medium			
Reptiles	<i>Liolaemus sp. 2</i>	185+000	Medium	9. Pampas-Palmitos River Basins	Tussock Grassland	Medium
Birds	<i>Asthenes dorbignyi (huancavelicae)</i>	176+100 179+500	Medium			
Reptiles	<i>Liolaemus cf. williamsi</i>	216+000	Medium	10. Huaytará High Plains and Ridges	Scarcely Vegetated High Andean Areas	Medium
Birds	<i>Asthenes dorbignyi (huancavelicae)</i>	199+500	Medium		Sward-forming Grassland	Medium
Reptiles	<i>Liolaemus cf. polystictus</i>	212+700	Medium		Tussock Grassland	Medium
Birds	<i>Asthenes dorbignyi (huancavelicae)</i>	204+800	Medium			
Mammals	<i>Vicugna vicugna</i>	201+000	Medium			
Birds	<i>Asthenes dorbignyi (huancavelicae)</i>	212+700 218+400 223+400	Medium			
Reptiles	<i>Liolaemus sp. 3</i>	210+000	Medium			
Reptiles	<i>Liolaemus sp. 4</i>	217+000	Medium			
Mammals	<i>Vicugna vicugna</i>	227+100 230+000	Medium			
Plants	<i>Chersodoma arequipensis</i>	259+100	High	11. Pisco Ica Watershed Divide	Mixed Scrub	High
Plants	<i>Aequatorium tovarii</i>	259+100	Medium			

Reptiles	<i>Microlophus aff. tigris</i>	254+900 255+000 259+500 259+800	Medium			
Plants	<i>Chersodoma arequipensis</i>	261+300	High		Thorny Scrub	High
Plants	<i>Aequatorium tovarii</i>	261+300	Medium			
Plants	<i>Cleistocactus acanthurus</i>	281+000	High	12. Coastal Bat Hills	Desert Scrub	High
Plants	<i>Armatocereus procerus</i>	281+000	Medium			
Plants	<i>Browningia candelaris</i>	281+000	Medium			
Plants	<i>Bulnesia retama</i>	281+000	Medium			
Birds	<i>Rhodopis vesper</i>	286+000	Medium			
Plants	<i>Cleistocactus acanthurus</i>	299+000 300+000 301+100	High		Columnar Cacti and Scrub	High
Plants	<i>Armatocereus procerus</i>	300+200	Medium			
Plants	<i>Bulnesia retama</i>	305+000	Medium			
Plants	<i>Cnidoscolus basiacanthus</i>	299+000 300+200	Medium			
Plants	<i>Ephedra americana</i>	295+000 299+000 305+000	Medium			
Plants	<i>Loasa incana</i>	299+000	Medium			
Plants	<i>Neoraimondia arequipensis</i>	295+000 299+000 305+000	Medium			
Plants	<i>Orthopterygium huaucui</i>	299+000 300+200	Medium			
Reptiles	<i>Microlophus tigris</i>	298+000 298+800 299+200 304+900 306+000	Medium			
Reptiles	<i>Phyllodactylus lepidopygus</i>	304+900	Medium			

Mammalogy	<i>Thylamys pallidior</i>	298+000 304+900	Medium			
Birds	<i>Rhodopsis vesper</i>	286+000 299+200	Medium			
Reptiles	<i>Dicrodon heterolepis</i>	329+000, 329+600	Medium	13. Pisco Sand Plains	Coastal Hydromorphic Islands and Lagoons	High
Reptiles	<i>Microlophus thoracicus icae</i>	329+000 329+600	Medium			
Birds	<i>Xenospingus concolor</i>	327+100 329+600	Medium			
Aquatic Fauna	<i>Aequidens rivulatus</i>	329+600	Medium			
Plants	<i>Acacia macracantha</i>	336+000	Medium			
Reptiles	<i>Alsophis</i> sp.	389+300	Medium	14. Ica-Lima Costal Plain	Cultivated Areas	Medium
Reptiles	<i>Chaunus limensis</i>	334+100, 361+500	Medium			
Reptiles	<i>Dicrodon heterolepis</i>	361+500 389+300	Medium			
Reptiles	<i>Microlophus tigris</i>	389+300	Medium			
Plants	<i>Acacia macracantha</i>	391+000	Medium			
Plants	<i>Tillandsia latifolia</i>	397+800	Medium		Desert Barrens	Medium
Plants	<i>Tillandsia paleacea</i>	348+600	Medium			
Reptiles	<i>Ctenoblepharys adspersa</i>	397+900	Medium		Riparian Corridors	High
Aquatic Fauna	<i>Cryphiops caementarius</i>	334+800	High			
Plants	<i>Acacia macracantha</i>	334+900	Medium			
Reptiles	<i>Chaunus limensis</i>	334+700, 362+500	Medium			
Aquatic Fauna	<i>Aequidens rivulatus</i>	334+800	Medium			
Aquatic Fauna	<i>Trichomycterus rivulatus</i>	362+500, 363+000 364+500	Medium			

Habitat Sensitivity Calification

Category	Habitat Sensitivity Range
High	1 or more High Sensitivity Species 7 or more Medium Sensitivity Plant Species; 5 or more Medium Sensitivity Animal Species.
Medium	3 or more Medium Sensitivity Plant Species; 2 or more Medium Sensitivity Animal Species.

23.8 HYDROBIOLOGY

Table 23.8.1. Data of Stations Evaluated along the ROW

Ecological Landscape Units (EUL) by Stations Evaluated							Physicochemical Parameters					List of Fish
ELU	Station	Habitat	Water Body	Name	Altitude (masl)	KP	T (°C) *	pH	Disolved Oxygen (mg/L)	Electric Conductivity (µS/cm)	Aquatic Environment	Especies
ELU14	Hi-02	Coastal	River	Chico	164	364+500					Chico (R)	<i>Trichomycterus</i> sp. <i>Poecilia</i> sp. <i>Oreochromis</i> sp.
	Hi-03	Coastal	River	Matagente	192	362+500					Matagente (R)	<i>Trichomycterus</i> sp. <i>Poecilia</i> sp. <i>Oreochromis</i> sp.
ELU13	Hi-04	Coastal	River	Pisco	240	334+800	25.1	8.6	8.6	480 *	Pisco (R)	<i>Aequidens</i> sp. <i>Oreochromis</i> sp. <i>Poecilia</i> sp.
	Hi-05	Coastal	Lake	Morón	282	329+600	27.8	7.9	3.6	176	Morón (L)	<i>Aequidens</i> sp. <i>Oreochromis</i> sp.
	Hi-06	Coastal	Lake	Lagunillas	ca. 300	329+000	29.6	7.9	3.5	127.6	Lagunillas (L)	<i>Aequidens</i> sp. <i>Oreochromis</i> sp.
ELU10	Hi-07	High Andean	Peat Bog	Taccra	4304	241+000	16.6	3.8 *	5.3	113.8	Taccra (B)	
	Hi-08	High Andean	Quebrada	Tacpampa	4031	224+000	12.6	8.8 **	7.1	98.8	Tacpampa (Q)	
	Hi-09	High Andean	Quebrada	Canya	4431	212+200	12.4	8.6	6.1	60.1	Canya (Q)	
	Hi-10	High Andean	Lake	Quinsacocha	4479	211+500	17.1	10.1 **	5.1	39.9	Quinsacocha (L)	
	Hi-12	High Andean	Quebrada	NN (Tayarangra)	4373	201+000	10.3	7	6.9	182.6	NN_Tayarangra (Q)	
ELU9	Hi-13	High Andean	River	Pampas	4027	186+500	12.9	8.6	7	281 **	Pampas (R)	
	Hi-14	High Andean	Quebrada	Pichjahuasi	4326	175+500	14.8	9 **	6.2	167.7	Pichjahuasi (Q)	
	Hi-15	High Andean	Quebrada	Huaycco Corral	4153	173+800	16.5	9.1 **	6	188.5	Huaycco Corral (Q)	

ELU8	Hi-16	High Andean	Peat Bog	Yuarilla	4814	162+000	7.5	7.4	5.9	47.1	Yuarilla (B)	
	Hi-17	High Andean	Lake	Yanacocha	4622	156+000	10.8	8.1	6.4	184.6	Yanacocha (L)	<i>Oncorhynchus mykiss</i>
	Hi-18	High Andean	Quebrada	Antacocha	4487	149+500	13.5	7.4	5.5	35.5	Antacocha (Q)	<i>Oncorhynchus mykiss</i>
	Hi-20	High Andean	Lake	Challhuacocha	4498	136+700	21.7	7.3	4.4	119.6	Challhuacocha (L)	
	Hi-21	High Andean	Peat Bog	Soytusoytu	4391	135+000	21.7	7.5	4.4	119.6	Soytusoytu (B)	
ELU7	Hi-22	Inter - Andean	River	Vinchos	3157	110+500	16.7	7.4	6.8	84.5	Vinchos (R)	<i>Trichomycterus sp.</i>
	Hi-23	Inter - Andean	Quebrada	Urpypampa	3210	110+000	17.3	7.4	6.4	36.8	Urpypampa (Q)	
ELU6	Hi-24	High Andean	Lake	Choccehuacgra	4144	95+500	14.4	7.1	5.6	37.7	Choccehuacgra (L)	<i>Orestias sp.</i>
	Hi-25	High Andean	Peat Bog	Chaquicocha	4053	92+200	14.8	7.4	5.7	42.8	Chaquicocha (B)	
	Hi-26	High Andean	Peat Bog	Ahcacacruz Orcco	3997	85+500	15.3	7.8	6.2	35.9	Ahcacacruz Orcco (B)	
	Hi-27	High Andean	Peat Bog	Carimayo	4103	80+800	15.7	8.3	5.7	42.3	Carimayo (B)	
ELU5	Hi-28	Inter - Andean	Quebrada	Jatunchancara	3528	71+000	22.7	7.3	4.7	45.8	Jatunchancara (Q)	
	Hi-29	Inter - Andean	Quebrada	Affluent to Yucay	2848	62+500	20.5	6.9	5.3	46.8	Affluent to Yucay (Q)	
	Hi-30	Inter - Andean	Quebrada	Huaycco	2854	62+500	20	8.4	5.6	48.5	Huaycco (Q)	
	Hi-31	Inter - Andean	River	Yucay	2822	62+500	14.6	7.8	7.3	50.8	Yucay (R)	<i>Astroblepus sp.</i> <i>Trichomycterus sp.</i>
ELU4	Hi-33	High Andean	Lake	Nina Orcco	4080	51+200	13.6	8.6	6.2	83.8	Nina Orcco (L)	
	Hi-34	Inter - Andean	Quebrada	Soccosmayo	2459	49+500	15.6	8.4	5.4	88.9	Soccosmayo (Q)	
	Hi-35	Inter - Andean	Lake	Yanacocha	4115	48+800	17.7	8.6	4.8	85.4	Yanacocha (L)	
ELU3	Hi-36	Inter - Andean	River	Torobamba	2368	39+000	15.5	7.8	7.5	98.3	Torobamba (R)	

	Hi-37	Inter - Andean	Quebrada	Uras	2562	30+000	14	8.4	7.6	102.2	Uras (Q)	
	Hi-38	Inter - Andean	Quebrada	Yanaccacca	2797	29+000	24.1	7.8	4	144.5	Yanaccacca (Q)	
ELU2	Hi-39	High Andean	Quebrada	Campana	3800	22+700	18.2	7.7	5.8	93.4	Campana (Q)	
	Hi-40	High Andean	Lake	Yanapaccha	3930	17+000	10.6	8.6	6.9	99.3	Yanapaccha (L)	
	Hi-41	High Andean	Peat Bog	Cochas	3404	14+500	14	8.5	6.7	71.4	Cochas (B)	<i>Oncorhynchus mykiss</i>
ELU1	Hi-42	Inter - Andean	River	Sachapampa	3171	10+000	11.5	7.8	7.5	111.6	Sachapampa (R)	<i>Oncorhynchus mykiss</i>
	Hi-43	Inter - Andean	Quebrada	Qollpa	3033	0+500	11.7	7.6	7.7	123.2	Qollpa (Q)	
	Hi-44	Inter - Andean	River	Alfarpampa	2971	0+000	14	7.5	7.2	123.3	Alfarpampa (R)	

23.9 SOILS DATA TABLE

Table 23.9.1. Fertilizer Recommendations for each ELU

High Risk Areas – site-specific within each ELU, defined during construction by Peru LNG and Contractor, where bio-restoration techniques including fertilizer application are considered beneficial in addition to other reinstatement measures, to restoring vegetation cover more quickly in the most vulnerable areas

ELU	SECTOR	FERTILIZER	KG/HA
1	High Risk Areas	CaCO ₃	1000
		Phosphate	150
2	High Risk Areas	CaCO ₃	1000
		Phosphate	150
3	High Risk Areas	CaCO ₃	1000
		Phosphate	150
4	High Risk Areas	CaCO ₃	1000
		Phosphate	150
5	High Risk Areas	Phosphate	150
6	High Risk Areas	Phosphate	150
7	High Risk Areas	CaCO ₃	1000
		Phosphate	150
8	High Risk Areas	CaCO ₃	1000
		Phosphate	150
9	High Risk Areas	CaCO ₃	1000
		Phosphate	150
10	High Risk Areas	CaCO ₃	1000
	High Risk Areas	Phosphate	150
11	High Risk Areas	Phosphate	150
12	High Risk Areas	Phosphate	150
13	-	-	-
14	-	-	-

