
ANNEX 6

ADDITIONAL BACKGROUND FOR THE ENVIRONMENTAL ASSESSMENT IN LA ENGORDA AREA

1 INTRODUCTION

In this Annex, additional background is presented which support what has been pointed out in EIA with regards the impact assessment in the La Engorda canyon sector, replying the enquiries done by the Environmental Authority in the ICSARA 1¹ and the questions done by SAG and CONAMA in work meetings developed in the environmental assessment process framework of PHAM.

Thus, the content of this report complements the environmental assessment done in Chapter 6 of the EIA and the description of preventive actions and environmental control that the Owner will implement during the construction stage of the works referred mainly to the installation of a conduction pipeline, intakes construction and fitting out a temporary road.

It is also included in this report, an additional analysis with regards the effects attributable to PHAM during its construction and operation stages, in relation to an alteration of the local irrigation conditions which sustain the seasonal vegetation in La Engorda area.

As a summary, the content of this document is focused on the following subjects:

- Complementation of the description of the edaphologic and hydrologic characteristics of La Engorda area.
- Details of the construction method and the mitigation measures.
- Complementation of the qualification associated to the wet prairie impact, pointed in section 6.4-7 of Chapter 6 of EIA.

Finally, big part of the presented background specified in this document is contents of EIA and its Annexes in detail.

¹ Enquiry 31, section 1. Enquiry 8 section 4. Enquiry 45 section 6. Enquiry 6 of section 7.

2 ENVIRONMENTAL CHARACTERISTICS OF LA ENGORDA CANYON

2.1 VEGETATION CHARACTERISTICS

A short summary of the vegetation characterization of the works of La Engorda canyon is presented next, which has been widely studied along the process of environmental assessment of the Project, and whose descriptions were presented at length in Chapter 5 of EIA and Annex 42 of itself.

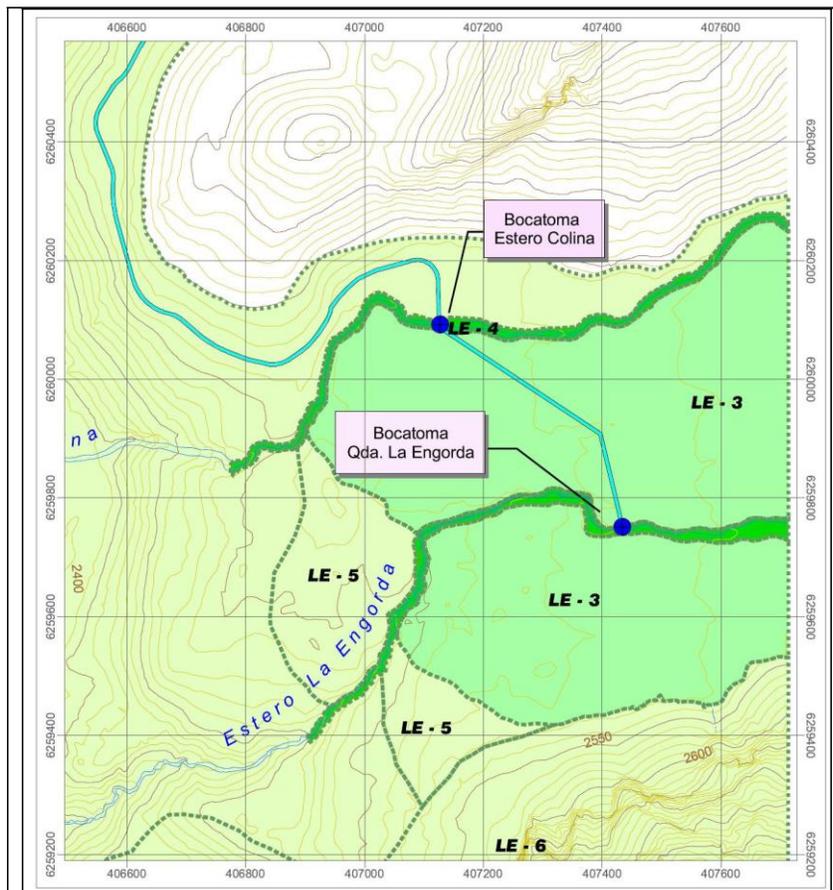
The existing vegetation in the Upper Volcán area was pointed out in Chapter 5 of the EIA corresponding to:

LE-3: Low ligneous formation with herbaceous, dense;

LE-4: Herbaceous formation, very dense;

The following figure represents the spatial distribution of these vegetation formations in the vicinity of the projected works area

Figure 1
Vegetable Formations in Relation to the Works of the Project in La Engorda Canyon Area



Source: Figure 5.4.1.3.30 of Chapter 5, EIA Base Line.

The vegetable formation LE-4, corresponds to wet grassland, formed by perennial herbs. The coverage of the vegetation is very high. *Juncus arcticus*, *Agrostis leptotricha*, *Polypogon australis* species and one species of *Deyeuxia* are predominant in it. It is presented as a very narrow strip located in the margins of the small streams running in La Engorda Canyon area (further details on the characterization of this vegetation formation is presented in section 5.4 of Chapter 5 of EIA).

With regards the formation LE-3, this corresponds to a formation of shrub type up to 30 cm height, where shrubs and herbs form a mosaic. Coverage of the vegetation reaches up to 90%.

The high coverage of herbs and shrubs would be given by a superficial aquifer (see section 2.2 and 2.3 of this document).

Although the zone is traditionally known as "La Engorda Wet Prairies", most of the area presents vegetation which is not typical of a grassland or permanent wet prairie, but, as it has been described, a dense shrub with high coverage of herbs and wet sites (LE-3) which seasonally presents wet prairie patches in greater superficial run-off seasons. The above was confirmed through a plot study in some areas of the canyon, performed in spring 2007, season with greatest presence of this formation.



Picture 1: Formations view of La Engorda Vegetation Area

Picture 2: Formations view of La Engorda Vegetation Area

Formation LE-3. *High-Andean low shrub with Chuquiraga oppositiflora, Berberis empetrifolia. Corresponds to the area known as "wet prairie" of La Engorda, with seasonal presence of them.*

Formation LE 4: *It corresponds to a wet prairie formation in the margins and some terraces of the streams.*

From the plot study done in unit LE-3, it was able to specify the zones of seasonal wet prairie and shrub zones (shrub unit). Regarding this, out of the mentioned study the following conclusions are taken:

A Wet Prairie Unit

It reaches a total coverage in the unit of 80%, using a flooding area located near the area of confluence between La Engorda and Colina streams, and an adjacent area to Las Placas stream. The unit, because of the perennial herbs presence, has a physiognomy of continuous grassland. The dominant species are: *Carex gayana*, *Phylloscirpus acaulis*, *Eleocharis albibracteata* and *Taraxacum officinale*. Although the unit presents a high coverage due to the excess of grazing, it has a minimum height. The presence of the feral allochthonous species, *Taraxacum officinale* and *Plantago lanceolata* reflect the alteration degree of this Unit.

In relation to the season, species reappear at the beginning of summer, then they grow and stay until autumn, although, due to the overload of the livestock, they tend to dry up and lose a lot of coverage during summer.

With regards the representativeness of this type of vegetation and the species are of wide distribution in the eco-region of Mediterranean Andes (The Andes between IV and VIII Region). There are no local endemism and this are scarce at national level.

The distribution of this unit is shown in Figure 2.

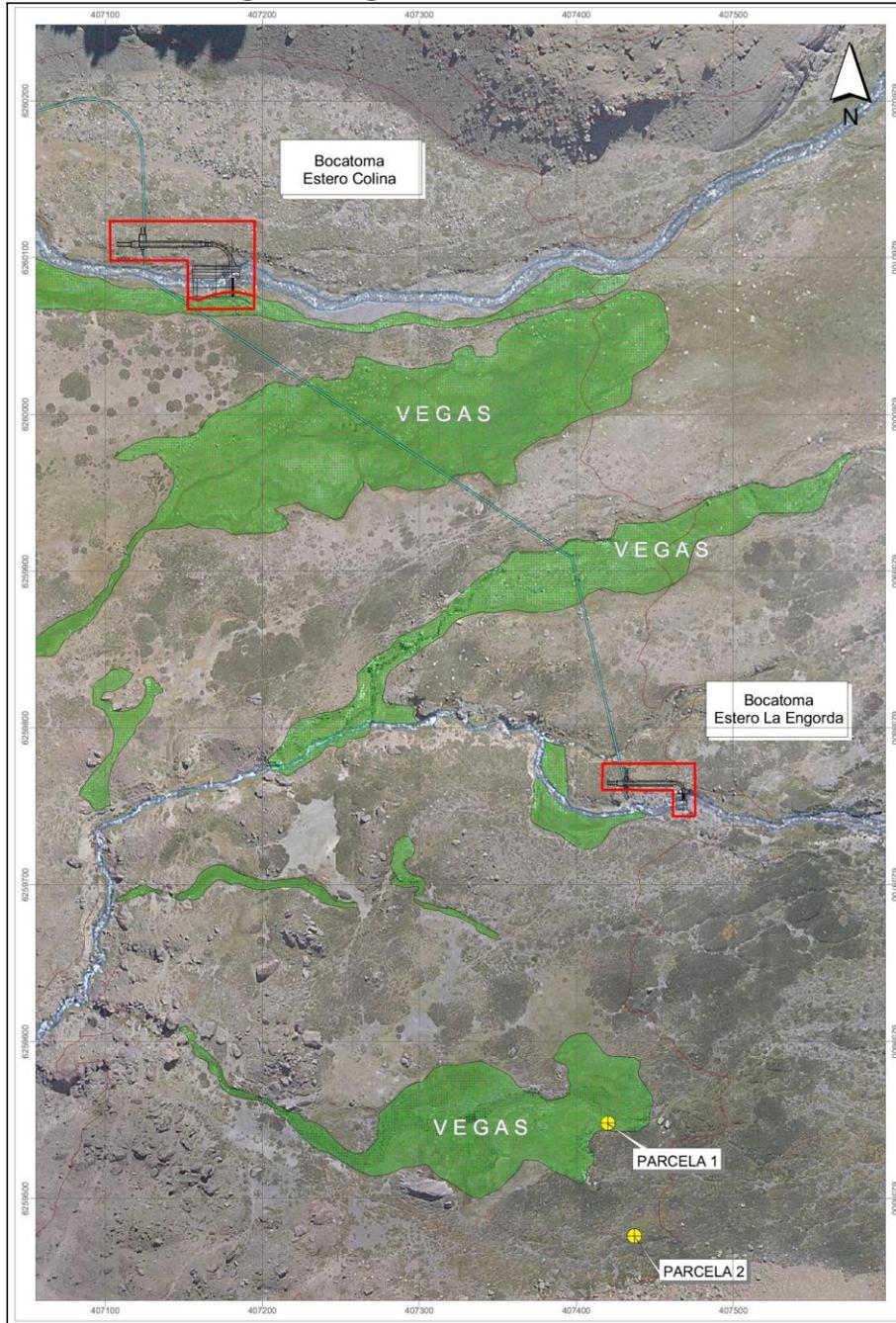
B Shrub Unit of Chuquiraga oppositifolia

The vegetation coverage in this unit reaches an average of 79.5%. The unit is dominated by shrub species which give a physiognomy of shrub of up to 30 cm height; perennial herbs grow between the shrubs which do not reach continuous generation coverage.

The dominant species are *Chuquiraga oppositifolia*, *Berberis empetrifolia* and *Laretia acaulis*. This unit is zone type, that is to say, the unit mainly depends on precipitation (snow and rainfall), locally, although, given the high coverage which presents, it is possible that it is using the humidity coming from some more or less superficial aquifer too. It uses the non-flooding area of the canyon.

From the regional representativeness standpoint, the unit has an affinity association with the *Mulinum spinosum* and *Chuquiraga oppositifolia*, a typical community for the formation of high Andean steppe in the mountain range of Santiago. The distribution of the formation goes from the Choapa basin up to the one from Teno.

Figure 2
La Engorda Vegetation Area Characteristics



Note: The appearance of seasonal wet prairies in La Engorda canyon is shown in green, in the area next to projected work sites.



Picture 3: View of La Engorda canyon where vegetation of seasonal wet prairie is clearly seen in green which appear during spring. The predominant shrub unit is in brown.

For further details with regards the composition of these units, please refer to Annex 42 of EIA.

2.2 LA ENGORDA CANYON EDAPHOLOGICAL CHARACTERISTICS

From the point of view of the origin of the lands comprising the plain of the La Engorda canyon, this corresponds to the accumulation of horizons of successive soils which have been produced by the accumulation of near sediments from the hillsides and upper parts of La Engorda valley. This material has its origin in the erosive action of snow over the current relief and it is very likely that it was generated in the Quaternary in ages of greater abundance of snow and conditions of greater humidity than nowadays (section 5.3.6 of EIA).

The above is confirmed analyzing the stratigraphic profile which is presented next, and which was done exactly in the area to be intervened, specifically in the UTM coordinates: East = 407.182 m; North = 6.260.040 m; at an altitude: 2.516 m.a.s.l².

2 profile done from a test pit performed in September 27th 2008.

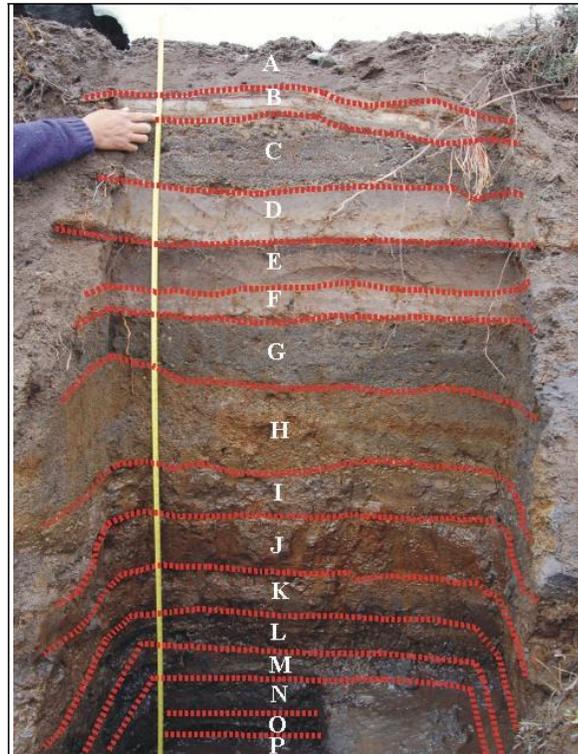
Table 1
Lithological Description of the Soil Profile in La Engorda Area

Depth (cm)	Description
0 – 18 A	Fine Sand of very dark grey color (2.5Y 3/1) in wet; slightly plastic and non-adhesive; very friable; structure of fine sub-angular blocks, weak. Presence of very fine roots, fine and mean abundant (wet prairie roots); very fine and abundant pores. Undulating and rugged inferior edge.
18 – 25 B	Sandy Silt of brownish-grey yellow color (2.5Y 4/2) in wet; slightly plastic and non-adhesive; very friable; structure of fine sub-angular blocks, moderate. Very fine and fine abundant roots; Very fine common pores. Undulating and rugged inferior edge. It is observed the presence of organic material level in upper section of the horizon in a thickness of 2 to 3 cm; black color (2.5Y 2.5/1) in wet, this level corresponds to a paleo-meadow.
25 – 43 C	Coarse Sand of multi colors in a black color matrix (2.5Y 2/1) in wet; non-plastic and non-adhesive; loose; simple grain structure. Very fine common roots; Very fine pores and abundant fines. Lineal edge, rugged. Presence of gravel in the base of the horizon with a thickness of 2 to 3 cm.
43 – 56 D	Sandy silt of brownish-grey yellow color (2.5Y 4/2) in wet; slightly plastic and non-adhesive; very friable; structure of fine sub-angular blocks, weak. Fine roots and very fine commons; very abundant pores. Lineal and rugged edges. It constitutes a limiting level for the vertical flow of water.
56 – 69 E	Silty sand to a very sandy silt of very dark grey color (2.5Y 3/1) in wet; non-plastic and non-adhesive; very friable; structure of fine sub-angular blocks, weak. Very fine and scarce roots, very abundant fine pores. Lineal and rugged edges. It is observed the presence of organic matter in upper section of the horizon (paleo-meadow) with a thickness of 2 to 3 cm and black color (2.5Y 2.5/1) in wet.
69 – 76 F	Sandy silt of brownish-grey dark yellow color (2.5Y 4/2) in wet; slightly plastic and non-adhesive; very friable; structure of mean sub-angular blocks, weak. Very fine and scarce roots, very fine common pores. Rugged edges. It constitutes a limiting level for the vertical flow of water.
76 – 91 G	Coarse Sand of multi colors in a black color matrix (2.5Y 2/1) in wet; non-plastic and non-adhesive; loose grain; simple grain structure. Very fine and very scarce roots, fine and very abundant fine pores. Lineal and diffused edges. Presence of organic matter in the superior stratum level (no more than 1 cm)
91 – 114 H	Coarse sand (high content of fine gravel) of multi colors in a black color matrix (2.5Y 2.5/1). The high presence of iron oxides gives a strong brownish-grey look (7.5Y 5/8) in wet; non-plastic ad non-adhesive, very friable; solid. Very fine and very scarce roots, very fine and abundant fine pores. Clear edges.
114 – 130 I	Sandy silt of brownish-grey dark yellow color (2.5Y 4/2) in wet; slightly plastic and non-adhesive; very friable; structure of fine angular blocks, moderate. Very fine common roots; fine common pores. Clear lineal edge. The horizon presents a low permeability, leaving in evidence that constitutes a limiting for the vertical flow of water.
130 – 149 J	Silty sand of very dark grey color (2.5Y 3/1) in wet; slightly cemented with iron oxide which gives it a strong brownish-grey color (7.5YR 4/6); non plastic and non-adhesive; friable; solid. Very fine common roots; very fine abundant pores. Clear lineal edge.
149 – 157 K	Sandy Silt of very dark grey (2.5Y 3/1) in wet; slightly plastic and non-adhesive; friable; structure of moderate means sub-angular blocks. Very fine common roots; very fine scarce pores. Undulating and gradual edges.

Depth (cm)	Description
157 – 173 L	Sand of black color (2.5Y 2.5/1) in wet; sandy; non plastic and non-adhesive; very friable; structure of mean sub-angular blocks, weak. Fine roots and abundant means; very fine abundant pores. Clear lineal edge.
173 – 183 M	Sandy Silt of dark brownish-grey color (2.5Y 4/2) in wet; slightly plastic and non-adhesive; friable; structure of fine sub-angular blocks, weak. Very fine scarce roots; very fine and scarce pores. Lineal rugged edge. The horizon presents a low permeability, observing that it constitutes a limit for the vertical flow of water. Sand lens are observed.
183 – 210 N	Coarse sand of black color (2.5Y 2.5/1) in wet; non plastic and non-adhesive; loose; simple grain structure. Fine and very fine abundant pores. Lineal rugged edge.
210 – 220 O	Sandy silt of dark brownish-grey yellow color (2.5Y 4/2) in wet; slightly plastic and non-adhesive; very friable; structure of fine sub-angular blocks, weak. Very fine and scarce pores. Lineal rugged edge. The horizon constitutes a limit to the vertical flow of water.
220 and more more	Coarse gravel constituted by rocky material of different diameters, big part of the angular type and round edges.

In Figure 3, are illustrated each one of the horizons previously described.

Figure 3
Detail Outlook of the Test Pit in La Engorda Area



Out of the stratigraphic analysis the following can be concluded:

- The wet prairie formation is established in a mainly organic edaphic environment, characterized by a water condition of permanent saturation. That is how, it corresponds to an ecological system out of the zone³, with a typical vegetation which is developed thanks to the relatively high and permanent content of edaphic humidity. Generally, its appearance is of a dense herbaceous stratum to a very dense (vegetation coverage above 50%), of low to mean height (5 - 30 cm), over a usually flat surface or with a scarce micro relief. The waterways, when there are, are restricted to the tracks of small size, completely vegetated.
- The land in La Engorda canyon, stands out for the rhythmic alternation of sandy and silty levels in the first 2 m superficial, the silty levels constitute due to its granulometric composition, surfaces **which limit the migration of water in vertical direction either by the capillary effect or downstream by gravitational effect.** In fact, it is about levels made up predominantly by silt and given its slightly plastic conditions by touch it has a relevant content of clay which gives waterproof characteristics to it. Therefore, it is highly likely that there is no land profile in the area of study in a vertical flow of water;
- Given its location in the Andes Mountain Range and with this, a greater occurrence of phenomenon or gravitational flow events, is characteristic in this formations the presence of paleo-meadow due to the bury of the previous vegetation coverage. On the other hand, the presence of some sand or silt lens in the matrices of some horizons, reflect minor events of relative frequency.



Pictures 4 and 5: La Engorda Area Platform

From left to right, Colina and La Engorda streams. Evidences of dragged sediment materials can be seen, which would point out that the valley is permanently modified in its relief, geo-shape, vegetation composition, etc., probably due to the superficial water drag force.

³ Out of zone vegetation: these are vegetable formations which are locally presented in reduced extensions, associated to some determined environmental factor. Under this name, the vegetation formations are grouped, which are completely discontinuous with regards the units of the environment and which its physiognomy typically corresponds to very localized environmental conditions (example of this are: wetlands or wet prairies; anthropically altered vegetation).

As Summary, the plain which holds the vegetation units, has been originated by sedimentation of fine and coarse texture classes carried by slides of material from the upper Mountain range. Is Because of this that highly stratified silt and sand loam are predominant under the surface of them; the first one giving low permeability to some horizons, limiting the vertical drainage in depth.

2.3 WATER CHARACTERISTICS

This high-Andean zone presents a hydrological regime of snow and glacial type, fed approximately by 36 km² of glaciers, among them, Marmolejo and Loma Larga stand out, besides of some other semi-permanent snowfield which are born in San José volcano (see Chapter 5 "Volcán River Basin System" of EIA). Generally, the run-off of the waters are from superficial and sub-superficial types, which is evident by the wide network of minor run-off associated to the main streams, and small isolated outcrops which appear between the vegetation. The geological material in this zone, as it has been previously pointed out, is characterized by the presence of torrential mudslides deposits comprised by coarse accumulations in fan or semi-cones shapes constituted in coarse deposits (see Chapter 5, section 5.3.6 of EIA). This surface would allow the formation of groundwater layer of semi-confined type (see Chapter 5 of EIA).

La Engorda stream, in particular, is mainly fed by the ice thaw of the high mountain range, through an important amount of ravines of intermittent character which descend from the hillsides which squeeze the waterway (See section 5.3.5 of EIA and Figure 4 of this document).

While Colina stream is developed as a unique waterway at the projected intake level, coinciding with an obvious change in the slope, which determines that the waters will flow towards El Morado stream, supposedly contributing to a low irrigation towards the area between Colina stream and La Engorda streams (See section 5.3.5 of EIA and Figure 4 of this document).

The area covered of Andean shrub and wet prairie vegetation, present in both streams previously pointed out, received waters from different sources. On one hand, there are waterways typical of the previously described streams, whose contribution is extremely low (for the area of interest of the project), and on the other hand the thalwegs or ravines of short development of intermittent behavior which drain waters from the thaws, solid and liquid precipitations, and the existing underground run-off (section 6.4.2.2 of Chapter 6).

To verify the above, a stereoscopic photo interpreting of the area corresponding to the projected collections of EL Morado, Las Placas, Colina and La Engorda streams was done, whose results are seen in Figure 6.4.2.2.1⁴, attached in Chapter 6 of EIA. This activity let the identification and characterization of a superficial drainage network, which is made clear in Figure 4, although from a more general panoramic view.

⁴ Aerial photographs SAF 1990, scale 1:20.000 and orthophotos year 2006 were used.

Insert Figure 4
La Engorda summer grazing area superficial
drainage network

The main conclusion of the photo interpreting done is the confirmation of the existence of a superficial drainage which feeds the vegetation units identified in La Engorda canyon, and especially in the area of study. The above based on:

- . Given the conditions of the relief, the area between Colina streams and La Engorda, is mainly irrigated by superficial flows which come off from the main flow in the upper part of the canyon zone (La Engorda stream, upstream the projected intake), which is anastomosing. The previous allows the water flow to branch out between elongated banks of mudslides or sediments, some of this flows or water arms feed Colina stream;
- . La Engorda stream has a slight to mean slope, in the sense of the flow of the streams, which facilitates the deposit of swept sediments from the upper zones, giving shape to a flooding plain where vegetation units are developed.
- . Colina stream has a North-South predominant direction, being flanked by mountains whose hillsides are covered by wide drift fans. It changes its direction in a predominant East-West direction. This waterway runs in parallel to La Engorda stream before meeting with El Morado stream. Colina stream develops a unique waterway at the projected intake, coinciding with an abrupt change in the slope, which determines that the waters flow towards El Morado stream.
- . As additional information to take into consideration, the following picture shows the difference in level of La Engorda stream river bed with regards the terrace level in which the previously described vegetation units are developed. As consequence, this terrace receives water from different sources which keeps the superficial or sub-superficial run-off which is part of the flooding plain, apart from the contributions of Colina and La Engorda streams.



Picture 6: Difference in level between the Platform where the Vegetation Units are presented and La Engorda Stream

- On the other hand, the analysis of the stratigraphic column described in section 2.2 of the document, shows the existence of other old vegetation levels which were covered by sediments (organic matter level in the top of levels B, E and G) which clearly suggests that together with the surface observations, the persistence of the identified vegetation units depend exclusively on the presence of superficial waters of diffuse run-off. This water comes mainly from thaw and fusion of snow and ice which are accumulated in the upper parts of La Engorda valley which runs-off in the surface in a sheet-shaped form and the breaded thread water along the whole valley and which have no relation with channeled water by the respective streams.

As Conclusion: From the analysis performed can be concluded that the zone covered by Andean shrub and wet prairies vegetation in this area, receives water from different affluents. On one hand, there are waterways from Colina and La Engorda streams, the thalwegs or ravines of short development of intermittent behavior which drain waters from thaws, solid and liquid precipitations, and the existing underground run-off.

3 DETAILS OF THE WORKS AND CONSTRUCTIVE PROCESSES OF LA ENGORDA AREA

The environmental sensitiveness of La Engorda summer pasture area has required a special treatment from the engineering of the project in relation to localization, design and constructive method of the works contemplated by PHAM in such area. This previous consideration has allowed including an environmental protection criterion in the planning of the works, which in the practice, constitutes the best formula to prevent or minimize every type of environmental impact.

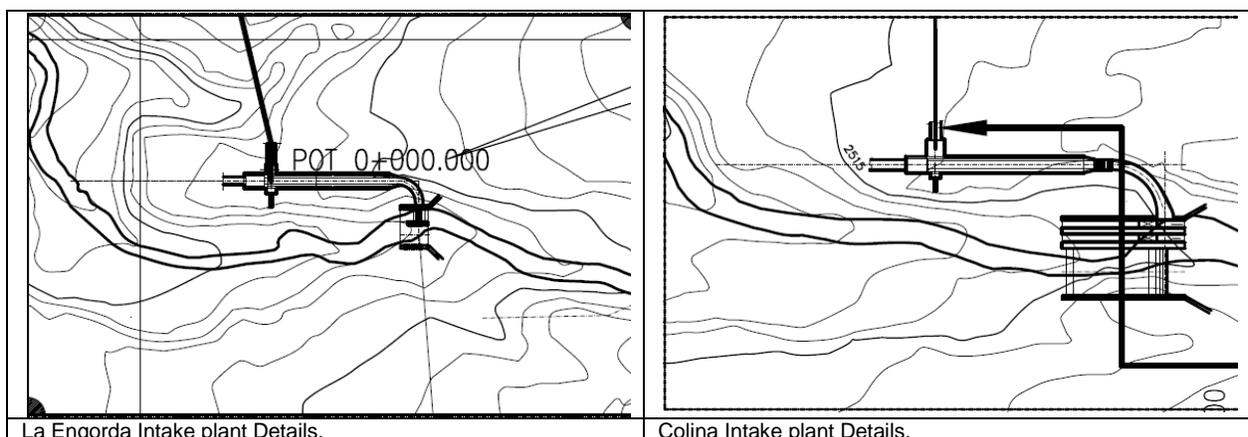
In this section, details of works and construction methods of the works foreseen for the tranche between Colina and La Engorda streams are described, because both go along the esplanade known as La Engorda Canyon which contains the greatest coverage of vegetation of interest of the area.

3.1 CHARACTERISTICS OF THE WORKS

The works to be developed in La Engorda area correspond to:

- La Engorda intake: Of high mountain type, consists of a sink (or grid chambers) of 3.2 m wide and a length of 2.2 m in direction to the run-off located in the river bed of the stream in order that the water will be collected in the bottom of the waterway. The sink discharges the collected waters towards a pipe of 1.4 m wide which at the same time conducts them towards a gravel chamber designed to remove particles of a diameter over 0.3 mm (further details are presented in Chapter 2 of EIA).
- The intake in Colina stream corresponds to a side type collection which considers the construction of a frontal barrier to the run-off of 12 m wide and approximately 2.5 m height from the bottom of the river bed. The barrier is contemplated to be made of reinforced concrete. Adjacent to the side take, two gravel chamber gates of 2 x 2 m opening of radial type are considered (further details in Chapter 2 of EIA).

Figure 5
Details of the Intake Plant to be developed in La Engorda Area

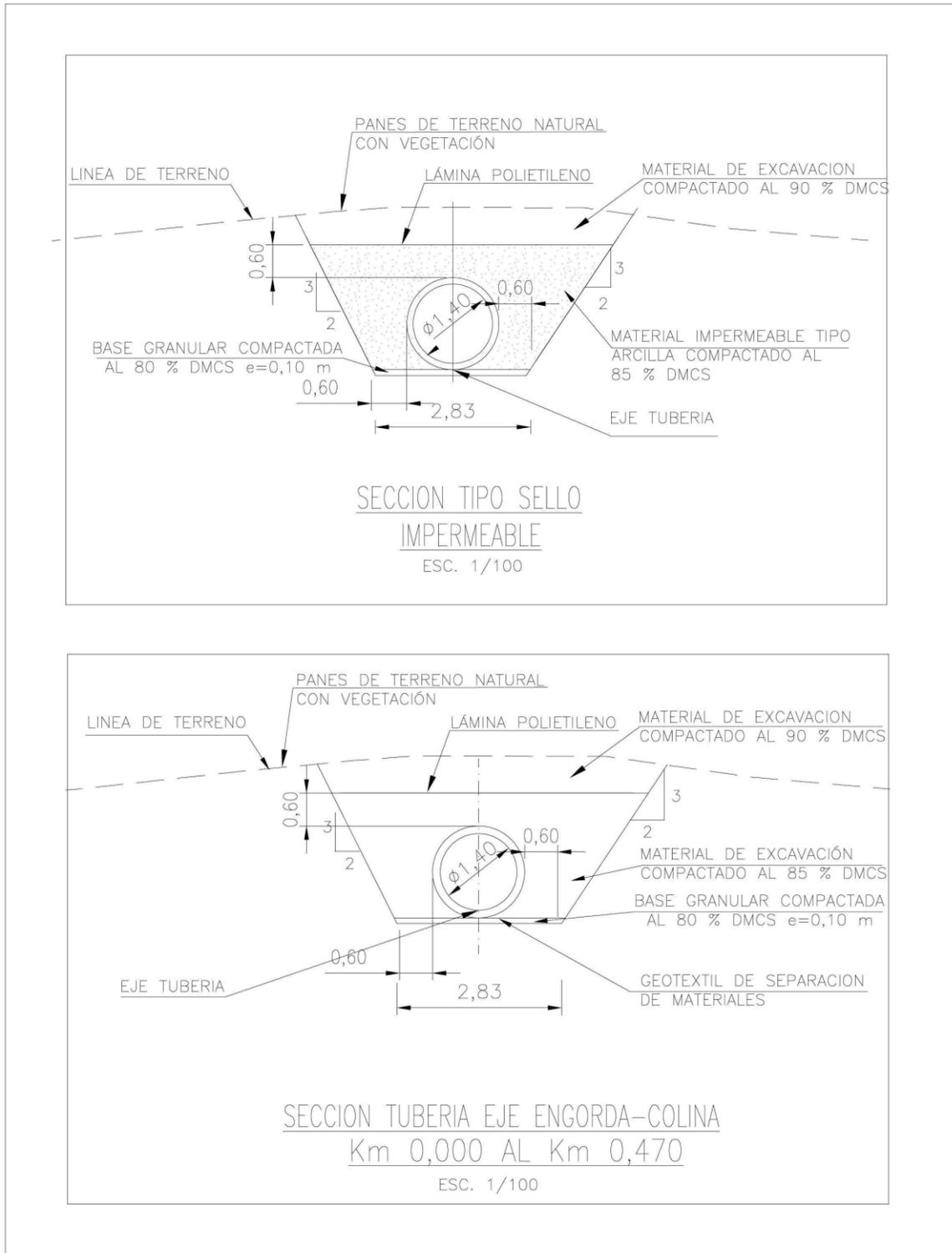


- . Conduction aqueduct: it corresponds to a circular pipe of reinforce concrete of 1.45 m diameter and 470 m length which starts in La Engorda intake up to Colina intake.

This aqueduct will be buried in a trench of approximately 2.5 meters, which will be later filled with the same extracted material, in order to keep the original conditions to avoid superficial and sub-superficial run-off which feeds the vegetation Units (see Figure 6).

Further details of the works to be constructed are presented in Chapter 2 of EIA, and in the Annexes 1 and 8 of itself.

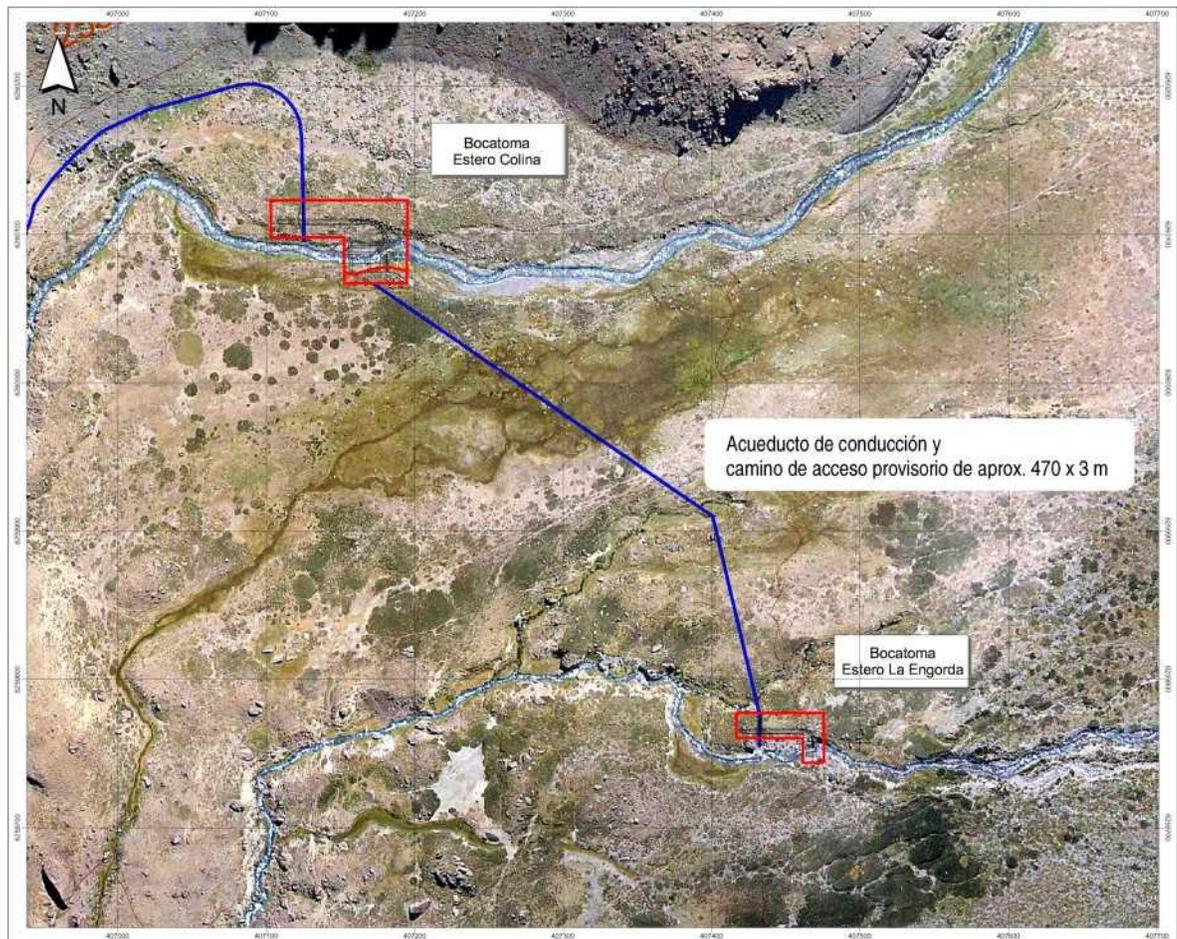
Figure 6
Details of the Piping Works to be developed in La Engorda Area



- Temporary access road. Additionally, for the initial phase of the construction of the works, it will be necessary to enable a temporary road, to be located on the side of the trench. This road will be used, only and exclusively during the construction stage, and its vegetation surface will be restored once the construction works have finished. The length of this road is approximately of 470 meters, while the width will be 3 meters.

The carry out of the works previously described are shown in the following Figure.

Figure 7
Details of the Works in La Engorda Canyon Area.



In the Figure can be observed a representation of the works of the project (intakes and conduction aqueduct). Additionally, a temporary road will be enabled for the defined route for the conduction canal.

3.2 CONSTRUCTION METHOD DETAILS

Generally, the construction of the works will be done using team works which will operate in different faces.

In the first place, a temporary road will be enabled which will let the transport of machinery and goods for the construction of La Engorda intake. The width of this road will be approx. 3 meters and will be located next to the piping line trace. For the above, the Contractor will extract in "pieces" the first vegetation horizon, which will be temporary stored next to the transit area. The storage areas have not been defined yet, but areas without or with less vegetation coverage adjacent to the road and without presence of seasonal wet prairies will be favored.

After the temporary road is been enabled, the construction works of La Engorda stream intake will start. Parallel to the construction of this work the construction works of the conduction aqueduct will start.

It is important to bear in mind that the works in this sector will be developed in summer period (September to April), limiting the construction of the piping line just to the period between the months of December to April.

With regards the construction itself of the conduction pipeline, this will be developed per tranches (no more than 30 meters). The fundamental idea of the construction method to be used, is that each teamwork will develop the complete sequence of construction per each tranche (excavation, enabling of the piping and filling), in order to restore the surface in the shortest time as possible. Between the finished tranche and the one starting, an open trench of no more than 3 m will be left.

It is important to point out that not all the land extension between intakes present wet prairie vegetation. For the tranches with presence of wet prairies, instructions will be given to the contractor so the works will last no more than 3 days.

Fulfilling the concerns of the Environmental Authority, a detailed description of the construction process is presented next:

a) Excavation and rescue of superficial soil layers

- . For the construction of the temporary road of approx. 3 meters width, the vegetation layer up to the first waterproof stratum of excavated soil will be extracted in "pieces", temporary storing them on the side of the transit area. The storage areas have not been defined yet, but areas without or with less vegetation coverage adjacent to the road and without presence of seasonal wet prairies will be favored.

- . For the construction of the headrace, the excavation will be done from the Colina stream intake towards the La Engorda stream intake. The previous considering that the differences of slopes will let a greater control of the superficial flow present in the plain. In a similar way to what has been described in the case of the temporary road, the excavation will be initially done taking out the upper strata of the soil, in "soil pieces" form. These pieces will include the vegetation layer up to the first waterproof stratum of the excavated soil.
- . Later, the excavation of the soil will start with a depth around 2.5 m (excavation seal). For the temporary storage of the "soil pieces" adjacent sites to the excavation face will be used, following the progress of them. As it was pointed out for the case of the temporary road, the temporary storage of the soil pieces will be done on the side of the excavation faces, following the progress of them. Areas without vegetation or with less coverage, and without seasonal wet prairies presence will be used.
- . There will be a preference for the temporary stored soil pieces to be artificially irrigated with water extracted from the excavation trenches.

b) Materials Removal and Transport to SAM

All the excavated material that might be suitable for the use as filling, could be used by the Contractor of the works as such, having always coordination by the Technical Works Inspection (ITO). The rest of the material will be transported towards the muck disposal area N°1, located in the construction zone of El Volcán tunnel.

c) Drainage during construction

- . All Excavations of any type, and classified either as common or in rock, will be done in dry. For the above, the contractor of works will be able to develop methods of gravitational or mechanical drainage according to the characteristics of humidity present on the trench.
- . Gravitational drainage corresponding to open trenches, temporary piped conductions, and any other type of drainage that the Contractors use for drying the excavation. Including its collection, conduction and discharge. The mechanical drainage corresponds to attrition with motor pump equipments, referred to the installation and operation of the portable pumping equipments.
- . As it has been stated, the waters extracted could be used for humidify the temporary stored "soil pieces", especially for its conservation in cases that recovery of material is extended by a greater amount of time to the expected one.

d) Filling of the support bed of the pipes

The placing of the filling per tranche will start when the excavation seals will be finished and received. Then, the filling or granular material bed of 10 cm where the pipeline will be supported on will proceed.

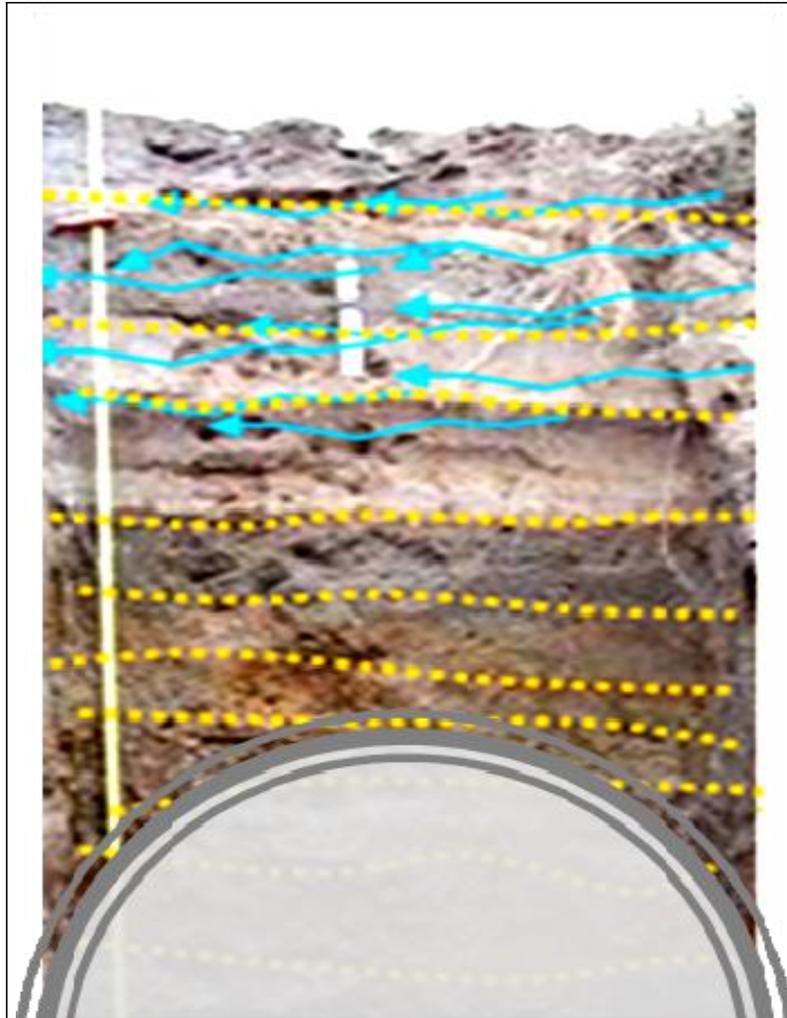
e) Installation of the pipeline

- . The Contractor will be able to place the pipes in the trench only after the ITO had been received according to the support bed.
- . Once the pipes are installed, the ITO will verify whether these comply with the slopes and elevations established in the Plans of the Project.

f) Fillings

- . The filling will be continuously placed in horizontal layers. The stored material from the excavation of the trench will be used. This filling will be placed wrapping the pipes and until it covers 60 cm above the key (see Figure 7 "Details of the piping works to be developed in La Engorda area").
- . Over the filling mentioned in the previous paragraph a layer of polyethylene will be placed to obtain a waterproof seal in vertical sense.
- . Over the polyethylene, material from the excavation will be placed with such thickness that together with the "vegetation pieces" of the upper strata will restore the original profile of the natural land and thus the conditions of original irrigation.
- . The filling layers will be pressed with suitable mechanical equipments and authorized by ITO.
- . Waterproof seals in order to measure a possible run-off will be placed across every 50 meters, in longitudinal sense of the excavation of the trench and using the whole section which lets the pipe free.

Figure 8
Piping Works Projection



4 LA ENGORDA AREA COMPLEMENTARY ENVIRONMENTAL ASSESSMENT

The complementary environmental assessment presented in Chapter 6 of EIA is presented next:

4.1 CONSTRUCTION STAGE

i) Identification and Impact Sources

PHAM will affect a reduced surface used by wet prairie and Andean shrub vegetation formations in La Engorda canyon, due to the construction of superficial works in the area. This effect will be temporary for most part of the intervened sites, and of permanent character in the case of the waterway works.

The Temporary affectation, will be limited to the months that the construction of the works will last in the area, and it is associated to the necessary land requirement to: enable the temporary road between La Engorda and Colina streams, the trench where the conduction and work areas will be carried out, is understood as the necessary surface to have temporary storage and allow the transit of people and machineries around the works. This intervention is temporary because over the affected surface, activities of restoration of soil and its vegetation coverage will be done.

No camp sites or work installations, nor muck disposals will be enabled given that these facilities will be enabled near the El Volcán tunnel threshold, as is pointed out in Figure 2.2.2 of Chapter 2 of EIA and out of the zones identified with wet prairie vegetation.

The permanent affectation is referred to the surface which will effectively be used by the intakes, these are the only works that will stay during the operation of the Project in La Engorda Canyon area.

i.a) Surface affected by temporary works

The following table points out the land requirements as per temporary work type:

Table 3
Estimation of the Temporary Surface Required by PHAM in La Engorda Canyon *

Work	Criterion of calculation	Surface (has)
Temporary road	3 m on the side of the trench	0.14
Conduction canal	7 m width	0.33
Work area around the works.	Surface containing the vehicles and people movement area	1,27*
Work area for temporary storage of materials	Surface containing temporary storage of soil pieces	0.73
Total		2.47

* includes the waterway occupation area

It is important to highlight that from the constructive method adaptations (presented in this Annex) has been possible to reduce the superficial requirements of PHAM for La Engorda area, according to what had been initially informed in Tables 6.4.1.5.1 and 6.4.1.5.5 of Chapter 6 of EIA.

The surface called "work area" considers a platform or work perimeter estimated in about 1.27 has for the intakes; 0.73 has for the temporary storage; and 0.47 has for the road and canal.

Generally, the area to be used by the Project is about a reduced surface. Considering that La Engorda canyon has a total approx. surface of 272 has (Figure 3, the temporary intervened area by PHAM constitutes 1% of the total surface of La Engorda canyon.

The works settling and use of the work areas will imply the intervention of vegetation units identified in the Base Line of La Engorda canyon (LE-3 and LE-4), in the proportion stated in the following table:

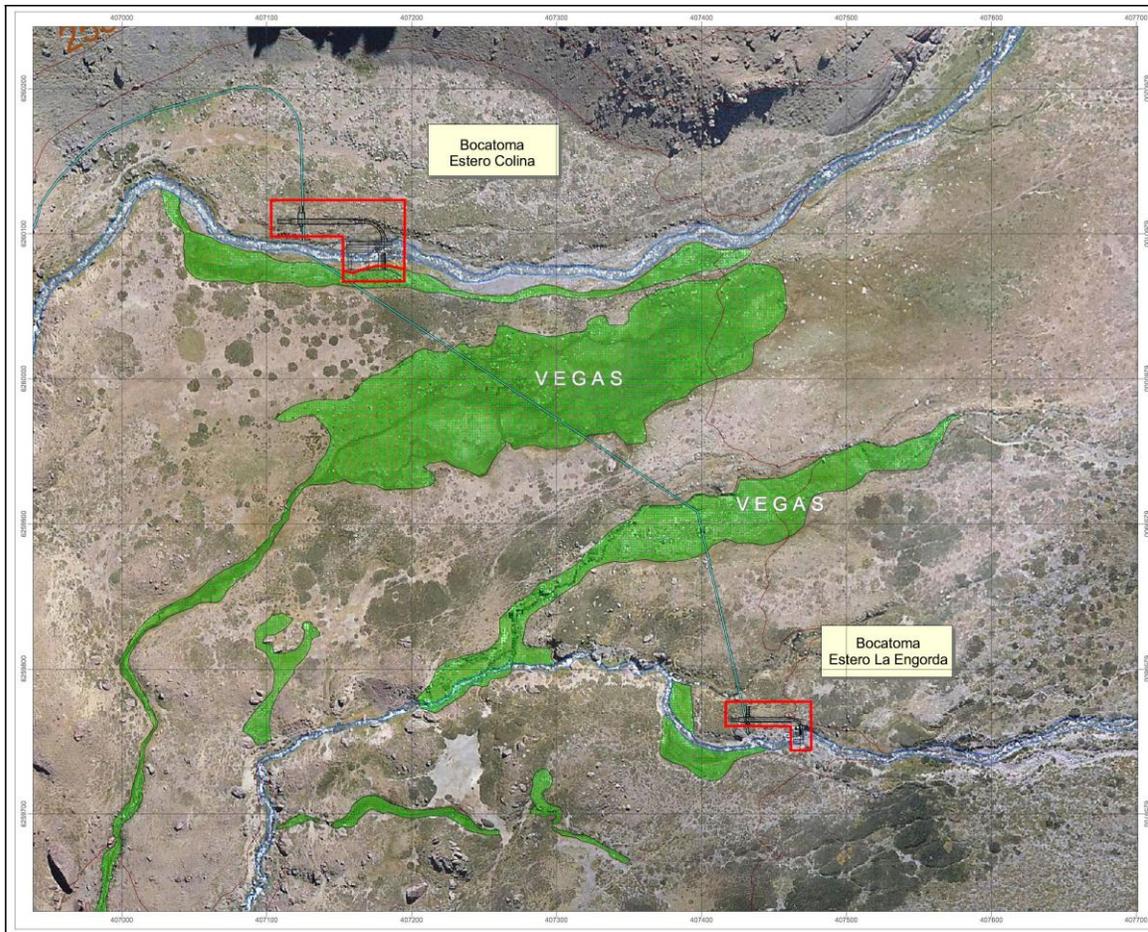
Table 4
Temporary Surface Estimation Required by PHAM
in Relation to the type of Vegetation to be
affected*

Unit	Surface (has)	Vegetation type	Vegetation Type	Work
LE – 3	2.20	Low shrub with stratum Dense Herbaceous	Ag Co Be ja py hc	Trench for conduction pipeline, temporary road, work areas
LE – 4	0.27	Grassland, Stream	ja al pa ds	Intakes
Total	2.47			

Source: Estimated calculation from the overlapping of the works over COT (figure 5.4.1.3.21, attached in Chapter 5, "Base Line" of EIA).

Just as it was stated in section 2.1 of this document, rotating with the high Andean shrub vegetation (unit LE-3) wet prairie vegetation patches are developed which appear during the period with greatest availability for humidity. Based on the observations done in the last in field campaigns carried out in spring 2007, it is estimated that the intervened area with seasonal wet prairie would be about 0.178 has (0.055 and 0.123 has associated to the road and canal respectively). This surface represents 0.1% of the total area of the LE-3 unit which will be intervened. This value is referential, due to the extension of these vegetation patches are variable depending on the time of the year, mainly due to the humidity of the soil and pressure of the grazing.

Figure 9
Details of the works about Seasonal Wet Prairies Unit (as per Campaign 2007)



i.b) Surface affected by permanent works

The permanent surface that the intakes will use will be a fraction of the land adjacent to La Engorda and Colina streams about 0.13 and 0.14 has respectively, and which present a vegetation coverage of the unit LE-4.

Considering the total surface of La Engorda canyon (272 has), the surface affected by the permanent works corresponds to 0.1% of such surface.

There will be no permanent works in the vegetation unit LE-3 (low shrub with herbaceous stratum), neither in the seasonal wet prairie units (as per the coverage represented in Figure 9 for the case of Campaign 2007).

ii) Environmental control measures

a) Mitigation and restoration actions

In this section the mitigation and/or environmental control measures foreseen for the area between Colina and La Engorda streams area described in this section, and which will be carried out for protection both for the wet prairies as for the Andean shrub.

- . Construction method ad-hoc to the environmental sensitivity of the area: The methods and construction sequence among other aspects, has minimized the surface requirements of the zone, and will guarantee, besides, the restoration of the wet prairie vegetation that might resist the stress of its rescue and restoration, and the recovery of the original conditions of the superficial drainage of the soil.
- . Micro-routing and new test pit: Previous to the carry out of the works and once the used areas are limited by the works and work platforms, a new inspection of the specimens per species to be intervened will be done. This will generate information in order to tune up the compensation actions and letting an optimum definition of the areas of temporary use. Additionally, at least 2 new test pits along the projected trace will be done for the headrace that complement information studied in the soil profiles, thus verifying the arrangement of the horizons described in the soils for the area.
- . Restoration of the vegetation in temporary use zones: In a complementary form to the rescue and restoration of the soil/vegetation pieces in the zones of temporary use between La Engorda and Colina streams, it has been contemplated a restoration plan for those lands used by other permanent and/or temporary works or facilities, even when these would not affect the wet prairie units (camp sites and Works installations, muck disposal). The previous will allow stabilizing the soils and restoring as much as possible the pre-existing vegetation.
- . In order to guarantee a maximum recovery of the wet prairie sectors restored after the temporary use of the works of PHAM, the Owner commits itself to restrict the domestic livestock access to those areas for 2 seasons, thus preventing the stamp on and browse on the vegetation coverage. This will be done through a temporary fence in the areas where the wet prairie vegetation would be restored. With this, the interest areas will be segregated not preventing the cross of third parties to the upper zone of La Engorda Canyon.
- . Compensation of specimens: As it has been pointed out, before the clearance of vegetation in La Engorda area, a micro-routing will be done in order to identify the specimens that might be part of a conservation category. Regarding this, EIA identified the species in conservation category detected in field or potentially able to be found in the area, nevertheless, it will be through this micro-routing that the location and exact amount of removed specimens will be identified. For these cases, the Owner has committed himself to compensate 10 specimens for each one eliminated.

- . Contractor's control: There should be special training activities for the contracting personnel so he can understand the importance and value of the flora and fauna conservation species present in La Engorda zone, especially with regards species that are in some conservation category and the importance of the area as habitats. Such training will be addressed to the identification, preservation value, associated legislation, protection actions and penalties. A record with name, date and signature of each trained worker will be kept. Also, this training will address all the commitments acquired along the environmental process of the project, and which will be contractually demanded.
- . Expert supervision during construction: GENER will count as part of the Technical Supervision of the Works with an environmental expert that will foresee that the works are carried out according to the environmental specifications.
- . Restricted zone: Restrictive zones for La Engorda area, out of the carry out of the physical works zone, banning the development of other construction activities under a preventive criterion will be established. The restricted zones will be marked on site with clearly distinguishable signs and visible to all the people employed by the Contractors in the construction stage. It has been considered as criterion for determination of these restricted zone, the presence of vegetation which constitutes habitat or shelters for fauna of interest.
- . The Contractor will be trained so he can unconditionally use the temporary road for exclusive circulation of the personnel, avoiding the workers to generate new footprints or pathways.
- . Verification of foreseen effects or more efficiency or ability of the proposed actions will be done through a vegetation monitoring during the construction stage of the Project (see Chapter 8 of EIA). The results of this monitoring will be systematically presented to the Environmental Authority.

b) Compensation actions

The Owner is committed to formulate 2 complementary studies to be developed out of the influence area of PHAM as compensation actions, and which will contribute to the territory management done by SAG in the zone of insertion of itself.

- . Gener will ask specialists for the development of a census study on pumas (*felis concolor*) for the area comprising the upper basins of Colorado, Yeso and Volcán rivers, specially, the areas that would include summer grazing and winter pasture areas of traditional use for grazing. This study will contribute to the knowledge of density and distribution of the species in the zones of anthropic use, especially where it has been registered a conflict of territorial friction associated to the existence of grazing in pumas hunting areas.

Currently, Gener has committed the economic support to help on financing a project of CONAMA called "Biodiversity Protection: assessment of the conflict generated between the livestock and the Colorado River puma"

. Gener is committed to the development of a wet prairie vegetation inventory and identification of the current threats which this type of environment is facing in the upper basins of Colorado, Yeso and Volcán rivers. The work approach and method will be proposed to SAG previous to the carry out of the study, understanding that there are other on-going studies on this matter that might support or complement the proposed inventory.

iii) Impact qualification

Based on the previous background it's possible to confirm that the intervention by PHAM during its construction will not compromise the sustainability of the wet prairie environments in La Engorda canyon area.

In spatial terms, the affected surface of La Engorda canyon by effect of the temporary works of the project, is considered of low magnitude. In fact, with regards the total area of the canyon (272 has) the intervened area by constructions works will be about 1% (2.47 has), out of which its greatest part (89%) will be restored (2.2 has). The permanent affected surface will be only 0.27 has, and it will be associated to the area that the intakes will use. It is estimated that the intervened area with seasonal wet prairie presence would be around 0.178 has (based on the results of Campaign 2007), which represents 0.1% of the total area of LE-3 area which will be intervened. The restoration of the soil and vegetation in the temporary intervened areas will favor the quick re-establishment of the habitat conditions which the wet prairie and Andean shrub offer to the local fauna.

With regards the representativeness of the vegetation units intervened by PHAM, these are not exclusives of the region. For the case of the wet prairie unit, this has a wide distribution in the eco-region of the Mediterranean Andes (The Andes between IV and VIII Region). For the case of the Chuquiragas shrub unit, this has affinity with the association with *Mulinum spinosum* and *Chuquiraga oppositifolia*, a typical community for the formation of high Andean steppe in the mountain range of Santiago. The distribution of the formation goes from the Choapa river basin up to the Teno river basin.

In relation to the species in some conservation category, for La Engorda canyon has been identified 5 species, out of which only the *Alstroemeria exerens* (insufficiently known) and *Laretia acaulis* (Vulnerable) species are possible to find, although in low frequency in the area where the works of PHAM will be carried out. The amount of affected individuals and its geo-referencing, will be part of the information that will be studied in the micro-routing stage and will be presented to the Environmental Authority before the start of the works.

The intervention of PHAM will not interfere with the grazing activities done in La Engorda canyon, by exception of specific points where the works will be carried out. Currently, the livestock activities perform a strong pressure over the wet prairie vegetation, making them quickly lose its coverage, especially in summer.

As consequence, based on everything that has been presented, it can be concluded that the impact of PHAM, in its construction stage, will have a negative character although of low importance.

4.2 OPERATION STAGE

i) Identification and Impact Sources

A strong potential impact is the local modification to the irrigation conditions of the bank vegetation, downstream the intakes of PHAM, due to the reduction of the flow. This impact will partially affect the vegetation of the existing wet prairie in the zone next to the waterway (LE-4). Another source of impact would be an eventual interruption or modification to the superficial run-off caused by the headrace canal, in the downstream areas of itself, where there is predomination of the high Andean shrub unit LE-3 which shelters seasonal wet prairies in summer, which appear once the snow on the area has disappeared.

Just as it has been concluded in the pointed analysis section 2.3 of this Annex, the zone covered by Andean shrub and wet prairies in La Engorda canyon receives waters from different sources, being these the main streams and in an important way the thalwegs or ravines of short development of intermittent behavior which drain waters of thaws, solid and liquid precipitations, besides of the existing underground run-off.

Therefore, the zones of vegetation located downstream the works of the project (intakes and piping canal) will generally stay irrigated by the different arms of the streams which are part of the flooding plain, and by ravines descending from the hillsides which enclose the valley. That is way the wet prairie vegetation would not be impacted in an important form, because they do not depend exclusively and directly on water flowing from the main streams and which effectively will have a reduction of its flow in a situation with the project.

According to the analysis performed, it is necessary to confirm that the conduction projected will not cause an interruption of the drainage, because this will be buried under the superficial irrigation area, and at more than one meter of depth. This pipeline will be buried arranging for it, the same material of superficial filling which currently has, which will let to keep the original conditions of subsoil, thus maintaining the natural drainage of the zone. It is not expected then, pools out of the waterway and upstream the collections and the headrace, nor a total reduction of the superficial run-off out of the waterways and downstream the works, therefore, the natural conditions will remain which will make possible the drainage and superficial waters to run-off and encourage the seasonal wet prairies development.

The wet prairie vegetation corresponds to formation which are established in an edaphic environment, mainly organic, characterized by permanent saturation water condition, in this case, due to the substratum upper layers which act as relative waterproof surfaces. To ensure the right re-establishment of this condition, it has been considered the installation of a polyethylene waterproof layer under the superficial horizons.

Therefore, restoration of the original morphology conditions, soil profile and vegetation coverage at the end of the construction works will guarantee that in the operation phase, the zone will recover and maintain the irrigation condition which supports the local vegetation.

iii) Environmental Measures

a) Restitution of the original drainage condition

The wet prairie vegetation corresponds to formation which are established in an edaphic environment, mainly organic, characterized by permanent saturation water condition, in this case, due to the substratum upper layers which act as relative waterproof surfaces. To ensure the right establishment of this condition, besides the tidy restoration of the superficial horizons of the soil, it has been considered the installation of a polyethylene waterproof layer under the superficial horizons to prevent the vertical migration of the waters.

Therefore, restoration of the original morphology conditions, soil profile and vegetation coverage at the end of the construction works will guarantee that in the operation phase, the zone will recover and maintain the irrigation conditions which support the local vegetation.

b) Environmental follow up

The verification of the foreseen effects will be done through a monitoring of the vegetation during the 5 first years of the operation stage of the Project (see chapter 8 of the EIA).

c) Compensation before a residual impact

In the eventual case that a foreseen impact or the efficiency/ability of environmental control does not work as expected, GENER is committed to reach a consensus with the Environmental Authority for new actions of compensations, such as:

- . Propose to SAG the definition of a wet prairie protection zone. A wet prairie zone will be selected which has conservation interest.
- . Propose to SAG the reference terms for the development of an environmental study and its load capacity in the zone mentioned in the previous paragraph.

iii) Impact qualification

According to the analysis presented in the previous sections, it has been estimated that the effect on the flow reduction of the streams, will not cause a relevant impact on the wet prairie vegetation in terms of spatial terms or extension. The above, therefore, will keep the main conditions of natural irrigation of the wet prairie.

Likewise, the presence of the conduction pipeline will not cause an interruption of the run-off due to it will be buried at one meter depth and it will be covered with the same extracted material and with the shape or distribution as per original layers of filling.

The vegetation zones located downstream the intakes will stay irrigated by the different arms of the streams which are part of the flooding plain, and by ravines descending from the hillsides which close the valley, and which feed the sub-superficial aquifer. As consequence, this impact is qualified as adverse or negative of low importance.

The assessment done is based on the expert opinion of the team comprised by biologists and geologists, among other professionals, EIA participants and the engineering studies. This predictive analysis will be confirmed over time through the follow up programs proposed in chap. 9 of EIA. The Owner is committed that in case that the foreseen impact or the environmental measures proposed do not work as expected, will reach consensus with the environmental authority for new compensation measures.

Finally, it is important to bear in mind that the land where the works will be carried out belong to third parties, therefore the Owner of the project cannot guarantee the protection of such lands out of the area to be defined for the carry out of the works. Regarding this, there are activities such as grazing and tourism nowadays that, although, they will not be interrupted by the carry out works of the Project, such activities may act against the purpose of conservation which is safeguard by PHAM.