EXECUTIVE SUMMARY

1 GENERAL ASPECTS

In the pipeline of potential hydroelectric projects identified by HMV Ingenieros Ltda. ("HMV") is the San Matías project, which takes advantage of the waters of the San Matías River and is intended to be registered as a clean energy project under the CDM framework. The project is located in the eastern area of Antioquia, approximately 95 km away from the city of Medellin, in the jurisdiction of the municipalities of Cocorná and Granada.

To develop the project, HMV requested the Corporación Autónoma Regional Rionegro Nare ("CORNARE")-, the local environmental authority, to express its pronouncement on the need to develop an Environmental Assessment of Alternatives ("EAA") for the hydroelectric development of the San Matias River. CORNARE provided an affirmative response and afterwards, selected the project that required an Environmental Impact Study ("EIS") as stated in Resolution 112-0306 dated as of August 23rd, 2010.

As required by CORNARE under the terms of reference for the EIS, HMV performed field work from September 2011 through March 2012 in order to complement the information previously collected during the EAA.

The EIS consists of 11 chapters:

- **Chapter 1. Introduction**. This chapter describes the general characteristics of the project such as its background, goals, scope, and work methodology.
- **Chapter 2**. **Project Description**. This chapter: (i) contains the technical specifications of the project in terms of its feasibility during both the stages of construction and operation; and (ii) presents project facilities design.
- **Chapter 3**. **Description of the Area of Influence**. This chapter contains an identification of the project's area of influence and describes the current state of the elements and components of the area's environment (physical, biological, and social). This chapter presents a comprehensive analysis of these components in order to establish its environmental sensitivity.
- **Chapter 4**. **Demand for natural resources**. This chapter contains an identification and quantification of the natural resources that may be affected by the project. This chapter also enumerates the permits, concessions, or authorizations required by the project.
- **Chapter 5**. **Identification and assessment of environmental impacts**. This chapter contains an identification and evaluation of the main environmental impacts of the project. Also, the chapter presents an analysis of potential cumulative impacts and their economic assessment.

- **Chapter 6**. **Zones for environmental management.** This chapter contains a synthesis of the vulnerability of the identified environmental units and a classification of the exclusion and intervention areas with, or without, restrictions.
- **Chapter 7**. **Environmental Management Plan.** This chapter presents the environmental management programs designed to prevent, mitigate, correct, and compensate for the project's impacts during construction and operation.
- **Chapter 8**. **Monitoring and follow up Plans.** This chapter describes the main measures that will allow us to effectively monitor and keep track of the implementation of the prevention, mitigation, remediation, and compensation programs described in the Environmental Management Plan for the physical, biotic, and social components.
- **Chapter 9**. **Contingency Plan**. This chapter presents the project's risk analysis and the emergency and contingency measures designed for the project's construction and the guidelines for its operation.
- **Chapter 10**. **Abandonment and Final Restoration Plans**. This chapter describes the various activities aimed to restore the initial conditions of the areas directly affected by the project.
- **Chapter 11**. **1% Investment Plan.** This chapter presents the technical and economic proposal for the implementation of the investment of the "1 % plan", as regulated by Decree 1900 of 2006.

2 PROJECT DESCRIPTION

2.1 LOCATION

The El Molino hydroelectric project (formerly known as El Molino I) is located in the eastern part of the department of Antioquia, about 95 km away from the city of Medellin, in the jurisdiction of the municipalities of Cocorná (El Molino, Campo Alegre, Los Mangos, La Inmaculada, and San Lorenzo counties) and Granada (Quebrada Abajo and Las Faldas counties).

2.2 TECHNICAL DESCRIPTION OF THE PROJECT

El Molino will be a run of the river hydroelectric project without reservoir. It will have an installed capacity of 21 MW, a design flow of 10 m^3 /s, and a net leap of 238.4 m. The conduction facilities will be approximately 3.4 km in total length.

Together with the San Matias project, El Molino will be part of a cascade hydroelectric system and therefore, the turbinated waters from the El Molino project will be taken first into a still tank and later down to the San Matías project.

In general, the Project consists of a low height concrete weir, a lateral intake, a sand trap for sediment retention, a box culvert, a conduction tunnel, a relief pipeline (*almenara*), a valves house, a pressure pipe, an overground power house, a still tank, and a discharge channel that will take the turbinated waters back into the San Matias River when the San Matías project is not operating. The general outline of the project's facilities may be found in the drawing 2148-04-CV-DW-015.

2.2.1 Intake facilities

The river flow deviation will be made using a concrete weir of approximately 4.0 m in height and 39.0 m in length, with a maximum elevation of 1,264 meters above sea level ("MASL"). On its right side, the weir will have a background discharge composed of a radial gate of 5.0 x 5.0m. The spillway section of the weir will allow the passage of rising waters up to 1,246 m^3 /s, corresponding to a return period of 100 years.

For the water intake, a lateral structure will be located on the right side of the weir. This structure will be composed of rectangular openings sized to direct the flow into the conduction system. After the openings, a channel will be installed as a gravel trap that will be connected with the conduction channel through a second series of openings. The first series of openings will be composed of two orifices of 2.50 m in width and 2.15 m in height. The second series will be composed of three orifices of 1.80 m in width and 1.70 m in height. At the end of the gravel trap channel, a gate will be installed with 2.50 m in width and 2.50 m in height.

2.2.2 Conduction channel

Adjacent to the gravel trap channel, a second channel will be installed to conduct the waters into a sand trap. This channel will be 4.0 m in width and 3.60 m in height and will have a longitudinal slope of one per thousand. After the first 38.0 m of the channel, a gate will be installed to regulate the water flow used for generation. Following this gate, a lateral spillway will be installed with estimated length of 30 m.

2.2.2.1 Facilities for the environmental guarantee flow

In order to ensure compliance with the proposed environmental guarantee flow ("CGA"), a square hole of 0.8 m will be made to the conduction channel, about 33.0 m after the water intake and immediately before the regulation flow gate for generation.

2.2.3 Sand trap

The project's sand trap will be installed on the right bank of the San Matias River. The trap will be of *Dufour* type with three chambers to allow the cleaning of an individual chamber while the plant is in operation. Each chamber will be 43 m in length and 6.0m in width.

To clean the material deposited in its chambers, the sand trap will have at the bottom two drainage channels perpendicular to the chambers. These channels will have a width of 1.20 m and a height varying between 1.10 m and 1.30 m, with a gradient of 1% along its route.

At the bottom of the sand trap there will also be a tailrace to direct the sediments back into the river. The system will be composed of a venting channel that will receive the sediments from the two discharge channels mentioned above. The venting channel will be 1.20 m in width, 1.20 m and in height, with a slope of 1.0 %, and will deliver the waters to a cyclopean concrete slab.

2.2.4 Conduction Facilities

2.2.4.1 Conduction Tunnel

After the sand trap, the project's conduction continues with a pressured system composed of a square box culvert of 2.50 m in width, 15 m in length, and longitudinal slope of 0.2 %.

After the box culvert, the pressure system continues with a tunnel of 2,651.6 m in length with a modified horseshoe section, 3.1 m diameter of excavation and with a slope of 0.7 %. The first 100 m of tunnel will have a covering of reinforced hydraulic concrete, forming an effective circular cross-section of 2.5 m in diameter

The relief pipeline role is to absorb overpressures generated in the transitional regime by the water hammer effect. The relief pipeline will start on abscissa 2,649.57 m of the false tunnel and will have a total length of 127 m with internal diameters of 1.8 and 2.4 m.

2.2.4.2 Pressure pipe

After the tunnel, the project's conduction continues with a pressurized pipe that will have a first tranche of 1.90 m internal diameter and 213.7 m in length, followed by a stretch of 394.5 m in length and 1.80 m in diameter. The pressure pipe will be connected with a steel pipe of 1.80 m in diameter and 8.79 m in length after which the conduction trifurcates to the two turbines inside the power house and to the pressure relief valve. All three branches will have a diameter of 1.20 m. The two branches connected to the turbines will be 22.17 m and 16.63 m long, until they reach the butterfly valve inside the power house.

2.2.5 Power house

The powerhouse will be overground, located on the right bank of the San Matias River, approximately 3.5 km upstream from the confluence between the San Matias and Cocorná Rivers, on a small square at elevation of 1,018.60 MASL, in a point with good foundation conditions both for the powerhouse and the major equipment, and with moderate excavation requirements for the square and the substructure. Access to the power hose will be reached through a road located 6.5 km away from the Medellin - Bogota highway. The house itself will be located about 95 km away from the city of Medellin, in the jurisdiction of the municipality of Cocorná. The tailrace will take the turbinated waters into a cargo tank and afterwards into the intake of the San Matias hydroelectric project.

2.2.6 Tailrace

The project's tailrace will be composed of a tank of 2 m in length and 8 m in width that will receive the waters from the channel - tank (still tank) located at the power house through a control spillway of 8 m in length. After the tank, a ramp of 1 m in height will be installed followed by a box culvert of 163 m in length that will take the waters back into the San Matias River at free flow hydraulic conditions.

The box culvert is divided into five sections with slopes of 9.9 % in 15.7m of length, 28.5 % in 17.7 m, 9.4 % in 36.4m, 72.7 % in 52.9 m, and 95.9 % at 40.5 m. The box culvert will be squared, with 1.5 m in width. The culvert's flow regime will be super critic, with speeds varying between 10 m/s in the initial section (lower gradient) and 25 m/s in the final stretch (increased slope).

2.2.7 Substation and connecting line

The project's electrical station will be built on the left margin of the access road to the project's power house, on a small square of 42 m by 30 m, at elevation 1,002 MASL, and located about 120 m away from the power house, in simple bar configuration, with the arrival fields for the generating units and line-out to the connection substation. The station will be equipped with high-voltage equipment and a control building. This station will be property of the project.

The connection between the power house and the station will be made through two circuits of 120 m in length to 110 kV, formed by four gateways, two at the end of the transformers and two at the arrival of the substation, and a self-supported intermediate tower of lattice type.

2.2.8 Access Roads

- **Intake.** This access starts at the road that communicates the populated centers of El Chocó and El Molino counties, about 1.50 km away from the El Chocó urban center. An unpaved road of 3.14 km in length connects today El Chocó and Cocorná and a new road will be built of 2.6 km in length and average slope of 8%.
- **Tunnel entrance portal.** This access starts at the intake road, abscise 2+288, and has a length of 0.12 km. The road will have the specifications of a secondary road.
- **Relief pipeline and tunnel exit portal.** This access starts at the road that communicates the populated centers of El Chocó and El Molino counties, about 1.80 km away from where the intake access road begins. The road has a total length of 2.02 m and reaches up to the tunnel exit portal.
- **Power house.** To get to the El Molino's power house, the access roads built for the El Popal hydroelectric project may be used. In particular, a 3.3 km road may be used which begins in the Medellin – Bogota highway, at the site known as "La Mañosa", and conducts to the El Popal's power house. Also, El Molino project benefits from the road connecting El Popal's power house with the relief pipeline (1.0 Km). The new road leading to the power house will have a length of 2.2 km, an average slope of 10%, and according to the characteristics of the expected traffic, it will have the design specifications of a major road.
- **Improvement of the Cocorná-El Chocó road.** This road connects the municipality of Cocorná with the populated center of El Chocó, and may also be used to get to the project's intake, its relief pipeline, access squares, and tunnel exit portal. The road will be improved in a length of 3.1 km implementing ditches and drainage features where needed and improving the traffic asphalt rectifying the curvatures of the road that do not have the best radios.
- **Improvement of the existing access road of El Choco- El Molino.** This road connects El Molino and El Chocó. Approx. 3.4 km of the road will be improved with asphalt.

3 ENVIRONMENTAL CHARACTERISATION

3.1 AREAS OF INFLUENCE

3.1.1 Area of direct influence (ADI)

According to the Terms of Reference of the Ministry of Environment, Housing and Territorial Development, for Environmental Impact Studies, for the Energy Sector, and the Construction and Operation of Hydroelectric Power Stations Generating I-B-1-01, *"the area of direct influence of a project is where the environmental impacts of the activities of construction and operation are manifested; the area is related to the project's site and corresponding infrastructure."*

For the abiotic and biotic environments, the area of direct influence is composed of those areas to be occupied by the project's works: intake, power house, workshops, industrial squares, camp, access roads, and reservoir zones. Total area is 30.71 ha.

Also, the area includes those locations adjacent to the San Matias River, between the project's intake and tailrace, where a reduction of flow rates is expected.

Regarding the socio-economic component, the area of direct influence includes the municipal territories affected by the project's works and the associated reduction in the river's flow. Total area includes the following counties: (i) Quebradona Abajo and Las Faldas (municipality of Granada), which will be affected by the reduction in river flow; and (ii) El Molino, Campo Alegre, Los Mangos, La Inmaculada, and San Lorenzo, which will be affected by the project's works and the reduction in river flow.

3.1.2 Area of indirect influence (AII)

The area of indirect influence is defined in the Terms of Reference of the Ministry of Environment, Housing and Territorial Development for hydroelectric projects as: *"the area where the environmental impacts transcend the physical space of a project and its associated infrastructure, i.e. the area outside the reach of direct influence and extends on to where such impacts are manifested".*

According to this definition, for the physical and biotic environments, the project's impacts would be perceived in the following sites: (i) a land strip of watershed between the San Matias and Cocorná rivers, on the left bank of the San Matias River; and (ii) a land strip between the existing roads to La arenosa and Las Faldas, up to where the effects of a reduction in the river flow would be perceived.

As for the socio-economic environment, the AII comprises the municipalities of Cocorná and Granada because they constitute the administrative centers and social and cultural units around the El Molini hydroelectric project.

3.2 ABIOTIC ENVIRONMENT

By communication number 47308 dated as of December 12th of 2011, HMV required from CORNARE information on the existing water uses in the project's area of influence. By memorandum number 134-0241 dated as of December 21st of 2011, CORNARE reported that, according to its database, there are no other water concessions for use of the basin or its drainages.

In general, we can state that the relevant sector of the San Matias River has good sanitary conditions (category 4 of 5). During the studies, we observed that 71% of the variables of interest presented high levels (>80), except for the coliform, which presented low values in all the evaluation sites. It's important to highlight the high values observed for OD, pH, T and nitrates which is characteristic of a healthy river in terms of its capacity to sustain a diverse aquatic biota.

According to the air quality study we performed in the El Molino's area of influence, which included the installation of monitoring stations in the counties Los mangos, Campo Alegre, La Playa, and El Molino, the levels of PST, PM10, SO2, NO2 and CO comply with the requirements of the current legislation and therefore, do not represent a risk for the health of the people.

During the noise measurements we identified areas where a non-compliance with the permissible standards required by current environmental regulations is present at all sampling points during nighttime. During daytime, compliance is present in the points 2 and 4, located in the counties Campo Alegre and El Molino, respectively, but only in holidays. The foregoing

es mainly explained by the presence of sources that generate tones at high frequencies and impulses, such as wild and domestic animals, insects, noise generated by the flow of the San Matias River, agricultural activities, vehicle traffic, and people transit, increasing the LAeq end by 6dB.

3.3 BIOTIC ENVIRONMENT

In the project's area of indirect influence, we observed a prevalence of the clean pastures (CP), followed by the secondary low vegetation (SLV), the secondary high vegetation (SHV), and the arboreal pastures (AP).

As for the project's area of direct influence, the use of the soil tends to be the same as for the IIA, which affects the type of vegetation covering of both areas. For the ADI the coverings are: predominance of clean grass (34.9%) and tree grasses (24.8%), followed by secondary high vegetation (11.2%) and secondary vegetation (10.4%), weeded grass (6.5%), open forest (4.77%), permanent herbaceous crops (1.50 %) and dense *guadua* forests (1.32%)

Regarding the terrestrial fauna, the mammals in particular, we identified three endemic species *Saguinus leucopus* (gray titi monkey), *Proechimys magdalenae* (spiny rat), and *santanderiensis Microsciurus flaviventer* (cusca ardita) and three species categorized as vulnerable: *Saguinus leucopus* (gray titi gray monkey), *Aotus lemurinus* (marteja or night monkey) *Lontra longicaudis* (Otter) and *Leopardus wiedii* (Margay).

Regarding the birds, the base line samplings show that the more bio diverse sites correspond to those with more interconnections and with the more diverse states of successional interconnections (low secondary vegetation, high secondary vegetation, and open forest). This fact highlights the importance of interconnections for the bird fauna. During the studies, we identified two endemic species: *Habia gutturalis* (Habia ahumada) and *Ortalis columbiana* (Colombian guacharaca).

As for the amphibians, most of the species were found to inhabit the coverings with the higher structural complexity, indicating a high availability of shelter, food, breeding areas, and, in general, conditions favorable to the maintenance of populations of this group.

Regarding the presence of fish in the area, we identified only 15 individuals grouped into five species: *Astroblepus homodon* (capitancito), *Hemibricon boquiae* (sardine), *Trichomycterus caliense* (briola), C*haetostoma leucomelas* (Cucho) and *Cordylancistrys sp* (Cucho). **None of the species is migratory**.

Some of the flora species categorized as threatened or included in the CITIES list show today good population sizes inside CORNARE's jurisdiction. According to Agreement 262 dated as of November 22nd, 2011, which declares an undefined ban on some forest species inside CORNARE's jurisdiction, none of the identified species in the region is categorized as threatened.

As for the fauna species, although some are registered as endemic in Colombia they have good population sizes inside CORNARE's jurisdiction (e.g., Saguinus leucopus) and therefore are not threatened in the region.

3.4 SOCIAL ANDECONOMIC ENVIRONMENTS

3.4.1 Demographic aspects

There are nine counties (in Spanish "*veredas*") that will be affected by the El Molino hydroelectric project, representing a combined population, according to the data obtained during field work, of 1,722 people. Of this population, 1,452 live in the municipality of Cocorná and represent only 9.60% of Cocorná's total population (15,119 persons). The remaining 270 people live in the municipality of Granada, representing 2.75% of the municipality total population (9,789 persons). Almost 100% of the population that inhabit the affected *veredas* live under poverty conditions, reflecting the area's harsh conditions.

3.4.2 Spatial Dimension

The urban sectors of both Cocorná and Granada enjoy a high percentage of utilities coverage; On the contrary, in the rural areas the coverage is much lower. This contrast is explained by the high dispersion among the rural homes, which complicates the access to the public services, and by the collective equipment of each one of the *veredas*. Electric power is the big exception: almost 100 per cent of the inhabitants of the area of direct influence, as well as the populations of the rural areas of both municipalities, have access to this service.

Also, in terms of social services such as health and education, the urban sector enjoys a better supply than the rural area; the inhabitants of some *veredas* have to travel to more populated towns or to the urban sector when they require access. Even the *veredas* that offer these services have significant gaps in terms of staffing and infrastructure. It is important to point out, however, that in terms of education, the number of students enrolled in the rural area of Cocorná proves to be greater than the number of students in the urban area.

In regard to the supply of served waters and garbage, the *veredas* do not have access to these services whereas in Cocorná and Granada, the supply of these services is quite precarious.

The municipality of Cocorná has an infrastructure that, in general terms, provides its citizens with the basic health care services (first level of complexity). In Granada, a general ignorance prevails among the communities about the health care services, particularly the complex services, and therefore the potential users do not demand the services. The low demand is also explained by the transport limitations and the lack of economic resources to pay the cost.

3.4.3 Cultural aspects

The inhabitants of the project's area of influence are farmers who, after the end of the forced displacement created by the Colombian armed conflict, have returned to their places of origin and are currently growing cane, banana, coffee, beans, maize, cassava, and citrus fruits. In the *veredas* of the municipality of Granada, the main crops are tomato and cucumber. The cultural traditions of the area's inhabitants correspond to the much broader context of the *paisa* culture (i.e., characteristic to Antioquia), where food, popular festivals or patron saints, labor and productivity to achieve the daily support, family, and religion are critical elements.

3.4.4 Economic aspects

The productive processes of Granada and Cocorná are characterized by a predominance of the agricultural activity, followed by livestock production, and trade. The most representative crops are coffee, sugarcane, and bananas. There are also transitory crops (semi-annual cycle) such as *chonto* tomato, corn, beans, potatoes, carrots, cabbage, and cucumber. It's also important to highlight the relative increase in the growing of fruit trees, a diversifying type of crop. Because of the high unemployment level of these two municipalities, a significative portion of the population usually migrates to other municipalities for work opportunities. Regarding land tenure, there is a prevalence of the small property scheme in the municipalities and in the *veredas* inside the project's area of influence. Under this scheme, farms' size range between one half and three hectares, although some farms may have 20 ha in extension. There is also a prevalence of ownership with payment to others.

Today, the populations of Cocorná and Granada seek to restore their ancient socio-economic and cultural dynamics, following the alleged culmination of a war that affected their economic activities, forcing them to the displacement and the abandonment of their land, and to the adoption of a new way of life in urban and strange contexts, usually in cities such as Cali, Barranquilla, and Bogota.

3.4.5 Political-Administrative dimension

During the last decade, the municipalities of Cocorná and Granada were the stage of a humanitarian tragedy of serious proportions; a territorial armed struggle was developing among the Country's regular forces, two armed fronts from the ELN guerrilla, two fronts from the FARC guerrilla, and three paramilitary fronts.

Following the demobilization process of paramilitary groups started in 2006, which reconfigured the war scenario between the guerrillas and the paramilitaries, and after many years of abandonment of both the urban sector and rural areas of these municipalities, people started to return home, about five years ago, supported by the Department for Social Prosperity and other institutions.

Today, Cocorná and Granada enjoy closer relationships among the municipalities' administrative bodies and also among those bodies and the communities. These relationships are developing outside the scope of traditional political associations. Now, the previous statement does not imply an end to the patronage or sponsorship to political organizations, nor does it mean that these organizations have stopped framing their actions in the traditional bipartisanship.

Regarding the credibility and image of the local institutions, perceptions vary from one municipality to another, as well as among the various entities, whether local, national, or departmental. This situation depends largely on the degree of commitment, performance, and continuity of the officer in duty.

4 IDENTIFICATION AND ASSESSMENT OF IMPACTS

In the qualitative evaluation, we identified 30 potential impacts of the San Matias project: seven in the abiotic environment, six in the biotic environment and 17 in the socio-economic environment, including one with both positive and negative consequences.

Abiotic environment:

- Two out of the seven identified negative impacts were categorized as “irrelevant”: (i) increase in levels of sound pressure (2.2); and (ii) changes to the physical and chemical properties of the soil (1.7) in areas where this latest effect cannot be prevented as the ground will be replaced by a hard surface. Now, although this effect will be compensated by reforestation programs and mitigated with proper management of the excavations made during construction, its low rating is explained by the fact that the affected area is less than 2% of the project’s area of influence.
- Five impacts classified as “moderate” can be prevented or mitigated: (i) increase in the concentration of particulate material (3.1); (ii) changes to the river dynamics (3.8); (ii) changes in the water quality (3,3); and (iii) modification of the landscape (4.1).

  A fifth “moderate” impact is the decrease in water availability (4.5) related to the possible effect that the conduction tunnel may generate on the surface currents located along its alignment. Now, the present EIS describes a program designed to manage the water supply to the communities established alongside the tunnel and that includes the performance of hydrological studies and the design and construction of local aqueducts.

Biotic environment:

- The biotic environment is affected by the greatest negative impact of the El Molino project: Increased pressure on natural resources. This impact was categorized as “relevant” with a rating of 6.65, a grade that nets the positive impacts of the project: improved local transportation as the community will gain access to the forest areas.

  With the construction of access roads to the project’s power house and intake, the population of the area of influence will be able to access more easily the coverings of forest timber such as: Heliocarpusamericanus (white balsum), Cinnamomumtriplinerve (Laurel Perillo), Nectandraspp., Jacaranda copaia (Chingale), Anibacf.Muca(Laurel inciden), Ficus popayanensis (salary), in addition to other with various uses in the area as the palma Euterpe precatoria (palmiche).

  The impact will be mitigated with: (i) environmental education programs aimed at the population of the project’s area of influence; and (ii) joint work between the project’s sponsor and the municipal administrations of Cocorná, Granada, and CORNARE.

- Besides the above mentioned effect, the project generates five additional negative impacts to the Biotic environment, including two categorized as “Irrelevant”: (i) changes to the fish community of the San Matias River (3.3); and (ii) changes to the structure of the aquatic biotope and biocoenosis (4.7). The impacts are mitigated with the establishment of a flow that minimizes ecological changes that may occur at the stretch of the river between the sites of collection and discharge.

  As for the remaining three negative impacts (changes to vegetation 4.3, loss or fragmentation of habitats 4.9, and death and displacement of terrestrial animals 3.4), the environmental management is very much related to the mitigation of changes in the vegetation covering and the establishment of environmental education programs including topics such as management of natural resources.

Socio-economic environment:

- Of the 17 identified impacts, five are positive, including two categorized as "relevant": (i) improved governance; and (ii) modifications to the municipal finance and regional corporations, with ratings of 6.2 and 5.7, respectively. The remaining three positive impacts were categorized as "moderate": (i) increase in the demand for goods and services (3.4); (ii) generation of temporary employment (4.5); and (iii) changes to the local mobility (4.4).

- One impact was regarded both as positive and negative: the effect on the archaeological heritage, an impact categorized as "moderate" with a rating of 3.6. The positive effect is the compliance with the provisions of Act 163 of 1959 and decree 264 of 1963 that demand from hydroelectric projects to perform preventive archeology works to help in the recovery of the knowledge of the early inhabitants of the project's area of influence.

- Eleven impacts were identified as negative, although they are preventable, including:

    a. Two impacts categorized as "Relevant": (i) generation of expectations (5.09); and (ii) generation of problems for the community (5.95). The impacts are explained by the former living conditions in the project's area of influence and the position of some organizations on power generation projects. These two effects can be prevented with the development of an information program, the community participation, and the establishment of environmental education and labor recruitment programs.

    b. Four impacts categorized as "Irrelevant": changes in population dynamics (1.8), pressure on the real estate market (0.8), increases in the risk of accidents (2.2) and variation in the levels of sanitation (1.0).

    c. The remaining five impacts were categorized as "Moderate": effects on economic activities (2,8), effects on the cultural heritage (3.8), strengthening of conflicts (2.6), displacement of infrastructure and housing (3.3),and changes in the uses of the soil (3.3).

For the impacts to the socio-economic, abiotic, and biotic environments, we will execute three programs to prevent or mitigate the project's impacts (i) information and community involvement; (ii) institutional and community strengthening; and (iii) education.

After analyzing the matrix of project's impacts, we identified that the project's operation activities will modify 14 elements of the environment (three of the abiotic environment, two of the biotic environment and nine of the socio-economic environment).

Other potential environmental modifications are expected from: (i) surface excavations, which will modify 12 elements (six to the abiotic environment, four to the biotic environment and two to the socio-economic environment); (i) construction and operation of camps and workshops, which will modify 12 elements (nine to the socio-economic environment, and three to the abiotic environment).

In addition there was an evaluation of the cumulative impacts that would generate the four projects that HMV ENGINEERS have studied in the East side of Antioquia: Popal hydroelectric project (under construction), San Miguel hydroelectric project (licensed), El Molino hydroelectric project (in development of EIA), and San Matias hydroelectric project (in development of EIA).

There was also an economic assessment of the impacts environmental management plan.

5 TO MITIGATE AND PREVENT THE PROJECT'S IMPACT THREE PROGRAMS WILL BE DEVELOPED: INFORMATION AND COMMUNITY INVOLVEMENT, INSTITUTIONAL AND COMMUNITY STRENGTHENING, AND EDUCATION. AN ECONOMIC ASSESSMENT OF THE IMPACTS IS PRESENTED IN SECTION 5 OF THIS DOCUMENT.ENVIRONMENTAL MANAGEMENT PLAN

In the following table it is presented a summary of the Environmental Management Plan and a summary of their costs:

Management plan	Impacts to be managed	Costo ($)
Environmental interjectory group		418.500.000
Environmental management group		476.367.700
Handling and disposal of materials	Increasing of concentration of particulate material and gases Changes in the physical and chemical properties of the soil Landscaping modification	The costs of this project are included in the civil works
Handling of sources of particulate material, gases y noise emissions	Increasing of concentration of particulate material and gases Increasing of the sound pressure levels Potentiation of conflicts Generation of expectations	93.000.000
Handling of liquid residuals	Changes in water quality Decreasing of water availability Alteration of flow dynamics. Changes in the physical and chemical properties of the soil	The costs of this project are included in the civil works
Handling of solid, domestic, industrial and dangerous materials	Increasing in the concentration of particulate material and gases Changes in water quality Decreasing of water availability Changes in the physical and chemical characteristics of the soil Landscape modifications Potentiation of conflicts Generation of nuisances to the community Variation in sanitary levels	109.000.000
Estimate of the flow of environmental guarantee	Changes of flow dynamics Changes on the ichthyic community of the river San Matias Changes in the structure of the biotope and biocenosis aquatic	The costs are included in the economic analysis of the project
Water supply to the people settled along the path of the conducting tunnel o	Changes on the quality and availability of water Potentiation of conflicts Generation of expectatives Generation of nuisances to the community	680.000.000

Management plan	Impacts to be managed	Costo ($)
Handling of vegetal coverage and bare soil.		12.995.000
Flora rescue	Changes on the vegetal coverage Pressure increasing on natural resources	77.088.430
Compensation for allocation to woodland coverage - biological corridor conformation	Changes on the vegetal coverage Loss or fragmentation of habits Pressure increasing on natural resources	456.201.400
Study of terrestrial vertebrate fauna	Loss or fragmentation of habits Death and displacement of terrestrial fauna Pressure increasing on natural resources	323.450.000
Management strategy of aquatic ecosystems	Changes of flow dynamics Changes on the ichthyic community of the river San Matias Changes in the structure of the biotope and biocenosis aquatic	92.775.000
Information and communitarian participation	All the identified impacts.	61.070.000
Environmental Education for the labor force	Affectation of cultural heritage Potentiation of conflicts Changes on population dynamic Increasing on the demand of goods and services Variation in sanitary levels	59.520.000
Environmental Education for the community		
Environmental Education Project	Generation of expectatives Generation of nuisances to the community Potentiation of conflicts Increasing in concentration of particulate material and gases. Increasing on sound pressure levels. Changes on water quality Changes on the vegetal coverage Death and displacement of terrestrial fauna Pressure increasing on natural resources	135.300.000
Reading and writing Project for adults		32.400.000
Institutional and communitarian Strengthening	Generation of expectatives. Generation of temporal employment. Changes on local mobility. Increasing on the demand of goods and services Modification of the municipal and the environmental corporations finances Changes on the governability level Affectation of cultural heritage. Potentiation of conflict Variation in sanitary levels	40.000.000
Relocation of infrastructure and housing	Displacement of infrastructure and housing Changes on population dynamic Generation of expectatives. Potentiation of conflicts. Affectation of economic activities.	203.009.000

Management plan	Impacts to be managed	Costo ($)
	Generation of nuisances to the community.	
Hiring of labor force	Generation of expectatives Generation of temporal employment Affectation of economic activities Generation of nuisances to the community Potentiation of conflicts Displacement of infrastructure and housing.	The costs are included in the management environment plan
Reestablishment of economic conditions	Generation of expectatives. Changes on local mobility. Displacement of infrastructure and housing Affectation of economic activities Generation of nuisances to the community Changes on the uses of soil	42.000.000
Rural Entrepreneurship	Generation of expectatives. Potentiation of conflicts. Changes on population dynamic. Increasing on the demand of goods and services Affectation of economic activities. Changes of employment level. Displacement of infrastructure and housing. Affectation of cultural heritage.	359.500.000
Memory and cultural heritage	Generation of expectatives. Affectation of cultural heritage. Changes on local mobility. Displacement of infrastructure and housing Pressure on the real estate market Generation of nuisances to the community. Affectation of cultural heritage	37.200.000
Restitution of affected infrastructure	Affectation of cultural heritage Potentiation of conflicts. Damages caused to third parties Generation of expectatives	The costs are included in the management environment plan and in the civil work
Archeological rescue and disclosure	Affectation of cultural heritage	180.950.000
Plan of monitoring and follow up		308.677.800
Contingency plan		303.570.000
Total		**4.502.574.330**

6 FOLLOW UP AND MONITORING PLAN

In the following table it is presented the programs of monitoring and follow-up and a summary of the costs.

Programs	Costs ($)
Monitoring of residual waters	31.548.800
Monitoring of superficial waters	64.545.600
Monitoring of benthic communities	25.200.000
Monitoring of quality of air and noise	128.000.000

Monitoring of ichthyic fauna	16.200.000
Monitoring of terrestrial habitat	30.733.400
Monitoring of social environment	12.450.000
Total	**308.677.800**

7 CONTINGENCY PLAN

The general criteria of the Contingency Plan that are presented must be specified and detailed by the constructor and the owner of the project, in the stages of construction and operation respectively, depending on how it is organized to develop the activities of the focused

To evaluate the contingency are used the criteria of menace, vulnerability and risk, which are defined as follows:

- Menace. It is understood as the probability of occurrence of the phenomenon, with certain intensity and potentially harmful to people, property, infrastructure, or the environment, within a specific period of time and in a geographically limited area.
- Vulnerability. Degree of loss or damage to an item or group of elements at risk, as a result of a likely occurrence of a disastrous event.
- Risk. Destruction or expected loss obtained from the convolution of the threat or probability of occurrence of hazardous events and the vulnerability of the exposed elements to such threats; mathematically is expressed as the probability of exceeding a level of economic and social consequences in a certain site, in a certain period. Principio del formulario

For the risk assessment was used the methodology raised by Arboleda and Zuluaga that define the risk such as:

$$R = A \times V = P \times I \text{ , where}$$

- R = Qualitative value of the risk.
- P = Probability of occurrence of a threat = A.
- I= Intensity and severity of potential consequences V.

And establishes the following classification

- Acceptable Risk (1-4), which do not represent a significant threat to the environment and their consequences are minor.
- Tolerable risk (5-9), which are those that can cause more significant damage to the environment, thus requiring the design of care plans.
- Critical Risk (10-20), which can result in serious damage on the environment and require priority care plans and in the short term, with high availability of resources and with an intense monitoring.

In the hydroelectric project in San Matias the identified events are classified as follows:

- Acceptable risks. In this category were classified contingencies generated by flood, earthquake, Failure of the tunnel driving, fire.

- Acceptable risks. In this category were classified contingencies generated by flood, earthquake, Failure of the conducting tunnel, fire.
- Critical Risk: Are associated events associated with public order

The previous rating served to design the programs of the attention to these events..