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TUNJITA HYDROELECTRIC PLANT – COLOMBIA

Figure 01: Machine house under construction
Source: Fotos AES Chivor

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Tunjita Hydroelectric Plant, Colombia

1. PROJECT DESCRIPTION & LOCATION

The Tunjita River Diversion Hydroelectric Project is spearheaded by AES Chivor, a major Colombian power company. Contractors broke ground on the project in 2012 and expect this $80 million plant to be fully operational by the first half of 2015. AES Chivor and its antecedent companies have decades of experience managing South American hydroelectric projects, including the Chivor Hydroelectric Plant, a larger sister facility completed in 1982. Engineers are leveraging Chivor's existing technical infrastructure, enabling them to control remotely much of the Tunjita Plant.

Power plant machinery will be sited in a new facility at the confluence of the Tunjita and Garagoa rivers. While only 100 km due northeast of Bogota, this is a predominantly rural area. As much of the required civil structures were built in the 1980s, concomitant with the erection of the nearby Esmeralda Reservoir, the scope of construction has been limited. Two Francis type hydraulic turbines will bring online an estimated 20 MW, or about 110 GWh/yr, supplementing the 1,000 MW currently generated by the Chivor plant. This 20 MW output compares favorably with Colombia's nine other small-scale hydro facilities.

A total budget of $60 million will be required to meet all project specifications. Apart from the turbines and turbine housing, these include dam modifications, tunnel improvements, and ancillary construction. Installation of the former will occupy the entire two year construction timetable. Fortification of the dam, chiefly to accommodate a one meter rise in water level, began midway through the project. Flow tests are expected to take up the final project month, concluding in 2015. AES Chivor will by then have laid down the 1.5 km of transmission line necessary to connect the plant to the National Interconnected Network (NIS), so power can be immediately introduced into the grid.

Proximity to key energy infrastructure such as NIS has served to substantially reduce development costs. As a catchment reservoir and adjacent water-control structures are already built, greenfield construction is substantially less than typically required in a hydroelectric project. Upgrades to these systems have therefore been able to proceed synergistically with new construction. The dam at which the Tunjita and Garagoa Rivers converge is located less than three kilometers from the Esmeralda Reservoir, so contractors have been able to easily work in parallel on all aspects of installation.

The biggest challenge involved in the project, rather than rerouting rivers or flooding valleys (colossal undertakings often required for hydropower projects), has been adding one meter to the water level at Esmeralda Reservoir. Contractors have focused on a range of additional issues, including: creating access roads to intervention points, reinforcing the diversion tunnel running from the machine house to the reservoir, bolstering the dam above the machine house, and constructing the machine house and neighboring above-ground equipment upon which it relies.

AES Chivor has worked closely with the United Nations Framework Convention on Climate Change (UNFCCC) as well as the Colombian Ministry of Environment, Housing and Territorial Development (MAVDT) to ensure that the project is sustainably planned and executed. The company has an internal protocol, the Integrated Safety and Environmental Management System, to advance best practice at all levels of project execution. As part of this protocol, a comprehensive environmental impacts study was carried out in advance of the project. Environmentally sensitive points identified therein are being monitored accordingly. Ultimately, little vegetation or animal life will be affected by construction, and project impacts should be minimal. Even the carbon footprint of construction activities will be rapidly offset by the completed plant, which is estimated to offset the emission of

over 30,000 tons of CO_2 each year.

Project managers have also crafted a Social Management Plan (SMP) to be implemented during construction. The SMP specifies how project execution will meet and exceed the Colombian government's Millennium Objectives, which address the social impacts of development initiatives. Four key focus areas inspired by the SMP include: providing educational opportunities for neighboring communities, facilitating local business development, supporting the most vulnerable sectors of the population, and creating jobs for local workers. Significant attention has been paid to these focus areas, and regional support runs high for both AES Chivor and the Tunjita Plant.

2. APPLICATION OF THE ENVISION RATING SYSTEM

The EnvisionTM system is a set of guidelines that aid in optimizing the sustainability of an infrastructure project during the planning and preliminary design phases, as well as a means to quantify the relative sustainability of the project. In this case study, the infrastructure to be assessed is the Tunjita Hydroelectric Project.

Envision consists of 60 credits grouped into five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. Each credit pertains to a specific indicator of sustainability such as reducing energy use, preserving natural habitat, or reducing greenhouse gas emissions. Those credits are rated on a five-point scale referred to as a 'level of achievement': 'improved', 'enhanced', 'superior', 'conserving', and 'restorative'. Evaluation criteria are provided to determine if the qualifications for each level of achievement have been met for a particular credit. In each of the five categories there is a specific credit called "Innovate or exceed credit requirements". This is an opportunity to reward exceptional performance that applies innovative methods within the subjects that Envision evaluates.

The criteria for the levels of achievement vary from credit to credit, but generally an 'improved' level of achievement is awarded for performance that slightly exceeds regulatory requirements. 'Enhanced' and 'superior' levels indicate additional gradual improvement, while 'conserving' often indicates performance that achieves a net-zero or neutral impact. 'Restorative' is the highest level and is typically reserved for projects that produce an overall net positive impact. The Envision system weighs the relative value of each credit and level of achievement by assigning points. Credit criteria are documented in the Envision Guidance Manual, which is available to the public on the ISI[1] and Zofnass Program[2] websites.

3. QUALITY OF LIFE CATEGORY

Envision's first category, Quality of Life, pertains to potential project impacts on surrounding communities and their respective wellbeing. More specifically, it distinguishes infrastructure projects that are in line with community goals, clearly established as parts of existing community networks, as well as consider the long-term community benefits and aspirations. Quality of Life incorporates guidance related to community capacity building and promotes infrastructure users and local members as important stakeholders in the decision making process. The category is further divided into three sub-categories: Purpose, Community, and Wellbeing.

[1] www.sustainableinfrastructure.org
[2] www.zofnass.org

Purpose

The Tunjita Plant exhibits a highly synergistic relationship with pre-existing AES Chivor assets. Indeed, project developers could count on a dam, reservoir, electromechanical control systems, and highly trained staff - all within a kilometer of the site. Simple upgrades to these systems, in conjunction with installation of a machine house, have sufficed to make the plant a reality. This low level of intervention means costs can be controlled to a degree seldom seen in hydroelectric projects. The construction timeline is also substantially reduced: just over three years are required to go from nothing to energy production. Finally, as the National Grid extends to within 1.5 kilometers of the site, minimal disruption of forest cover is required to bring the energy online.

The Tunjita Plant will thus in short order join the dozens of hydroelectric plants supplying power to Colombia's national grid. This bolsters Colombia's energy independence and also should serve as a source of national pride; by leveraging a naturally moist climate, Colombians have managed to raise the renewable-sourced portion of their energy matrix to a level rivaling rich European states.

The local employment landscape also benefits as Colombia builds its clean energy credentials. Over 500 people from the nearby communities have been hired to upgrade facilities in and around the Tunjita dam. Ultimately, more than 900 locals will participate in construction. Nearly 3/4 of the total work force will indeed derive from towns in the region. These local workers dovetail into AES Chivor's Social Management Plan (SMP), which specifies how project execution will meet and exceed the Colombian government's Millennium Objectives. The four focus areas described within the SMP include: providing educational opportunities for neighboring communities, facilitating local business development, supporting the most vulnerable sectors of the population, and creating jobs.

Community

The Tunjita project is notable for its minimal footprint. The Colombian Institute for Rural Development has certified that no indigenous or Afro-Colombian peoples reside near the project site. In fact, only one structure - a small monitoring house belonging to AES Chivor - will be affected by the construction activities. The project is sited in a rural area, given primarily to pasture for grazing and subsistence farming, where forest cover does break, and hence it is unlikely that settlements will push against the project footprint or compete for resources.

Project managers still made a diligent effort to involve people from neighboring towns in the development process. In 2010, well-attended meetings were held in the towns of Garagoa and Macanal. Community members weighed in on development decisions and asked a multitude of questions about ways in which development might affect them. A telephone hotline was created for those with questions or comments about the project subsequent to these meetings. This level of outreach succeeded in winning broad local support.

Locals who secured employment on site have benefited from prioritization of worker safety. AES Chivor and its primary contractor, Coninsa Ramon, conduct operations in accordance with strict safety and wellness protocols, such as the *Health Plan and Security Guide*. A clinic, cafeteria, and dormitories, among other structures, have been brought on site, in addition to the typical project office. Out of respect for those living nearby, concerted efforts have been made to curtail light and noise pollution, as well as vibration from heavy machinery. In summation, community members can expect to benefit from the project in tangible terms from the short term through to the long term: more and better jobs will be created, pollution of all kinds will be kept to an absolute minimum, and ultimately the project site will become a scenic destination.

Wellbeing

Community wellbeing will be bolstered in large part due to the creative reuse of excavated dirt, which will be stacked and sculpted into a scenic overlook. This overlook is positioned above the dam and with dramatic sightlines over the Esmeralda Reservoir. It is conceivable that this outlook become a destination not just for locals but tourists from abroad. Few large scale infrastructure projects are carried out in such a way as to be visit-worthy, but the Tunjita Plant and broader Chivor Site look to prove an exception. The outlook mound and surrounding dirt are slated to be revegetated with indigenous plants immediately following conclusion of construction activities. This will serve to minimize erosion and restore habitat for displaced flora and fauna. No pesticide or fertilizer will be used. And as vegetation grows at a fast rate in this climate, locals can expect the return of a verdant landscape by the end of 2015.

Apart from this outlook, locals will be grateful for the judicious project footprint. A machine house at the base of the dam will be the only permanent visual record of construction. Minimal logging and minimal construction mean minimal disruption of the natural landscape, not to mention a reduced project timetable. Chivor's Environmental Management Plan stipulates many additional environmental safeguards. For instance, all materials purchased for the machine house and diversion tunnel must be of high quality and not contain possible contaminants. A thorough recycling program helps ensure that construction materials not go to waste. Everything has been built to last for at least 50 years.

Alternative modes of transportation are unfortunately not available in the area, due to its remoteness. Unpaved, steep dirt roads make cycling difficult. Project managers should therefore not be faulted for the primacy of vehicular transport in site access. In any case, employing chiefly local labor ensures that transportation distances are below what they might be, were foreign or long-distance work crews selected instead. In any case, AES Chivor has diligently sought to accommodate local labor and avoid exclusionary practices in its hiring.

4. LEADERSHIP CATEGORY

Leadership evaluates project team initiatives that establish communication and collaboration strategies early on, with the ultimate objective of achieving sustainable performance. Envision rewards stakeholder engagement as well as encompassing a holistic, long-term view of the project's life-cycle. Leadership is distributed into three sub-categories: Collaboration, Management, and Planning.

Collaboration

Project managers has been diligent in soliciting and providing channels for stakeholder collaboration. To begin, managers were in contact with the Colombian Institute for Rural Development, which advocates for the rights of indigenous peoples. A set of stakeholder meetings were held in the nearby towns of Macanal and Garagoa, with interested community members being the primary audience. Proceedings were thoroughly documented, and concerns and questions raised by locals were addressed by project managers. Community members who would still like to comment or inquire about the process have access to a project hotline, as well as a physical office.

On the governmental end, trimestral meetings are held with four different entities: the Ministry of the Environment and Sustainable Development, the National Environmental License Authority, the Chivor Autonomous Regional Corporation, and the Ministry of Mining and Energy. This ensures that regulators and officials have access to current and relevant information about project progress. Finally, AES Chivor has admirably constructed their organization hierarchy, integrating internal team members as well as representatives from their contractor,

Coninsa Ramon, and a Construction Management Team (CMT). Lines of authority and accountability are enhanced through this fine-grained focus on collaboration procedure. Frequent issuance of reports, in addition to monthly cross-team meetings, precipitates dissemination of up-to-date information and best practice.

Management

Managers at AES Chivor have demonstrated strong environmental leadership throughout the planning and construction process. Active measures have gone beyond what is required by law. Apart from complying with the Colombian Ministry of Environment, Housing and Territorial Development's environmental protocols, leaders have systematically implemented plans to reduce deforestation, noise pollution, overlighting, and contractor overreach. Outreach to community members, up to and including the hiring of local labor, further bolsters the project's leadership credentials. Developer commitment to reuse of existing infrastructure, rather than construction of new alternatives, should also be applauded.

AES Chivor has furthermore shown a laudable public commitment to sustainability. The company was admitted to the exclusive United Nations Global Compact, an intensive corporate responsibility initiative. This requires that they be actively engaged in implementing best practices - socially, environmentally, and beyond - across their organization. Project managers have taken the lead in publicizing and promoting clean energy in national publications. Even the company website is filled with content about the features and benefits of their clean energy projects, including the work done at Tunjita.

Managers have placed substantial emphasis on sustainability management systems. AES Chivor not only has general internal sustainability guidelines, but Tunjita-specific protocols in place as well. In the roles and responsibilities of the Tunjita project organizational chart is embedded a systematic focus on sustainable practice implementation. This is evidenced by titles such as *Environmental Analyst, Environmental Director,* and *Environmental and Safety Manager*. Such experts have ensured that best practices have been adopted systematically throughout the project, from initial planning to execution.

Planning

Project managers have created a set of plans outlining goals along many dimensions, including assurance of health and safety. To ensure all employees deliver on these goals, monthly meetings are held wherein progress is assessed and areas for improvement are identified. Weekly reports are issued wherein this progress is recorded and tracked. Branches within the project management team focus on monitoring and compliance with environmental and safety regulations. There is also a risk sharing mechanism in place with the primary contractor. Financial and legal penalties will follow incomplete compliance with the terms of the arrangement. Conversely, there are incentives to reward project personnel diligent in maintaining full compliance.

Planning extends to long-term monitoring and maintenance of the Tunjita Plant as well. One plan specifies the monitoring and maintenance operations to take place, the units charged with carrying out these duties, as well the funds required. As Tunjita functions as an arm of the Chivor plant, all of the personnel required to carry out the plan are already on the job and ready to execute these responsibilities.

Planners have rated the Tunjita Plant to produce power for 50 years. Project documents stipulate that the plant be designed according to high technical standards and that only high quality materials be used in construction. As so much capital has been invested in creating the associated hydropower infrastructure, however, its owners will likely update and run the plant beyond the current machinery's rated longevity. That AES Chivor has a history of responsibly maintaining and upgrading their systems increases the likelihood of an extended-life outcome for the

project.

5. RESOURCE ALLOCATION CATEGORY

Resource allocation deals with material, energy, and water requirements during the construction and operation phases of infrastructure projects. The quantity and source of these elements, as well as their impact on overall sustainability, is investigated throughout this section of the Envision rating system. Envision guides teams to choose less toxic materials and promotes renewable energy resources. Resource Allocation is divided into three subcategories: Materials, Energy, and Water.

Materials

In spite of having limited sourcing options for equipment being installed, AES Chivor has systematically endeavored to acquire the most sustainable variants available. Particular attention has been placed on the procurement practices of the primary site contractor, Coninsa Ramón, which holds Environment Management Systems ISO 14001:2004 certification. This international licensure enforces a methodical approach to sustainable construction practices. An example of this sustainable procurement focus is the choice of cement and concrete supplier, Argos. The environmental performance of this multinational is recognized in the Dow Jones World Sustainability Index.

Recycled materials have been used throughout the project. All dirt and gravel used in construction, for instance, is reclaimed from initial excavation activities. The remainder has been left on-site, and will shortly be reshaped into a permanent landmass. Most will be dedicated to a creating a substantial hill with scenic views of the entire complex. Thorough policies are in place for the collection, storage, reuse, and/or sale of non-dirt waste on site.

The project's support structures, such as a medical center, office, and dining hall, are all dismantlable and reusable. They will be redeployed at other sites following completion of work at Tunjita. Mission critical structures, most importantly the machine house, have been designed with longevity in mind. This focus on structure quality means that emissions-intensive replacements and repairs, or worse yet premature failure, are far less of a liability. While it is impossible to fully de-risk infrastructure projects, the thoughtful deployment of materials - as evidenced at Tunjita - is a major step toward creating a renewable energy infrastructure upon which Colombians can rely for decades to come.

Energy

Contractors have taken steps to reduce energy consumption during construction, including minimizing use of lighting and erecting reusable temporary housing stock. While no renewable energy sources per se were used to power construction, energy was drawn primarily from Colombia's national grid, which itself derives 70%+ from renewable sources.

The plant will be a net positive renewable energy source as soon as it comes online. It will draw from its own energy, about 8,000 kWh/mo, to power itself. The remainder of the energy is to be directed into the national grid. This means about 20 MW of clean, emissions-free energy will be generated, totaling to over 110 GWh per year.

In the future, AES Chivor should expect to benefit from performing an embodied energy assessment with respect to procurement practices, which was not carried out in the the case of Tunjita. While these assessments do require a fair amount of effort to complete, they offer unprecedented insight into the actual environmental impact of the work under consideration.

Water

Hyper-local hydrological conditions have been monitored for the past 35 years by AES Chivor. Much of their data are drawn from meteorological stations run by the Colombian Institute of Hydrology, Meteorology, and Environmental Studies (IHMEAC). This fine-grained understanding of local waterways, precipitation, and other hydrological phenomena allows prediction of water conditions at Tunjita with a high degree of certainty. The dam being upgraded allows control of water flow rate, so water can be metered at the appropriate rate given these predictions. The machine house is accordingly equipped with a diverse array of equipment and software to monitor and meter water. The region surrounding Tunjita is very moist, with an average precipitation in excess of 1.5 meters annually, so flow rates should consistently remain high.

Policies are in place to monitor and minimize water usage during construction. The aforestated water management policies are expected to decrease water consumption by 5% from non-intervention levels. The machine house will use very little potable water, so no substantive effort to curtail this nominal usage was deemed necessary. Independent contractors, including Asafranco Ltd., have been retained to evaluate the performance of water management systems as well as water quality. Many in-flowing streams are already monitored for water quality by AES Chivor.

Once the Tunjita project is complete in 2015, overall water control capability will be far in excess of previous capabilities. The Esmeralda Reservoir will have an additional meter of capacity, the dam will be reinforced, and the diversion tunnel will get upgraded. AES Chivor's ability to handle adverse conditions, in particular extreme hydrological events such as flooding, will consequently be much improved. It is still recommended that project managers attend more assiduously to the quality of water being handled by these systems, and especially if and how it might be improved.

6. NATURAL WORLD CATEGORY

Natural World focuses on how infrastructure projects may impact natural systems and promotes opportunities for positive synergistic effects. Envision encourages strategies for conservation and distinguishes projects with a focus on enhancing surrounding natural systems. Natural World is further divided into three sub-categories: Siting, Land and Water, and Biodiversity.

Siting

No zones within or adjacent to the Tunjita project site qualify as prime habitat, and as a result the project avoids development in this areas. The surrounding soil is of poor quality, and when used at all by locals, it tends to be for the purposes of animal grazing rather than agriculture. Nevertheless, the vast majority of land within the project site will remain undisturbed. It is a credit to developers that forest cover will be preserved nearly in its entirety.

Geological conditions in the area have been studied extensively by AES Chivor. Three studies in particular - *Environmental Management Plan, Evaluation of Erosive Activity and Geological Threats of the Chivor Watershed, and Evaluation of Geology, Geomorphology and Chivor Facility Risk Areas* - have informed construction-related decision making. The former plan stipulates operating procedures in accordance with these geological conditions and concomitant risks. This is a tectonically stable area and overall risk levels are assessed as low.

As far as siting vis-a-vis water is concerned, the machine house has been constructed at 1282 meters above sea level and five meters above the maximum reservoir level of 1277 meters. In spite of being above floodplain levels,

impervious surfaces have been kept to a minimum. Post-construction landscaping and revegetation of the adjacent land further enhances site performance under flooding conditions.

Land & water

Stormwater management has been a priority throughout the development process. Excavation has been conducted with stormwater flow in mind, and post-construction landscaping will likewise be carried out to better control flow. The Chivor reservoir is also being upgraded so as to accommodate a one meter water level increase. Ultimately, A 90% water storage/retention rate is expected.

In terms of affecting land and water quality, no pesticides or fertilizers will be applied at the project site. Species to be planted are all indigenous and hardy, and hence do not require chemicals to grow in the area. This means runoff will not lead to a deterioration in water quality or conditions for aquatic life. Indeed, AES Chivor's purchasing policies prioritize non-polluting substances that will not lead to contamination, even in the case of accidental release. To that point, plans have been drafted to ensure an effective response to spills and leaks. The machine house has been designed with leak risk mitigation in mind.

Biodiversity

Project managers have worked to identify and protect habitat and biodiversity. This is a highly biodiverse region, with the nearest nature preserve located only four km away. Biodiversity will be maintained due to the landscaping and revegetation initiatives to be conducted upon construction completion. As mentioned before, the vast majority of the project land not be disturbed by contractors, meaning there is minimum net habitat loss to begin with. Furthermore, signage has been posted on nearby roads warning motorists that they are entering a wildlife corridor. There ought to be minimal traffic surrounding the site, however, once machine house and diversion tunnel assembly are concluded. In sum, habitat surrounding the dam will quickly be restored to pre-intervention levels.

Plant species to be planted post-construction are all indigenous to the region. No noxious weeds, pesticides, or fertilizers will be used to expedite revegetation. Invasive species control has not therefore factored into decision-making or environmental management plans.

7. CLIMATE & RISK CATEGORY

Envision aims to promote infrastructure development that are sensitive to long-term climate disturbances. Climate and Risk focuses on avoiding direct and indirect contributions to greenhouse gas emissions, as well as promotes mitigation and adaptation actions to ensure short and long term resilience to hazards. Climate and Risk is further divided into two sub-categories: Emissions and Resilience.

Emissions

This project will contribute to the greenhouse gases reduction (GHG) emission reductions, providing renewable energy for Colombia. An estimation of the carbon reduction has been conducted in the (CDM PDD).[3]Project managers estimate that about 32,000 tons of CO2 emissions will be avoided each year the plant runs2, though this estimate is not related to the carbon consumption or emissions released during construction. While project team took myriad steps to reduce the carbon footprint of construction activities. For instance, minimizing logging and

[3] *"PROJECT DESIGN DOCUMENT FORM (CDM PDD)", November 6, 2014, 30-41.*

excavation, as well as recycling unused materials on site, served to reduce the energy demands of development. It is also worth noting that, thanks to leveraging pre-existing site infrastructure; the Tunjita project is expected to require a total of just over three years to reach completion, which is significantly less than the timeframe implicated in most hydroelectric projects. Reducing the time on site of course also limits the online time of polluting heavy machinery.

The construction activities complied with Colombia's air quality law - Resolution 0610. The pollutants controlled by the Colombian regulations are: particulates, ozone, carbon monoxide, sulfur oxides, nitrogen oxides.

Resilience

The project team has worked hand-in-hand with local communities to build a comprehensive action plan that accounts for long-term costs and risks. Resource depletion and infrastructure traps have been assessed. Residents in the adjacent towns of Garagoa and Macanal met in town hall meetings with the project team to discuss project vision and air concerns. A project hotline was established to provide a simple and transparent means of communication and collaboration for all stakeholders. Project risks were incorporated into the latest contingency plan, which is updated every five years to reflect the current risk landscape.

Furthermore, AES Chivor has rigorously prepared for one in 50 year hazards. Their Emergency and Environmental Contingency Plan outlines in detail possible threats faced by the facility, including landslides, floods, dam breaches, and electromechanical failure, among others. Threat-specific responses are described in each case. Facility employees will be familiarized with these threats and response protocols. In summation, project managers have worked to achieve a resilient power plant - and one with a well-elaborated safety program to be observed by plant employees. This focus on safety guidelines for employees is laudable, as most power plant accidents arise from human rather than mechanical error.

8. SUMMARY AND CONCLUSION

The Tunjita Small Hydroelectric Plant, or PCH Tunjita, entered its planning stage in the spring of 2009. A project team at AES Chivor, an energy multinational with strong roots in Colombia, was assembled to assess plant development options and corresponding impacts. The team's job was made easier by the propitious location of the envisioned dam: the Department of Boyaca, a rural area some 100 km northeast of Bogota, Colombia's capital city. Here, AES Chivor was already managing the Esmeralda Reservoir as well as the Chivor Hydroelectric Plant. The Chivor plant is massive, outputting some 1,000 MW, and it long ago demanded the construction of powerful control facilities as well as the onboarding of knowledgeable staff. These assets, among myriad other civil structures erected by an antecedent company, made the planning process far less complex - and capital intensive - than it might otherwise have been.

Planning activities ran through 2012. Project managers evaluated in high resolution all aspects of the process. They ensured that the new development would not impinge on land inhabited by indigenous or Afro-Colombian communities. They looked at the various turbines that might be installed and how the turbine housing could best accommodate them. Potential environmental impacts ranging from water pollution to logging to vehicle emissions were predicted. Once it became clear that a plant was both desirable and realizable, work began to draft a comprehensive set of project guidelines and protocols.

An organizational hierarchy was described, involving a general contractor and subcontractors, in addition to AES Chivor's team members. This chart has been one of the greatest strengths of the Tunjita project. Lines of authority and accountability are clear, and frequent meetings with stakeholders both inside and outside the team as well as

reports assessing progress serve to keep the effort on budget and on time. Commitment to implementation of best practice surrounding sustainability is evidenced by org chart titles such as *Environmental Analyst, Environmental Director,* and *Environmental and Safety Manager.*

A timeline was one of the first documents to be drafted by the project team. Machine house construction is the one near-constant: construction on it began month one, and should only stop on month 23, one month short of project completion. Tubing and diversion tunnel upgrades began about mid-way through, and should likewise culminate about one month shy of completion. The final month, in the spring of 2015, will be occupied by water tests to calibrate instrumentation and finalize standard operating procedures.

Another of the key documents governing project execution has been the *Record of Environmental Management*. Coninsa Ramon, the general contractor on site, was primarily responsible for drafting and implementing the document, which outlines policies for reducing vehicle emissions, erosion, concrete consumption, construction waste, and myriad other impacts. The document is notable for its attention to detail: specific steps are outlined for the mitigation of each impact type. For instance, erosion is combated through a series of six steps including swales, landscaping, and rapid revegetation.

The machine house, centerpiece of the Tunjita Plant, is as of December 2014 nearing completion. It is occupied by two Francis type hydraulic turbines, putting out a combined 19.8 MW, or 113 GWh per year. The turbines can collectively process 8 m^3 of river water each second. It is sited at 1282 meters above sea level, five meters above the maximum reservoir level of 1277 meters. Electromechanical systems have been designed to allow for virtually full remote operation of the plant. This is advantageous in that it lowers the amount of habitable volume needed to accommodate employees, and ought also boost the efficiency of engineers at the Chivor facility, who should be able to oversee Tunjita plant data - including flow rates and electricity generation - without needing to leave their desks. While the scale of the machine house is comparatively small, it has permitted rapid development on site, and facilitates the ease of fine-tuning and monitoring.

Project managers took care to design the facility to withstand one in 50 year events, including landslides, flooding, and chemical spills. The facility's small scale also means that it involves less embodied energy than projects of a similar type. To that point, project managers have worked to reduce the carbon footprint not just of the machine house, but of all construction activity across the project site. Indeed, few carbon stones have been left unturned. Purchasing protocols favor local businesses and products designed with longevity in mind. Recycling opportunities have been aggressively pursued, both on the input and output side. Special zones have been designated for leftover materials which can be resold or reused. Even dirt displaced by initial excavation has been set aside for reintegration.

Soil management is in fact one of the most remarkable aspects of the Tunjita project. While some soils will be reintegrated in and around the machine house and dam landmass, much will remain. Rather than dump it locally or dispose of it off-site, project managers decided that it could be consolidated into a mound overlooking the dam. This will create a scenic outlook with views of the entire reservoir. Such a design decision has changed the leftover soil from a liability to an asset, creating what may prove to be a point of pride for the community and possible destination for tourists.

To ensure that the soil does not run off into the stream or reservoir, contractors have been proactive in landscaping it into masses with low gradients less conducive to erosion. Planting and revegetation begins immediately following the sculpting of the earth. The growth of plant life improves resilience of earthworks and also promotes the return of biodiversity. The dam is fortunate to exist in the midst of a highly biodiverse zone. Restoring vegetation provides habitat for the animals and plant life that have been displaced by construction activities. There is no doubt that many on the project team and in the local community eagerly anticipate this scenic outlook's return to nature.

In summary, AES Chivor has admirably leveraged surrounding infrastructure. Rather than waste an opportunity to harvest energy from a pre-existing dam, they have proactively developed a small scale hydroelectric facility that

will bequeath energy and jobs to Colombians for decades to come. Community approval of the project runs high, and it is no wonder why. Project managers have actively involved all stakeholders, from project investors to concerned citizens from the planning stages to the final steps of execution. The result will be minimally disruptive to the natural environment but maximally impactful in terms of energy generation. The Tunjita project goes a long way toward demonstrating to policymakers, not just in Colombia but around the world, that small scale hydro facilities can be both practical and cost effective.

In closing, the Tunjita project provides an example of the extraordinary synergies that can be realized when developers collaborate with Envision. Project managers at AES Chivor interfaced with researchers at the Zofnass Program to provide data regarding the five dimensions along which projects are rated: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. In the process, both parties achieved a more rich and finely-tuned understanding of the environmental principles at play. For instance, Envision scores indicate that leadership is a notable strength at AES Chivor. The rigorous Environmental Management Plan drafted by project managers, in combination with a well thought-out organization chart, have secured superior results on a number of metrics, from teamwork and collaboration to infrastructure integration. On the other hand, Envision scoring suggests areas for improvement, with a special focus on low-hanging fruit. The Climate and Risk category in particular offers several credits whose thrust project managers might consider in greater detail in their next projects. Quantitative emissions accounting as well as plans for short- and long-term hazards will empower and better prepare developers to deal with unforeseen circumstances. A more measured approach regarding the monitoring and maintenance of water quality should also help put locals' minds more at ease. Investors should likewise appreciate a greater emphasis on data-centric due diligence. While not every credit can be achieved through focus on number-crunching and data - project location in particular is a hard constraint - this is an excellent area on which to place additional effort. The battle to implement best practice in sustainable infrastructure is indeed hard and long, but it is a worthy one whose benefits disburse across time and constituency.

This report evaluates the sustainability performance of the Tunjita Hydroelectric Plant project according to the Envision™ Rating System. The report identifies areas in which the project scored highly, as well as low-scoring areas that represent opportunities for which the project team can learn and improve on in future projects, as they strive to achieve sustainable project design and construction methodologies.

APPENDIX:
APPENDIX A: PROJECT PICTURES AND DRAWINGS

Figure 02: View from above machine house
Source: Fotos AES Chivor

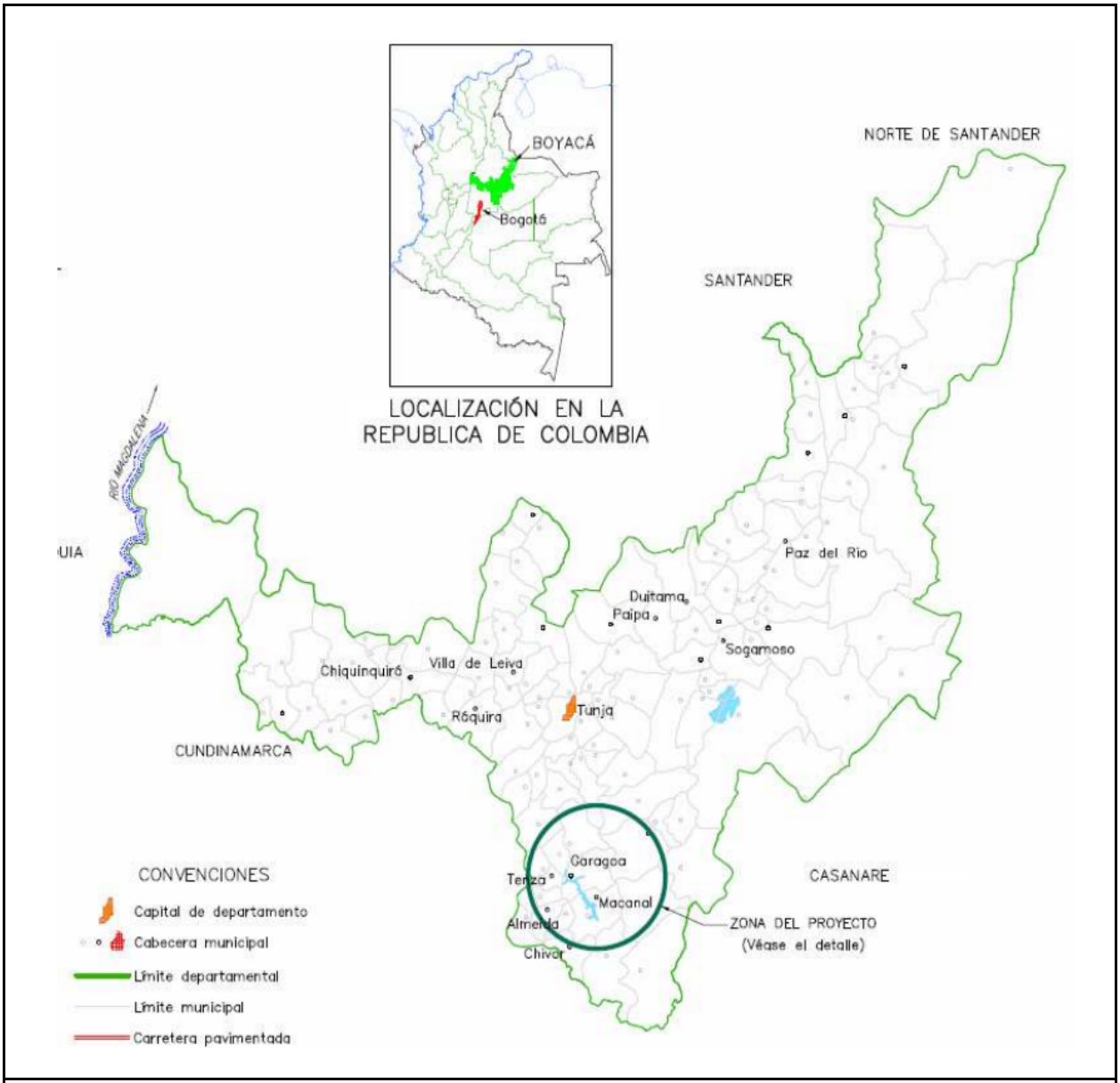

Figure 03: Location map 1
Source: United Nations Clean Development Mechanism Project Design Document Form

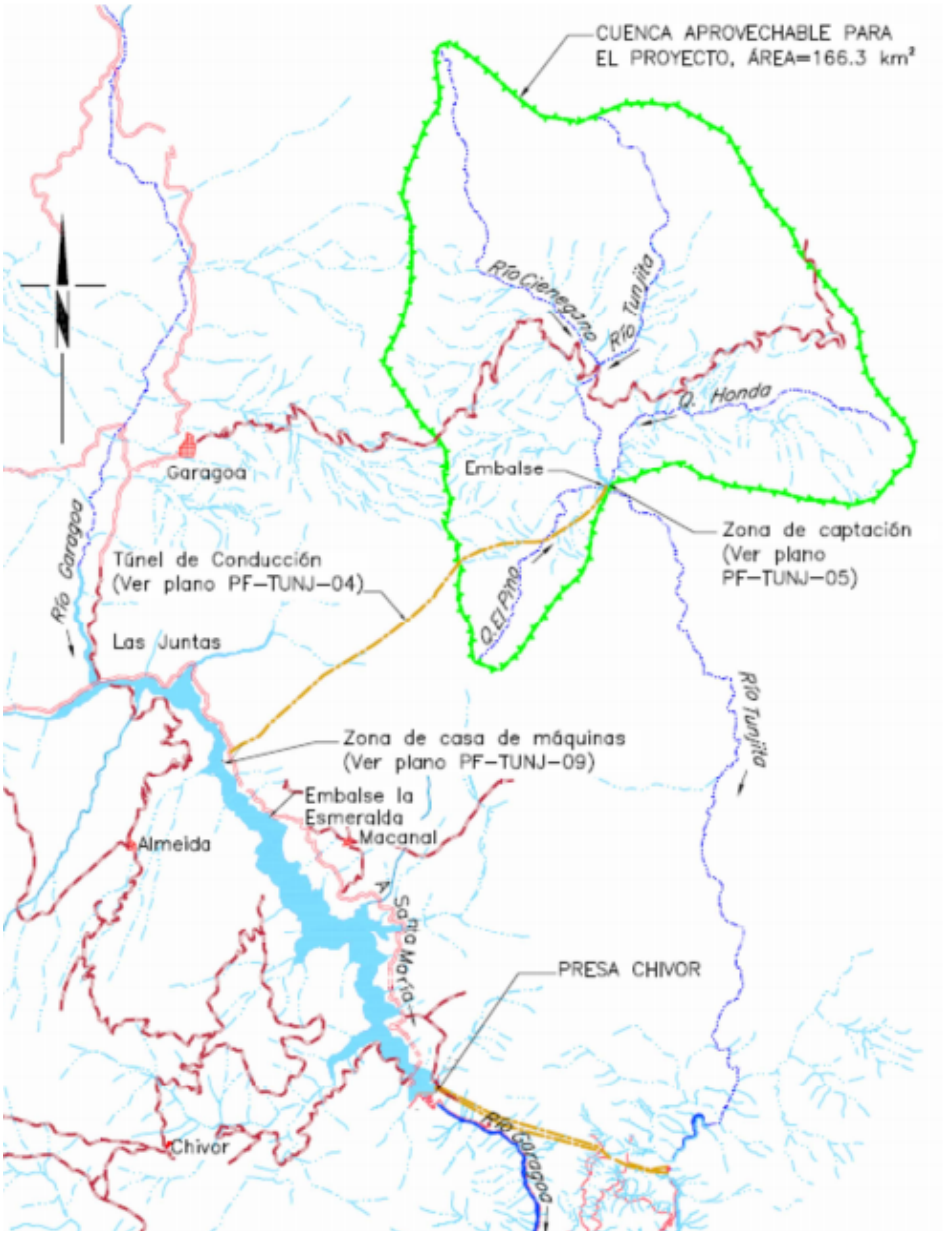

Figure 04: Location map 2
Source: United Nations Clean Development Mechanism Project Design Document Form

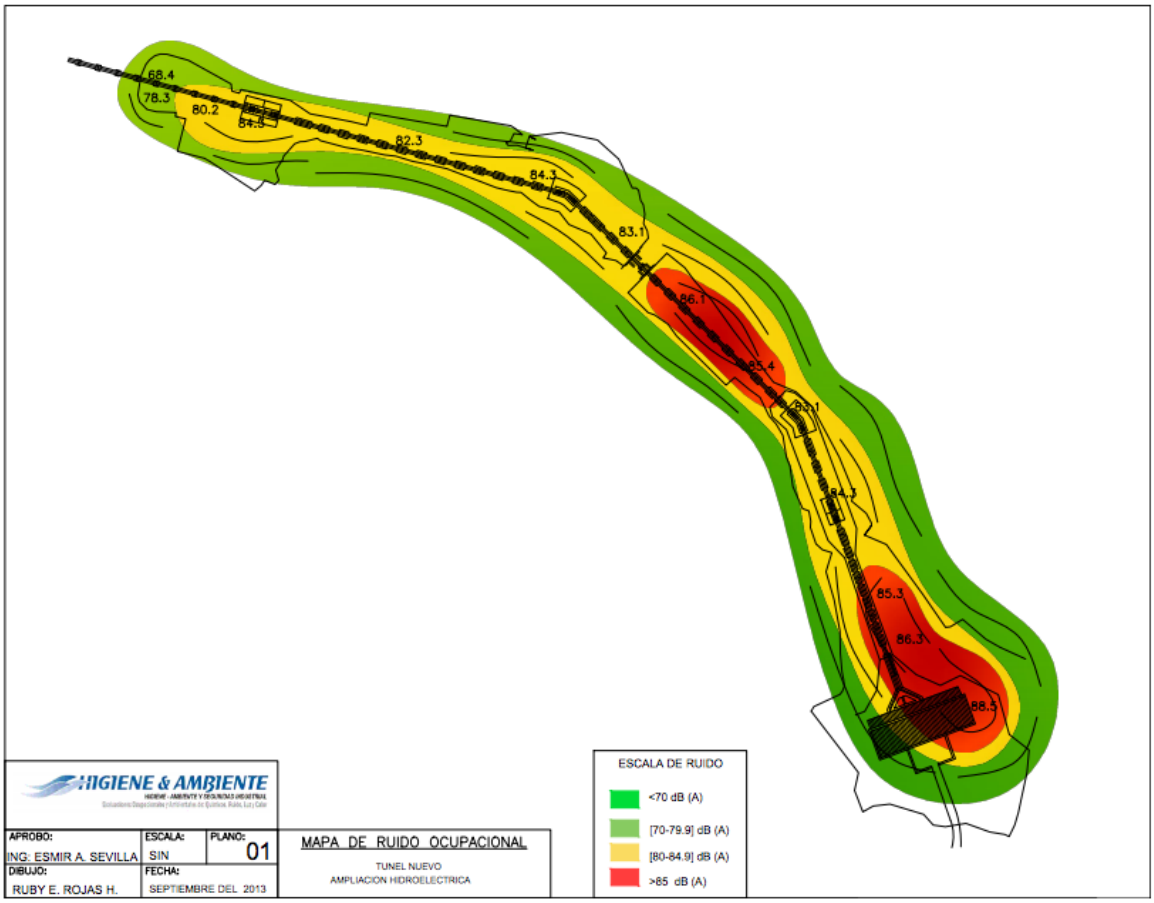

Figure0 5: Sound pollution map
Source: Mapa de ruido ocupacional

Figure 06: Community meeting in the town of Macanal
Source: Fotos AES Chivor

Figure 07: Only building to be displaced
Source: Documento Completo

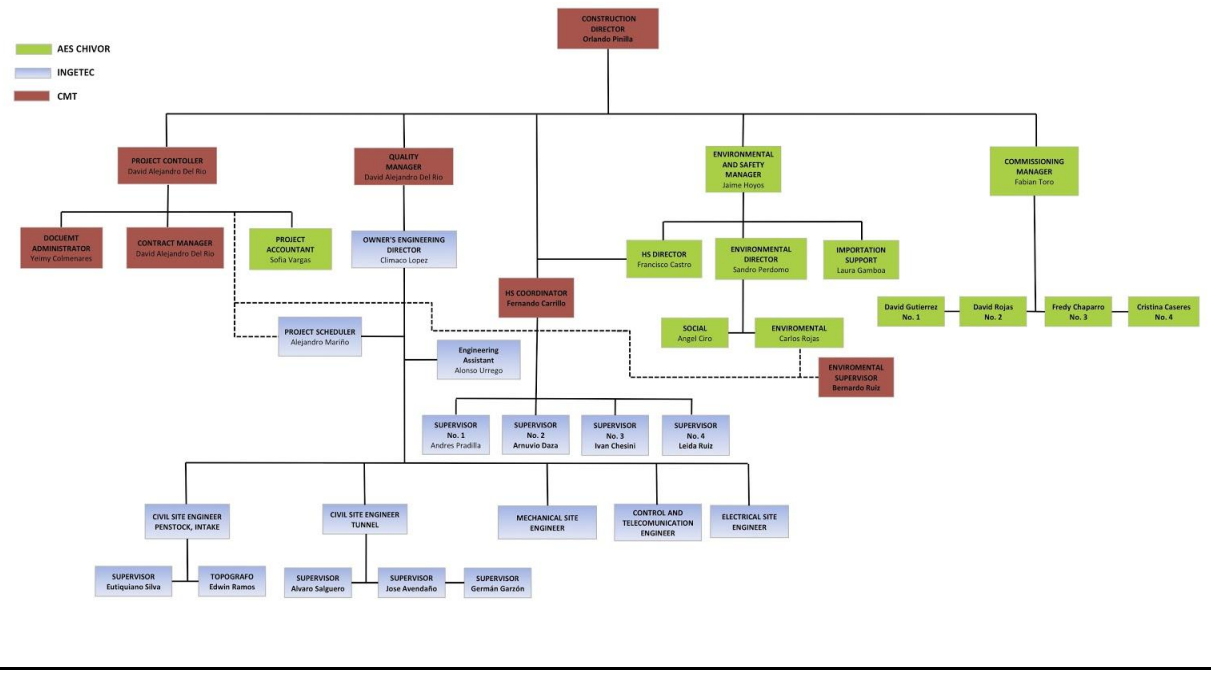

Figure 08: Organization chart
Source: Organigrama Tunjita

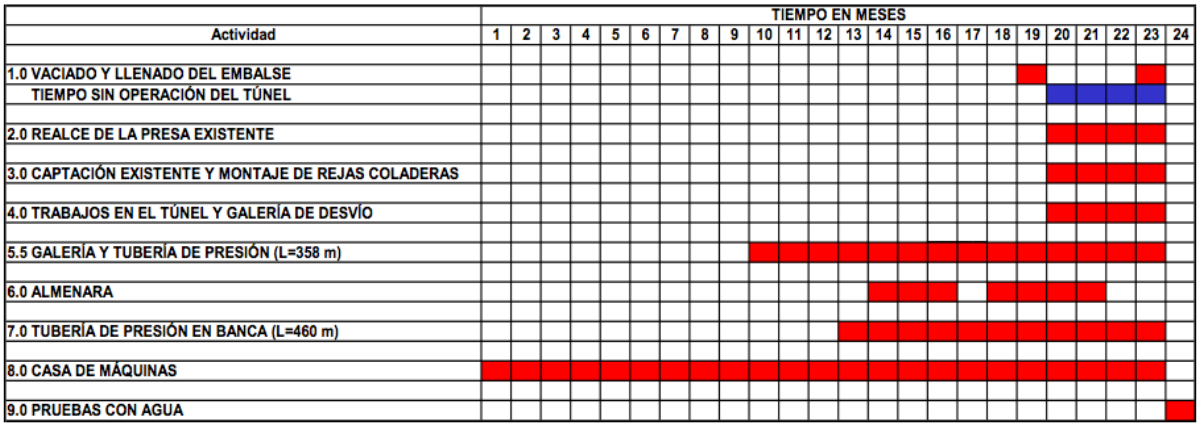

Figure 09: Projected project timeline
Source: Documento Completo

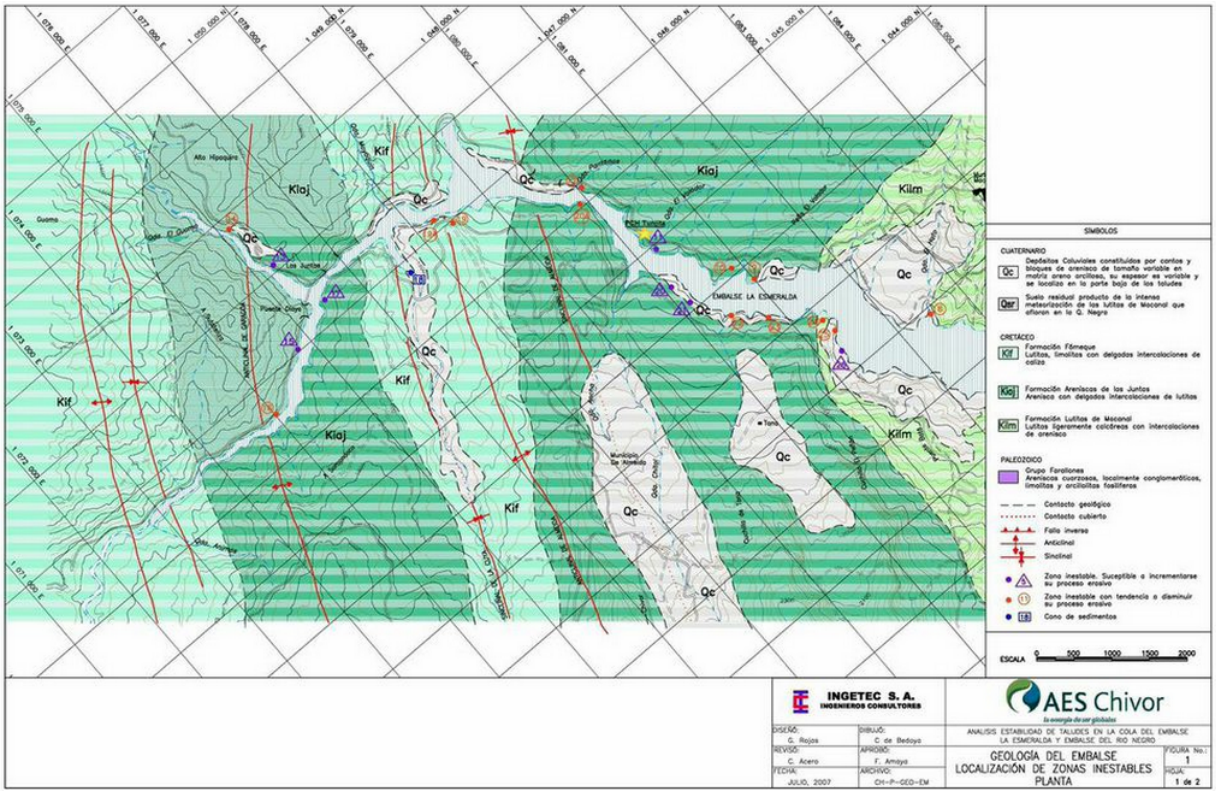

Figure 10: Geological map of the Chivor watershed
Source: Mapa geológico del embalse la esmeralda

Figure 11: Recycling depot for unused wood
Source: Documento Premio BID

Figure 12: Esmeralda reservoir pictured after water level rise.
Source: Fotos AES Chivor

APPENDIX B: ENVISION POINTS TABLE

CREDIT SCORING

					IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
1	QUALITY OF LIFE	PURPOSE	QL1.1	Improve community quality of life	2	5	10	**20**	**25**
2			QL1.2	Stimulate sustainable growth and development	1	2	5	13	**16**
3			QL1.3	Develop local skills and capabilities	1	2	5	12	**15**
4		COMMUNITY	QL2.1	Enhance public health and safety	2			**16**	
5			QL2.2	Minimize noise and vibration	1			8	**11**
6			QL2.3	Minimize light pollution	1	2	4	8	**11**
7			QL2.4	Improve community mobility and access	1	4	7	**14**	
8			QL2.5	Encourage alternative modes of transportation	1	3	6	12	**15**
9			QL2.6	Improve site accessibility, safety and wayfinding		3	6	12	**15**
10		WELLBEING	QL3.1	Preserve historic and cultural resources	1		7	**13**	**16**
11			QL3.2	Preserve views and local character	1	3	6	11	**14**
12			QL3.3	Enhance public space	1	3	6	11	**13**
							Maximum points possible:		**181**
13	LEADERSHIP	COLLABORATION	LD1.1	Provide effective leadership and commitment	2	4	9	**17**	
14			LD1.2	Establish a sustainability management system	1	4	7	**14**	
15			LD1.3	Foster collaboration and teamwork	1	4	8	**15**	
16			LD1.4	Provide for stakeholder involvement	1	5	9	**14**	
17		MANAGEMENT	LD2.1	Pursue by-product synergy opportunities	1	3	6	12	**15**
18			LD2.2	Improve infrastructure integration	1	3	7	13	**16**
19		PLANNING	LD3.1	Plan for long-term monitoring and maintenance	1	3		**10**	
20			LD3.2	Address conflicting regulations and policies	1	2	4	**8**	
21			LD3.3	Extend useful life	1	3	6	**12**	
							Maximum points possible:		**121**
22	RESOURCE ALLOCATION	MATERIALS	RA1.1	Reduce net embodied energy	2	6	12	**18**	
23			RA1.2	Support sustainable procurement practices	2	3	6	**9**	
24			RA1.3	Use recycled materials	2	5	11	**14**	
25			RA1.4	Use regional materials	3	6	9	**10**	
26			RA1.5	Divert waste from landfills	3	6	8	**11**	
27			RA1.6	Reduce excavated materials taken off site	2	4	5	**6**	
28			RA1.7	Provide for deconstruction and recycling	1	4	8	**12**	
29		ENERGY	RA2.1	Reduce energy consumption	3	7	12	**18**	
30			RA2.2	Use renewable energy	4	6	13	16	**20**
31			RA2.3	Commission and monitor energy systems		3		**11**	
32		WATER	RA3.1	Protect fresh water availability	2	4	9	17	**21**
33			RA3.2	Reduce potable water consumption	4	9	13	17	**21**
34			RA3.3	Monitor water systems	1	3	6	**11**	
							Maximum points possible:		**182**
35	NATURAL WORLD	SITING	NW1.1	Preserve prime habitat			9	14	**18**
36			NW1.2	Protect wetlands and surface water	1	4	9	14	**18**
37			NW1.3	Preserve prime farmland			6	12	**15**
38			NW1.4	Avoid adverse geology	1	2	3	**5**	
39			NW1.5	Preserve floodplain functions	2	5	8	**14**	
40			NW1.6	Avoid unsuitable development on steep slopes	1		4	**6**	
41			NW1.7	Preserve greenfields	3	6	10	15	**23**
42		LAND & WATER	NW2.1	Manage stormwater		4	9	17	**21**
43			NW2.2	Reduce pesticide and fertilizer impacts	1	2	5	**9**	
44			NW2.3	Prevent surface and groundwater contamination	1	4	9	14	**18**
45		BIODIVERSITY	NW3.1	Preserve species biodiversity	2			13	**16**
46			NW3.2	Control invasive species			5	9	**11**
47			NW3.3	Restore disturbed soils				8	**10**
48			NW3.4	Maintain wetland and surface water functions	3	6	9	15	**19**
							Maximum points possible:		**203**
49	CLIMATE & RISK	EMISSIONS	CR1.1	Reduce greenhouse gas emissions	4	7	13	18	**25**
50			CR1.2	Reduce air pollutant emissions	2	6		12	**15**
51		RESILIENCE	CR2.1	Assess climate threat				**15**	
52			CR2.2	Avoid traps and vulnerabilities	2	6	12	16	**20**
53			CR2.3	Prepare for long-term adaptability				16	**20**
54			CR2.4	Prepare for short-term hazards	3		10	17	**21**
55			CR2.5	Manage heat islands effects	1	2	4	**6**	
							Maximum points possible:		**116**
									803

**The five innovation credits are bonus points and not included in total point tallies*

APPENDIX C: GRAPHS

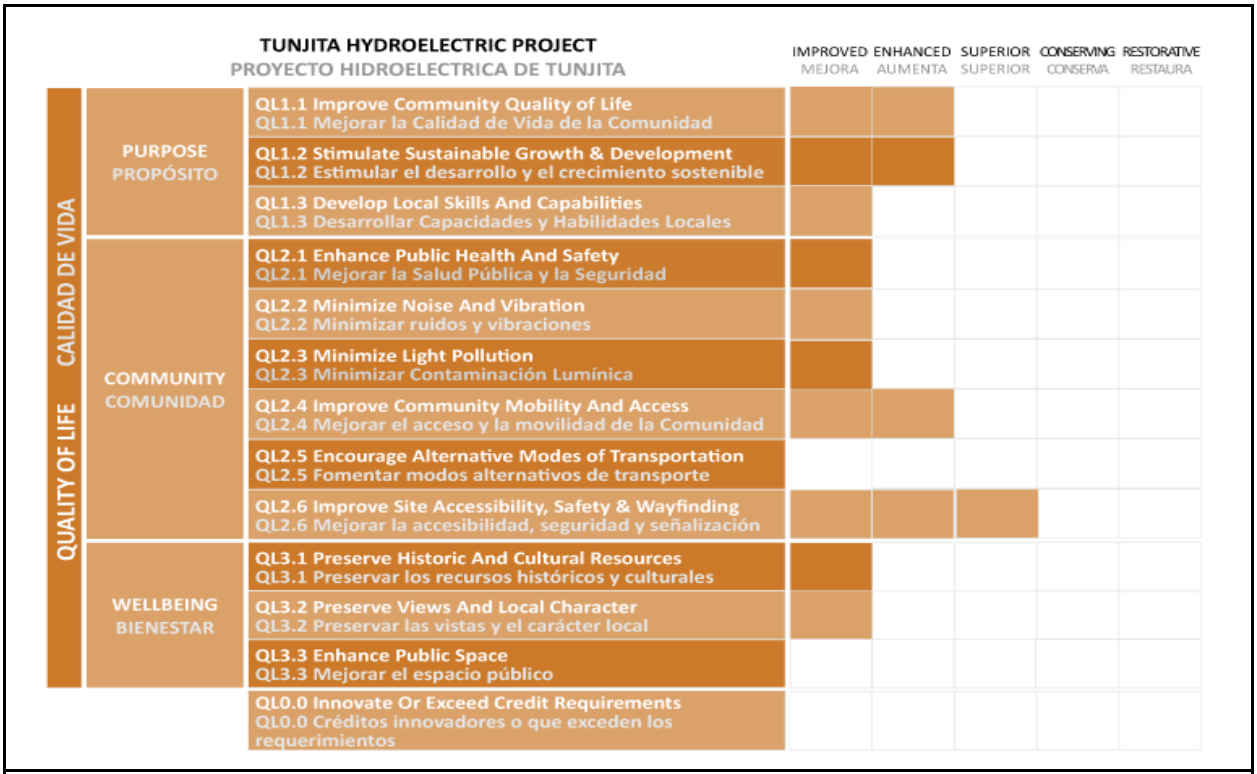

Figure 13: Quality of Life category_ Summary of results

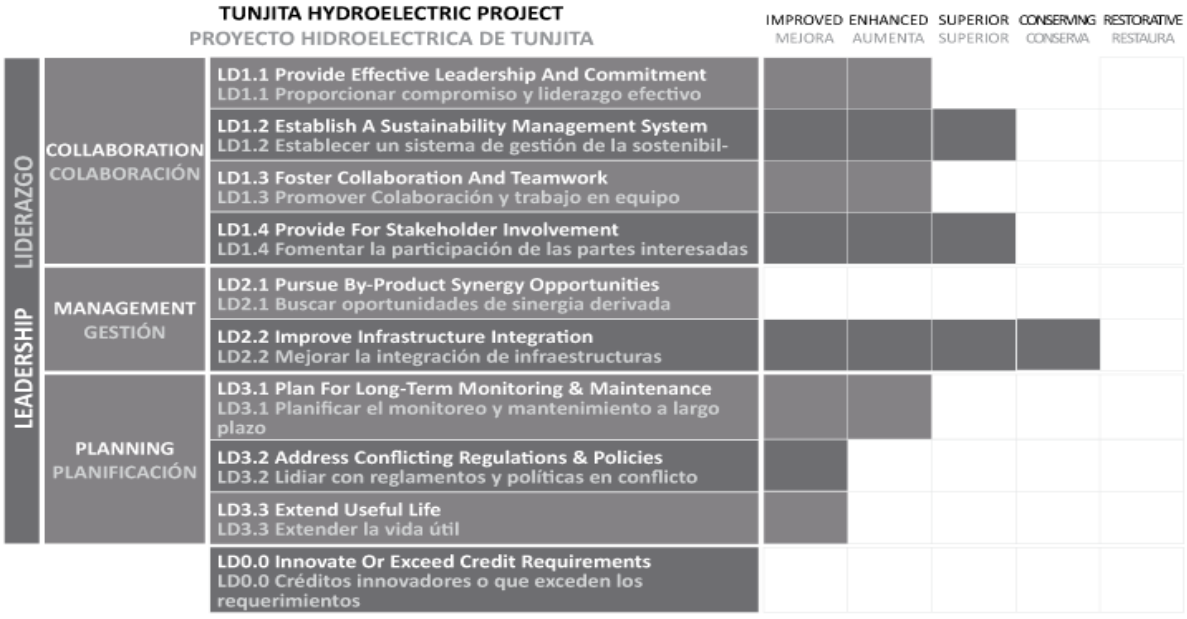

Figure 14: Leadership category_ Summary of results

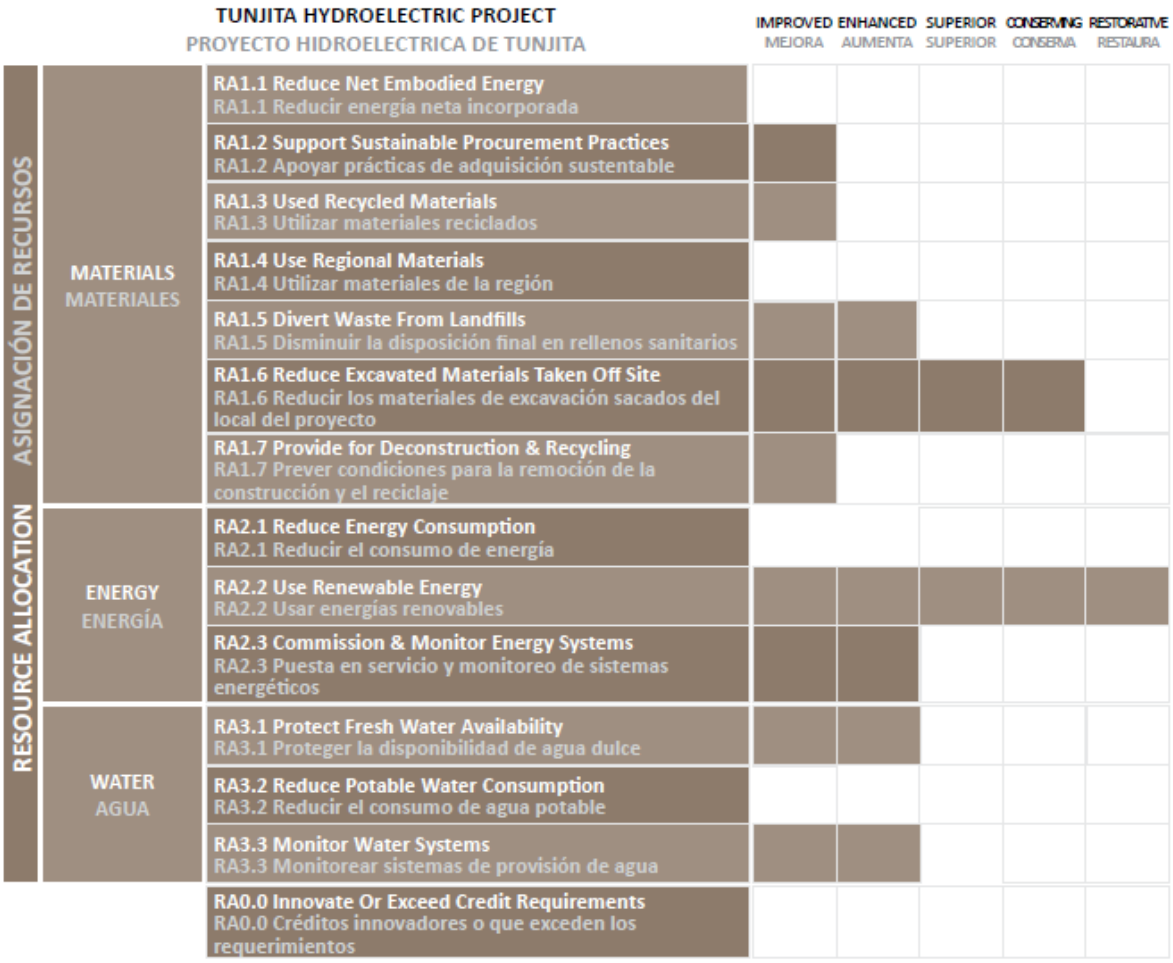

Figure 15: Resource Allocation category_ Summary of results

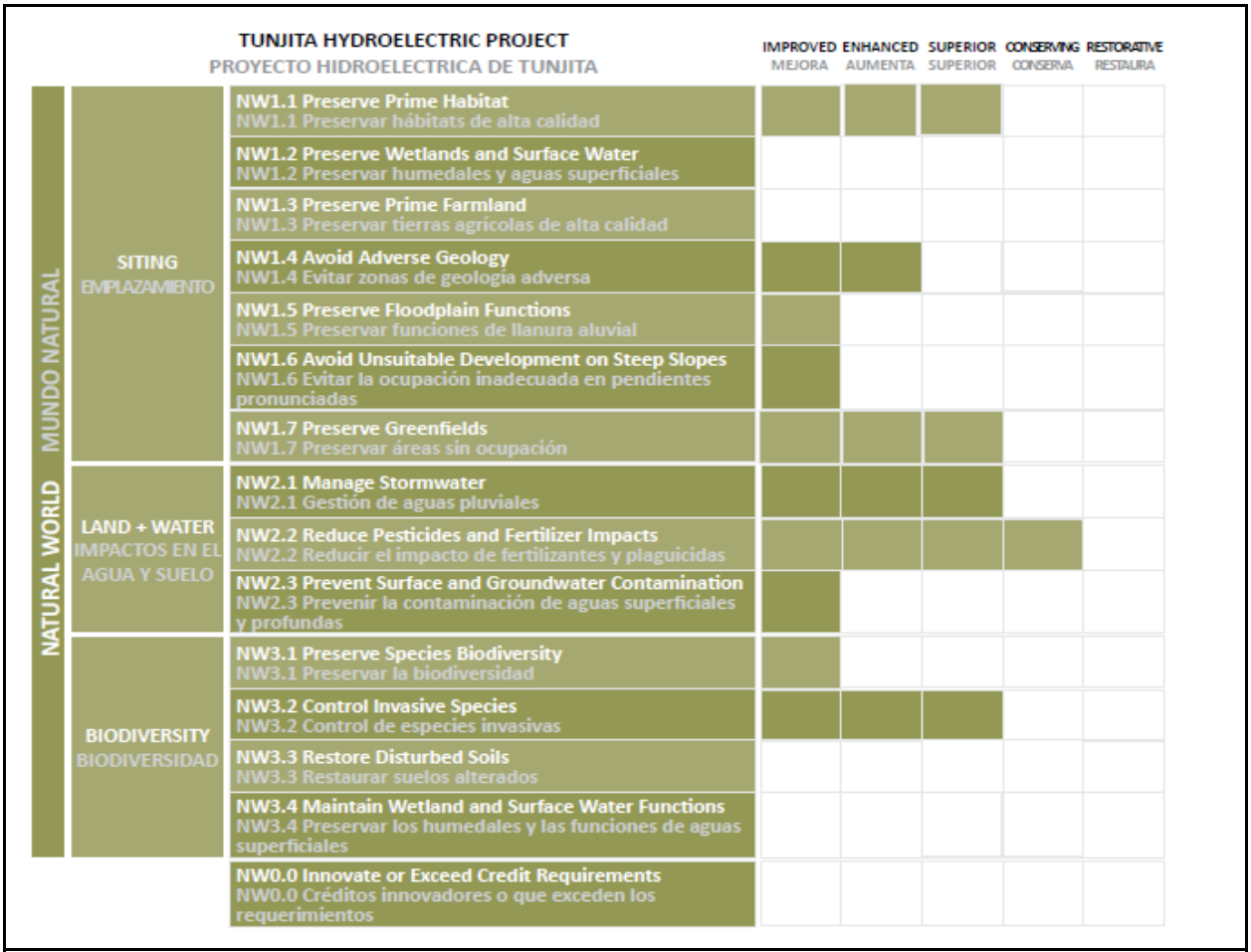

Figure 16: Natural World category_ Summary of results

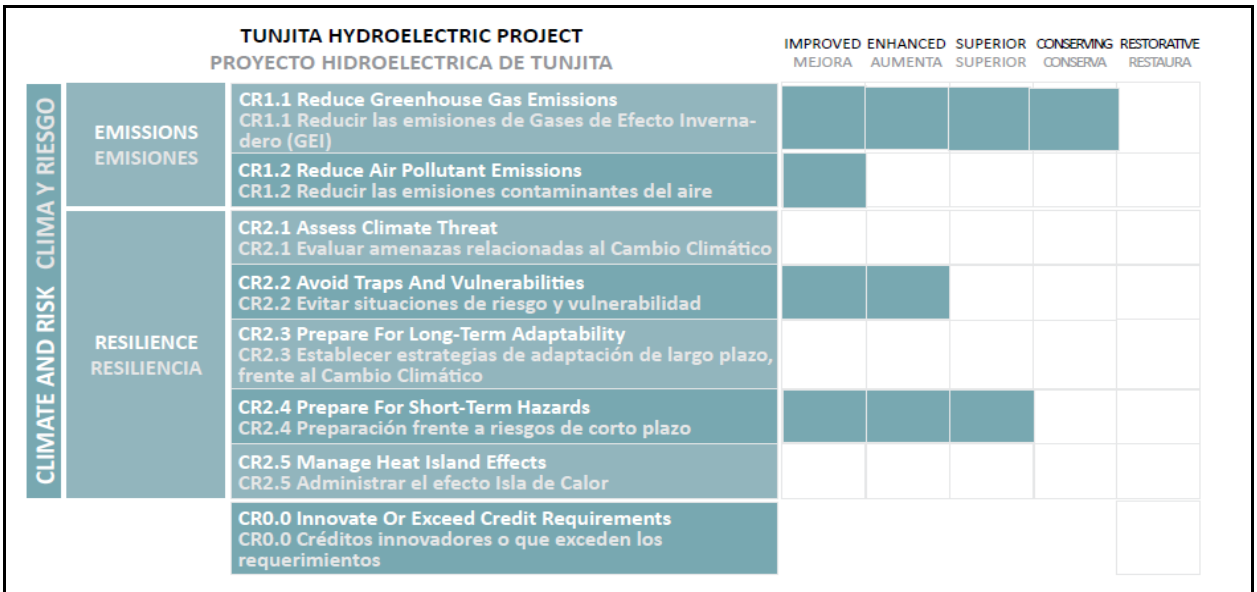

Figure 17: Climate & Risk category_ Summary of results

Figure 18: People & Leadership award Summary of results

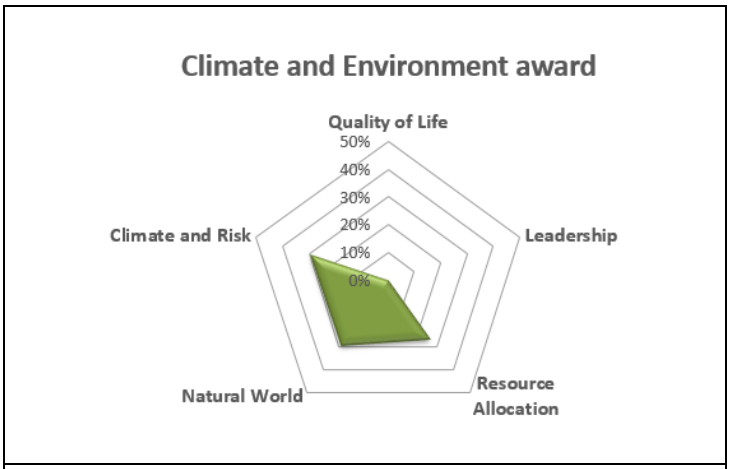

Figure 19: Climate & Environment award Summary of results

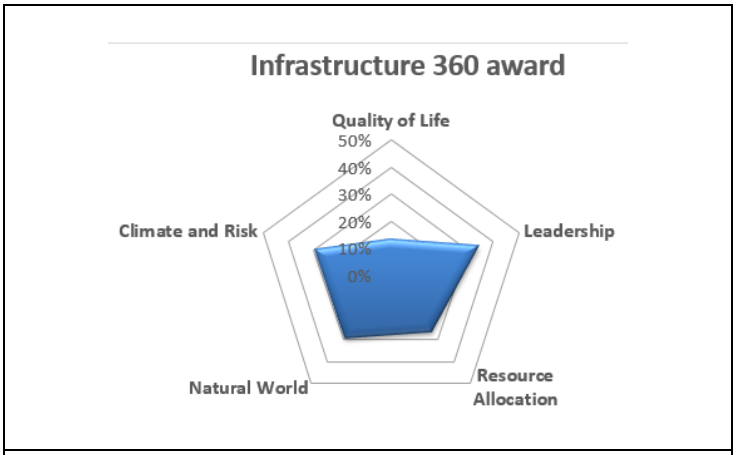

Figure 20: Infrastructure 360 award Summary of results

			TUNJITA HYDROELECTRIC PLANT, COLOMBIA	PT.	Performance
1	QUALITY OF LIFE	PURPOSE	QL1.1 Improve Community Quality of Life	5	Enhanced
2			QL1.2 Stimulate Sustainable Growth & Development	2	Enhanced
3			QL1.3 Develop Local Skills And Capabilities	1	Improved
4		COMMUNITY	QL2.1 Enhance Public Health And Safety	2	Improved
5			QL2.2 Minimize Noise And Vibration	1	Improved
6			QL2.3 Minimize Light Pollution	1	Improved
7			QL2.4 Improve Community Mobility And Access	4	Improved
8			QL2.5 Encourage Alternative Modes of Transportation	0	Improved
9			QL2.6 Improve Site Accessibility, Safety & Wayfinding	6	Improved
10		WELLBEING	QL3.1 Preserve Historic And Cultural Resources	1	Improved
11			QL3.2 Preserve Views And Local Character	1	Improved
12			QL3.3 Enhance Public Space	0	Improved
			QL0.0 Innovate Or Exceed Credit Requirements	0	N/A
			QL	24	

			TUNJITA HYDROELECTRIC PLANT, COLOMBIA	PT.	Performance
13	LEADERSHIP	COLLABORATION	LD1.1 Provide Effective Leadership And Commitment	4	Enhanced
14			LD1.2 Establish A Sustainability Management System	7	Superior
15			LD1.3 Foster Collaboration And Teamwork	4	Enhanced
16			LD1.4 Provide For Stakeholder Involvement	9	Superior
17		MNGMT.	LD2.1 Pursue By-Product Synergy Opportunities	0	No Score
18			LD2.2 Improve Infrastructure Integration	13	Conserving
19		PLANNING	LD3.1 Plan For Long-Term Monitoring & Maintenance	3	Enhanced
20			LD3.2 Address Conflicting Regulations & Policies	1	Improved
21			LD3.3 Extend Useful Life	1	Improved
			LD0.0 Innovate Or Exceed Credit Requirements	0	N/A
			LD	42	

			TUNJITA HYDROELECTRIC PLANT, COLOMBIA	PT.	Performance
22	RESOURCE ALLOCATION	MATERIALS	RA1.1 Reduce Net Embodied Energy	0	No Score
23			RA1.2 Support Sustainable Procurement Practices	2	Improved
24			RA1.3 Used Recycled Materials	2	Improved
25			RA1.4 Use Regional Materials	0	No Score
26			RA1.5 Divert Waste From Landfills	6	Conserving
27			RA1.6 Reduce Excavated Materials Taken Off Site	6	Conserving
28			RA1.7 Provide for Deconstruction & Recycling	1	Improved
29		ENERGY	RA2.1 Reduce Energy Consumption	0	No Score
30			RA2.2 Use renewable energy	20	Restorative
31			RA2.3 Commission & Monitor Energy Systems	3	Enhanced
32		WATER	RA3.1 Protect Fresh Water Availability	4	Enhanced
33			RA3.2 Reduce Potable Water Consumption	0	No Score
34			RA3.3 Monitor Water Systems	3	Enhanced
			RA0.0 Innovate Or Exceed Credit Requirements	0	N/A
			RA	**47**	

			TUNJITA HYDROELECTRIC PLANT, COLOMBIA	PT.	Performance
35	NATURAL WORLD	SITING	NW1.1 Preserve Prime Habitat	9	Superior
36			NW1.2 Preserve Wetlands and Surface Water	0	No Score
37			NW1.3 Preserve Prime Farmland	0	No Score
38			NW1.4 Avoid Adverse Geology	2	Enhanced
39			NW1.5 Preserve Floodplain Functions	2	Improved
40			NW1.6 Avoid Unsuitable Development on Steep Slopes	1	Improved
41			NW1.7 Preserve Greenfields	10	Superior
42		L & W	NW2.1 Manage Stormwater	9	Superior
43			NW2.2 Reduce Pesticides and Fertilizer Impacts	9	Conserving
44			NW2.3 Prevent Surface and Groundwater Contamination	1	Improved
45		BIODIVERSITY	NW3.1 Preserve Species Biodiversity	2	Improved
46			NW3.2 Control Invasive Species	5	Superior
47			NW3.3 Restore Disturbed Soils	0	No Score
48			NW3.4 Maintain Wetland and Surface Water Functions	0	No Score
			NW0.0 Innovate or Exceed Credit Requirements	0	N/A
			NW	50	

			TUNJITA HYDROELECTRIC PLANT, COLOMBIA	PT.	Performance
49	CLIMATE	EMISSION	CR1.1 Reduce Greenhouse Gas Emissions	18	Conserving
50			CR1.2 Reduce Air Pollutant Emissions	2	Improved
51		RESILENCE	CR2.1 Assess Climate Threat	0	No Score
52			CR2.2 Avoid Traps And Vulnerabilities	6	Enhanced
53			CR2.3 Prepare For Long-Term Adaptability	0	No Score
54			CR2.4 Prepare For Short-Term Hazards	10	Superior
55			CR2.5 Manage Heat Island Effects	0	No Score
			CR0.0 Innovate Or Exceed Credit Requirements	0	N/A
			CR	16	

Total points	**199**	**0**

APPENDIX D: CREDIT DETAIL

TUNJITA HYDROELECTRIC PROJECT: CREDIT SPREADSHEET WITH DETAILS		
CATEGORY I, PEOPLE AND LEADERSHIP		
SUB CATEGORY: QUALITY OF LIFE		
	Score	**TUNJITA HYDROELECTRIC PROJECT**
QL1.1 Improve Community Quality of Life	**5**	Enhanced
		The Tunjita Plant is being constructed in a rural area removed from major population centers. The project footprint consists primarily of new access roads, a small machine house located at the base of a preexisting dam, and slight expansion of the perimeter of the Esmeralda Reservoir1. The tunnel and piping are the key elements in getting the water from the river confluence to the dam. These were built decades ago almost exclusively underground, therefore it can not be considered to comprise any significant portion of the current footprint. No people are to be displaced and only one building, property of the developer, is to be affected2. AES Chivor has still been diligent in seeking out and listening to community member input. All municipalities and tribes in the vicinity were contacted and invited to two local stakeholder meetings. The meetings covered the threat of climate change, an overview of the project, the impact on local communities, and ways in which attendees could procure more information. Feedback was largely positive. Local labor has been contracted for the project, so construction has benefited neighboring communities from an employment standpoint. Once the plant becomes operational, a percentage of the proceeds will be reinvested in the area, further boosting the project's community contribution.
		Source: *1. "United Nations Clean Development Mechanism Project Design Document Form", last modified October 4, 2010, http://cdm.unfccc.int/filestorage/K/E/3/KE3WLJ1G9FNAQUTSOYRMIB5H680427/PDDAESTunjita.pdf?t=dnp8bmR3bGVmfDBIBbbbGNrA0wcZFyOGDjbV, 49.* *2. "Central Hidroelectrica de Chivor", last modified September 4, 2014, 59.*
		RECOMMENDATIONS
		AES Chivor might consider forming a corporate-community partnership. Participants could meet biannually to discuss issues of interest and perhaps coordinate events that benefit the community, as well as instill pride that local energy comes from a renewable source.
QL1.2 Stimulate Sustainable Growth & Development	**2**	Enhanced
		The Tunjita Plant continues the sustainable growth tradition of its sister facility, the Chivor Hydroelectric Plant. No deforestation is required to build the plant, nor will environmental degradation result from project activities. Land in and around the project remains uncontaminated and safe for locals, eco-tourists, and all other foreseeable constituencies. Furthermore, the plant will soon feed emissions-free, year-round electricity into the local grid1. Four hundred workers, drawn in part from surrounding communities, are involved in construction. Many will likely remain employed with AES Chivor to oversee plant operations and maintenance upon project completion.

		Source: *1. "United Nations Clean Development Mechanism Project Design Document Form", last modified October 4, 2010, http://cdm.unfccc.int/filestorage/K/E/3/KE3WLJ1G9FNAQUTSOYRMIB5H680427/PDDAESTunjita.pdf?t=dnp8bmR3bGVmfDBIBbbbGNrA0wcZFyOGDjbV, 8.*
		RECOMMENDATIONS To advance to the Superior classification, AES Chivor might consider providing educational tours of the facilities. The tours could discuss hydropower, the importance of renewable energy, and how future development projects in Colombia might emulate the successful aspects of the Tunjita and Chivor plants. It is moreover recommended that facility access and capacity be measured so that changes can be assessed and improvements can be affected.
QL1.3 Develop Local Skills and Capabilities	**1**	Improved
		AES Chivor has committed to working with local labor for the full duration of the project. Local firms have also been hired to provide specialized services during construction1. The educational component of Colombia's Millennium Objectives, to which project managers have pledged support, further bolsters the development of local skills and abilities.
		Source: *1. "United Nations Clean Development Mechanism Project Design Document Form", last modified October 4, 2010, http://cdm.unfccc.int/filestorage/K/E/3/KE3WLJ1G9FNAQUTSOYRMIB5H680427/PDDAESTunjita.pdf?t=dnp8bmR3bGVmfDBIBbbbGNrA0wcZFyOGDjbV, 3.*
		RECOMMENDATIONS With the end-goal of cultivating potential hires, project managers might consider creating a training program whose participants are recruited from local communities. In this way, a permanent talent pipeline will be maintained, and AES Chivor will not have to go through protracted nationwide searches whenever a position opens up. They could also work to promote educational programs that will foster long-term competitiveness and communal learning.
QL2.1 Enhance Public Health And Safety	**2**	Improved
		Great care has been taken to safeguard public health and safety since the inception of the project. The technologies being implemented, namely small-scale hydraulic turbines and supporting machinery, are well-established and non-threatening from a wellness standpoint. River conditions at the project site have been monitored for decades, and regional hydrological patterns are understood at an exceptionally high level of granularity. Impact studies were carried out in advance of the project, and alternative development means and methods were considered, but the current design and build trajectory was judged the safest and most effective1.
		Source: *1. "Plan de Salud y Guia de Seguridad: AES Corporation", last modified September 26, 2014.*
		RECOMMENDATIONS None at this time.
QL2.2 Minimize Noise And Vibration	**1**	Improved
		Project managers hired a consultancy, Coninsa Ramón, to undertake studies on noise and vibration.

		Coninsa determined that two small zones, one surrounding the tunnel diversion and one surrounding the machine house, were temporarily producing noise between 80 and 85 dB1. This is lower than the 90 dB per eight hour limit imposed by the Colombian government. Employees were nonetheless given ear protection. Noise levels will drop significantly or vanish entirely once construction is complete2.
		Source: *1. "MAPA RUIDO CONINSA 2013", last modified September 26, 2014.* *2. "Documento Proyecto Premio BID de Infraestructura: Calidad de Vida", last modified October 17, 2014, 19.*
		RECOMMENDATIONS None at this time.
QL2.3 Minimize Light Pollution	**1**	Improved
		The project team carried out a comprehensive light needs evaluation at the outset of development. Site and task-specific lighting solutions were implemented as a result. Illumination is required primarily in the tunnel, where energy-efficient bulbs have been installed1. The machine house has been designed to receive substantial natural light and hence does not have major artificial lighting needs.
		Source: *1. "Anexo Iluminación A Estándar para la construcción de instalaciones eléctricas provisionales seguras", last modified September 26, 2014.*
		RECOMMENDATIONS Consider alternatives to standard high wattage bulb coverage. This might involve rethinking of fenestration orientation, use of lower energy consuming LED panels, or eliding lighting altogether.
QL2.4 Improve Community Mobility And Access	**4**	Enhanced
		The Tunjita Plant has been sited several meters from a preexisting road. New road networks will not be required to make full use of the facility. The project therefore does not contribute to sprawl, nor does it negatively impact access to any other community destination. Limited access roads have been constructed to maximize site accessibility, but these do not contribute to congestion. Synergistic use of the Chivor plant infrastructure means that most project-related traffic is routed along existing roadways1.
		Source: *1. "United Nations Clean Development Mechanism Project Design Document Form", last modified October 4, 2010, http://cdm.unfccc.int/filestorage/K/E/3/KE3WLJ1G9FNAQUTSOYRMIB5H680427/PDDAESTunjita.pdf ?t=dnp8bmR3bGVmfDBIBbbbGNrA0wcZFyOGDjbV, 2.*
		RECOMMENDATIONS None at this time.
QL2.5 Encourage Alternative	**0**	No Score
		The project is sited beyond the reach of standard mass transit options. Few people live in the vicinity

Modes of Transportation		of the plant, as this is a predominantly rural area. Cycling is impeded by unpaved access roads that often turn to mud, as well as extreme gradients. Project managers therefore do not have much latitude with respect to encouraging alternative modes of transportation.
		Source:
		RECOMMENDATIONS None at this time.
QL2.6 Improve Site Accessibility, Safety & Wayfinding	**6**	Superior
		It was confirmed by the project team that wayfinding signage has been mounted both within and outside the facility1. They point out that accessibility for users of all sorts, including emergency personnel, is a focus of the signage. In addition, signage is used to indicate where recycling stockpiles are located, and cautions motorists that they are entering a wildlife-rich zone.
		Source: *1. "Documento Proyecto Premio BID de Infraestructura: Calidad de Vida", last modified October 17, 2014, 32-34.*
		RECOMMENDATIONS None at this time.
QL3.1 Preserve Historic and Cultural Resources	**1**	Improved
		AES Chivor carried out thorough impact studies in advance of construction. No cultural sites will be disrupted. There are no indigenous or Afrocolombian communities in the vicinity. Indeed, only one building, which is property of the developer, is to be displaced by project activities.
		Source: *"Documento Proyecto Premio BID de Infraestructura: Calidad de Vida", last modified October 17, 2014, 22.*
		RECOMMENDATIONS None at this time.
QL3.2 Preserve Views and Local Character	**1**	Improved
		As the Tunjita Plant piggybacks off preexisting Chivor Plant infrastructure, little has been done to disrupt views or local character. Two meetings with community stakeholders were conducted to get feedback surrounding construction impacts. Minutes indicate that attendees are most attuned to ensuring that economic benefits of the project trickle down to those nearby. The most visible construction site is the machine house, but this occurs at the base of a preexisting dam, and its footprint is minimal.
		Source: *"Documento Proyecto Premio BID de Infraestructura: Calidad de Vida", last modified October 17, 2014, 23.*
		RECOMMENDATIONS In the few places where trees have been felled due to project activity, implement a post-construction replanting plan. Ensure that all areas affected by construction receive attention so as

		to restore their former appearance.
QL3.3 Enhance Public Space	**0**	No Score
		Credit The area surrounding the Tunjita Plant consists exclusively of forest and pasture. There are no spaces that draw the public.
		Source:
		RECOMMENDATIONS None at this time.
QL0.0 Innovate Or Exceed Credit Requirements		*N/A*
	24	
SUB CATEGORY:LEADERSHIP		
	Score	**TUNJITA HYDROELECTRIC PROJECT**
LD1.1 Provide Effective Leadership And Commitment	**4**	Enhanced
		Project managers at AES Chivor have demonstrated strong environmental leadership throughout the planning and construction process. Steps have gone beyond what is required by law. Apart from complying with the Colombian Ministry of Environment, Housing and Territorial Development's environmental protocols1, leaders have systematically implemented plans to reduce deforestation, noise pollution, overlighting, and contractor overreach. Outreach to community members, up to and including the hiring of local labor, further bolsters the project's leadership credentials. Developer commitment to reuse of existing infrastructure, rather than construction of new alternatives, should also be applauded. AES Chivor has furthermore shown a laudable public commitment to sustainability. They were admitted to the exclusive United Nations Global Compact, an intensive corporate responsibility initiative2. This requires the company to be actively engaged in implementing best practices - socially, environmentally, and beyond - across their organization. Project managers have taken the lead in publicizing and promoting clean energy in national publications3 4 5. Even the company website is filled with content about the the features and benefits of their clean energy projects, including the work done at Tunjita6.
		Source: *1. "United Nations Clean Development Mechanism Project Design Document Form", last modified October 4, 2010, http://cdm.unfccc.int/filestorage/K/E/3/KE3WLJ1G9FNAQUTSOYRMIB5H680427/PDDAESTunjita.pdf?t=dnp8bmR3bGVmfDBIBbbbGNrA0wcZFyOGDjbV, 2.* *2. "United Nations Global Compact: Participants & Stakeholders", last modified June 20, 2013, https://www.unglobalcompact.org/participant/19548.* *3. Echavarría, F. "AES Chivor sigue apostándole a la energía limpia," Andesco, June 2014, 59.*

		4. Alarcón, W., Toro, F., Fuquen, H., Sánchez, C. "Prueba piloto para el desarrollo y automatización de la pequeña central hidroeléctrica Tunjita de AES Chivor," Colinnovación, June 2014, 5-8. *5. Santos, D. "Optimizamos los recursos para no impactar al medio ambiente," IngeSOCIOS, August - September 2014, 14-15.* *6. "Tunjita Power Plant", last modfied December 21, 2013, http://www.chivor.com.co/en/qui/SitePages/PCH%20Tunjita.aspx*
		RECOMMENDATIONS Work in greater coordination with local stakeholders: ask for input regarding community accommodation (e.g. perhaps they could oversee tours of the facilities) and maintain greater transparency with project details and milestones. This may involve regular updating of an online resource, or otherwise making available physical copies of said information at local town halls.
LD1.2 Establish A Sustainability Management System	**7**	Superior
		Many best practices have been implemented across the project, including efforts to reduce deforestation and air, water, noise, and light pollution1. These practices are enforced through substantial emphasis on sustainability management systems. AES Chivor not only has general internal sustainability guidelines2, but Tunjita-specific protocols in place as well3. In the roles and responsibilities of the Tunjita project organizational chart is embedded a systematic focus on sustainable practice implementation4. This is evidenced by titles such as Environmental Analyst, Environmental Director, and Environmental and Safety Manager. Such experts have ensured that best practices have been adopted systematically throughout the project, from initial planning5 to execution3.
		Source: *1. "United Nations Clean Development Mechanism Project Design Document Form", last modified October 4, 2010, http://cdm.unfccc.int/filestorage/K/E/3/KE3WLJ1G9FNAQUTSOYRMIB5H680427/PDDAESTunjita.pdf?t=dnp8bmR3bGVmfDBIBbbbGNrA0wcZFyOGDjbV.* *2. "Informe de Sostenibilidad 2013 - Construyendo un Cambio", last modified June 2014. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCEQFjAA&url=http%3A%2F%2Fwww.chivor.com.co%2Fen%2Fnue%2FInformes%2520de%2520gestin%2FInforme%2520de%2520Sostenibilidad%25202013%2520-%2520Construyendo%2520un%2520cambio.pdf&ei=9q1JVOOkO9SAsQTQm4DIDg&usg=AFQjCNFC_U70QFx4DtqUB7p8kmtxQY-I1A&sig2=579LNFnCtMq1lleF1f_chA* *3. Escobar, Arango. "Inventoria y Asesoria Ambiental: Informe N. 16," May 2014.* *4. "Documento Proyecto BID de Infraestructura de Tunjita," October 17, 2014.* *5. "Matriz General Aspectos - Impactos Ambientales Chivor - Tunjita," November 8, 2012.*
		RECOMMENDATIONS None at this time.
LD1.3 Foster Collaboration And Teamwork	**4**	Enhanced
		Project managers have created a set of plans outlining their health and safety goals at Tunjita1. Local labor has been hired and integrated into the team2. To ensure all employees deliver on these goals, monthly meetings are held wherein progress is assessed and areas for improvement are identified3. Weekly reports are also issued wherein this progress is recorded and tracked4. Branches within the project management team focus on monitoring and compliance with environmental and safety regulations. There is also a risk sharing mechanism in place with the primary contractor5.

		Financial and legal penalties will follow incomplete compliance with the terms of the arrangement. Conversely, there are incentives to reward personnel diligent in maintaining full compliance. No specific evidence of integrated design and delivery methodologies between project owner and project team have been provided.
		Source: 1. "MATRIZ TRAZABILIDAD STD AES PCH TUNJITA CRH," September 26, 2014. 2. "United Nations Clean Development Mechanism Project Design Document Form", last modified October 4, 2010, http://cdm.unfccc.int/filestorage/K/E/3/KE3WLJ1G9FNAQUTSOYRMIB5H680427/PDDAESTunjita.pdf?t=dnp8bmR3bGVmfDBIBbbbGNrA0wcZFyOGDjbV, 3. 3. Escobar, Arango. "Inventoria y Asesoria Ambiental: Informe N. 16," May 2014. 4. "Informe semanal SISO Tunjita," September 16, 2014. 5. "Documento Proyecto BID de Infraestructura de Tunjita," October 17, 2014, 13.
		RECOMMENDATIONS Integrated project delivery method between project owner and project team could result in a higher level of achievement. Members of the project team that are often brought on board in the latest phases of the project, like constructors, would be an important piece to have in consideration during the earlier stages of the project.
LD1.4 Provide For Stakeholder Involvement	**9**	Superior
		AES Chivor has been diligent in both soliciting and providing channels for stakeholder input. Managers were in contact with the Colombian Institute for Rural Development, which advocates for the rights of indigenous peoples1. None reside near, or will be affected by, the development. Next, a set of two stakeholder meetings were held in the nearby towns of Macanal2 and Garagoa3. Both were well attended. Proceedings were thoroughly documented, and concerns and questions raised by locals were addressed by project managers. Community members who would still like to comment or inquire about the process have access to a project hotline, as well as a physical office4. The frequency of these meetings, in combination with the accessibility of project managers to local community members, has ensured that all stakeholders have been empowered to influence project trajectory.
		Source: *1. "Respuesta Incoder Comunidades Etnicas", February 22, 2010.* *2. "Minuta reunion stakeholders ago 2010", September 26, 2014.* *3. "Minuta reunion stakeholders jun 2010", September 26, 2014.* *4. "Documento Proyecto BID de Infraestructura de Tunjita," October 17, 2014, 27.*
		RECOMMENDATIONS None at this time.
LD2.1 Pursue By-Product Synergy Opportunities	**0**	No Score
		By-product synergy opportunities were investigated by project managers. The initiatives identified have been the donation of unwanted material more than the identification of by-products or discharged materials coming from other facilities operations, mostly because of the location of the project. In terms of unwanted material very little will remain in the form of waste after primary construction activities are concluded. Excess dirt and gravel were the primary forms of waste, and both of these have been reused on site to the extent possible. Managers noted that, as the project is in a rural area, there are no nearby installations capable of accepting or reusing waste.

		Source: *"Documento Proyecto BID de Infraestructura de Tunjita," October 17, 2014, 29.*
		RECOMMENDATIONS Create a specific plan that identifies opportunities to reuse materials from other operations nearby. There may also be opportunities for in situ power generation during construction through use of a mobile river turbine unit.
LD2.2 Improve Infrastructure Integration	**13**	Conserving
		Project managers have succeeded in leveraging existing infrastructure to a significant extent. Indeed, the current project would not be possible without much of the civil structures that are already in place. The Tunjita dam, Esmeralda Reservoir, and Chivor plant monitoring systems, for instance, will all be instrumental to the functioning of the Tunjita Plant. That these facilities have been refurbished concomitant with machine house construction adds to the overall performance of the project. This high level of infrastructure integration is also beneficial in that it reduces the project timeline substantially below that typically associated with hydroelectric projects. At the close of construction activities, all land that has been affected will be reforested by contractors. Ultimately, the machine house will be the only visible sign that a project took place.
		Source: 1. "United Nations Clean Development Mechanism Project Design Document Form", last modified October 4, 2010, http://cdm.unfccc.int/filestorage/K/E/3/KE3WLJ1G9FNAQUTSOYRMIB5H680427/PDDAESTunjita.pdf?t=dnp8bmR3bGVmfDBIBbbbGNrA0wcZFyOGDjbV. 2. Documento Proyecto BID de Infraestructura de Tunjita
		RECOMMENDATIONS None at this time.
LD3.1 Plan For Long-Term Monitoring & Maintenance	**3**	Enhanced
		Project managers have drafted a plan for the long-term monitoring and maintenance of the Tunjita Plant. The plan specifies the monitoring and maintenance operations to take place, the units charged with carrying out these duties, as well the funds required. As Tunjita functions as an arm of the Chivor plant, all of the personnel required to carry out the plan are already on the job and ready to follow through. AES Chivor has a decades-long track record of thorough monitoring and maintenance, from systems performance to hydrological conditions. Indeed, the new plant is rated - and should be expected - to feed a consistent 20MW to the grid many decades into the future.
		Source: *"Documento Proyecto Premio BID de Infraestructura: Liderazgo", last modified October 17, 2014, 22.* *"United Nations Clean Development Mechanism Project Design Document Form", last modified October 4, 2010, http://cdm.unfccc.int/filestorage/K/E/3/KE3WLJ1G9FNAQUTSOYRMIB5H680427/PDDAESTunjita.pdf?t=dnp8bmR3bGVmfDBIBbbbGNrA0wcZFyOGDjbV*
		RECOMMENDATIONS None at this time.
LD3.2 Address	**1**	Improved

Conflicting Regulations & Policies		AES Chivor has been diligent in ensuring that project activities are in full compliance with national, department, and local laws. Project managers reached out to relevant authorities and sought permission when the status of prospective construction activities was not absolutely clear. The Colombian Ministry of Environment, Housing and Territorial Development in particular invested substantial time vetting the project, and ultimately condoned the final project specifications. In sum, any possible policy conflicts were resolved before contractors broke ground. On the other hand there is no specific evidence that the regulations addressed created barriers to the implementation of sustainable practices.
		Source: *"Concepto MAVDT - Tunjita", September 12, 2014.* *"Acta compromiso comunidad Macanal", September 26, 2014.* *"Minuta reunion stakeholders ago 2010", September 26, 2014.*
		RECOMMENDATIONS None at this time.
LD3.3 Extend Useful Life	**1**	Improved
		The Tunjita Plant is rated to produce power for 50 years. Project documents stipulate that the plant be designed according to high technical standards and that only high quality materials be used in construction. As so much capital has been invested in creating the related hydropower infrastructure, however, its owners will likely update and run the plant beyond the current machinery's rated longevity. That AES Chivor has a history of responsibly maintaining and upgrading their systems increases the likelihood of an extended-life outcome for the project.
		Source: *"United Nations Clean Development Mechanism Project Design Document Form", last modified October 4, 2010, http://cdm.unfccc.int/filestorage/K/E/3/KE3WLJ1G9FNAQUTSOYRMIB5H680427/PDDAESTunjita.pdf ?t=dnp8bmR3bGVmfDBIBbbbGNrA0wcZFyOGDjbV, 47.*
		RECOMMENDATIONS None at this time.
LD0.0 Innovate Or Exceed Credit Requirements		*N/A*
	42	

CATEGORY II: CLIMATE AND ENVIRONMENT		
RESOURCE ALLOCATION		
	Score	**TUNJITA HYDROELECTRIC PROJECT**
RA1.1 Reduce Net Embodied Energy	**0**	No Score
		Embodied energy analysis was not performed and therefore could not factor into contractor

		purchasing decisions.
		Source:
		RECOMMENDATIONS Perform a net embodied energy analysis per Envision guidelines. This will help to make improvements in this area by possessing a solid understanding of the energy dynamics of the project materials.
RA1.2 Support Sustainable Procurement Practices	**2**	Improved
		In spite of having limited sourcing options for the equipment being installed, AES Chivor has systematically endeavored to acquire the most sustainable variants available. Particular attention has been placed on the procurement practices of the primary site contractor, Coninsa Ramón H. S.A.1 Coninsa holds Environment Management Systems ISO 14001:2004 certification2. This international licensure enforces a methodical approach to sustainable construction practices. An example of this sustainable procurement focus is the choice of cement and concrete supplier, Argos3. The environmental performance of this multinational is recognized in the Dow Jones World Sustainability Index4.
		Source: *1. "FICHAS DE MANEJO AMBIENTAL OBRA PCH TUNJITA", October 24, 2014, 10.* *2. "ISO 14001:2004 Coninsa R. H. S.A.", October 24, 2014.* *3. "INFORME MENSUAL DE PROGRESO FEBRERO 2014", October 24, 2014, 55.* *4. "Sostenibilidad", last modified last modified October 24, 2014, http://www.argos.co/colombia/sostenibilidad.*
		RECOMMENDATIONS None at this time.
RA1.3 Used Recycled Materials	**2**	Improved
		Recycled materials have been used to some extent throughout the project. All dirt and gravel used in construction, for instance, is reclaimed from initial excavation activities. In addition, the project's support structures, such as a medical center, office, and dining hall, are all dismantlable and reusable1. They will be redeployed at other sites following completion of the work at Tunjita. In sum, it is expected that over 20% of materials comprising the project will have been recycled.
		Source: *1. "Documento Proyecto BID de Infraestructura de Tunjita: Distribucion de Recursos," October 24, 2014, 5.*
		RECOMMENDATIONS None at this time.
RA1.4 Use Regional Materials	**0**	No Score
		The project takes place in a rural area away from manufacturing centers. While AES Chivor procurement policy preferences purchasing of locally produced goods, procurement personnel were unable to find such goods. For instance, the only South American manufacturer of the most important component of the project, hydraulic Francis turbines, is based out of Brazil, making Colombian turbine sourcing a moot point.

		Source: *"Documento Proyecto Premio BID de Infraestructura: Distribucion de Recursos", last modified October 24, 2014, 4.*
		RECOMMENDATIONS None at this time.
RA1.5 Divert Waste From Landfills	**0**	No Score
		Thorough policies are in place for the collection, storage, reuse, and/or sale of divertible project waste on site. In 2013, 11% of waste qualified for diversion, which is below the 25% minimum threshold for credit attainment1.
		Source: *1. "Documento Proyecto BID de Infraestructura de Tunjita: Distribucion de Recursos," October 24, 2014, 9.*
		RECOMMENDATIONS None at this time.
RA1.6 Reduce Excavated Materials Taken Off Site	**6**	Conserving
		Excavation has yielded about 100,000 m3 of material. Of this, 4,000 m3 was reintegrated into the machine house and diversion tunnel1. The remainder has been left on-site, and will shortly be reshaped into a permanent landmass2. Most will be dedicated to a creating a substantial hill with scenic views of the entire complex3. Plans are in place to revegetate the excavated materials once landscaping is complete. These steps, taken collectively, may to serve to make the dam a tourist destination and point of pride for the community.
		Source: *1. "Documento Proyecto BID de Infraestructura de Tunjita: Distribucion de Recursos," October 24, 2014, 12.* *2. "Plano depósito", October 24, 2014.* *3. "Concepto técnico - Viabilidad ambiental depósitos N2 y N7 Corpochivor", October 24, 2014.*
		RECOMMENDATIONS None at this time.
RA1.7 Provide for Deconstruction & Recycling	**1**	Improved
		End-of-life assessments have been made concerning project materials. The dam and machine house components have been designed to last for a minimum of 50 years, however, with occasional upgrades to follow1. Ease of deconstruction was therefore not a part of the design intent. Nevertheless, it is estimated that 10% of the civil structures and 100% of the project electronics can be viably recycled2.
		Source: *1. "United Nations Clean Development Mechanism Project Design Document Form", last modified October 4, 2010, http://cdm.unfccc.int/filestorage/K/E/3/KE3WLJ1G9FNAQUTSOYRMIB5H680427/PDDAESTunjita.pdf?t=dnp8bmR3bGVmfDBIBbbbGNrA0wcZFyOGDjbV, 43.* *2. "Documento Proyecto BID de Infraestructura de Tunjita: Distribucion de Recursos," October 24,*

		2014, 14.
		RECOMMENDATIONS Even though it is expected that the plant will be operational for the better part of a century, its design should still take into account facilitation of disassembly and component reuse. It may be wise, for instance, to ensure that the turbines can be removed and replaced without needing to demolish any machine house walls. Natural disaster and unexpected equipment failure, among many other factors, may precipitate premature deconstruction, making easy disassembly worthy of consideration as a critical design feature.
RA2.1 Reduce Energy Consumption	**0**	No Score
		Power is being drawn from the national grid during the project. While this energy is 70%+ renewable in origin, it does not constitute an energy consumption reduction measure in itself.
		Source:
		RECOMMENDATIONS Early in the planning process, make a point of assessing how facility energy demand can be reduced. Demand can often be reduced through cost-free measures, such as smart manipulation of the building orientation and envelope shape.
RA2.2 Use Renewable Energy	**20**	Restorative
		The plant will be a net positive renewable energy source as soon as it comes online. It will draw from its own energy, about 8,000 kWh/mo, to power itself1. The remainder of the energy is to be directed into the national grid.
		Source: *1. "Documento Proyecto BID de Infraestructura de Tunjita: Distribucion de Recursos," October 24, 2014, 14.*
		RECOMMENDATIONS None at this time.
RA 2.3 Commission & Monitor Energy Systems	**3**	Enhanced
		Advanced monitoring systems have been implemented across the facility so Chivor Plant managers will know exactly how much electricity is being generated at any given time and how efficiently it is being delivered to the grid1.
		Source: *1. "Documento Proyecto BID de Infraestructura de Tunjita: Distribucion de Recursos," October 24, 2014, 16.*
		RECOMMENDATIONS None at this time.
RA3.1 Protect Fresh Water Availability	**4**	Enhanced
		Hyper-local hydrological conditions have been monitored for the past 35 years by AES Chivor. Much of their data is drawn from meteorological stations run by the Colombian Institute of Hydrology,

		Meteorology, and Environmental Studies (IHMEAC)1. This fine-grained understanding of local waterways, precipitation, and other hydrological phenomena allows them to predict water conditions at Tunjita with a high degree of certainty2. The dam being upgraded allows control of water flow rate, so water can be metered at the appropriate rate given these predictions. The region surrounding Tunjita is very moist with an average precipitation in excess of 1.5 meters annually so flow rates should consistently remain high.
		Source: *1. "Documento Proyecto BID de Infraestructura de Tunjita: Distribucion de Recursos", October 24, 2014, 16.* *2. "Programa Uso Eficiente y Ahorro del Agua - Tunjita Valle", October 24, 2014.*
		RECOMMENDATIONS None at this time.
RA3.2 Reduce Potable Water Consumption	**0**	No Score
		Policies are in place to monitor and minimize water usage during construction. The aforestated policies have resulted in an anticipated 5% decrease in overall consumption1. The machine house will use very little potable water, and no substantive effort to curtail this nominal usage was deemed necessary.
		Source: *1. "Programa Uso Eficiente y Ahorro del Agua - Tunjita Valle - Uso de Agua Industrial (Adecuación Y Construcción De Túneles Y PCH)", October 24, 2014.*
		RECOMMENDATIONS None at this time.
RA3.3 Monitor Water Systems	**3**	Enhanced
		As Tunjita is a hydroelectric plant, it is equipped with a diverse array of equipment and software to monitor and meter water. Independent contractors such as Asafranco Ltd. have been retained to evaluate the performance of these systems as well as water quality. Many in-flowing streams are already monitored for water quality by AES Chivor.
		Source: *1. "Monitoreo de calidad de agua del embalse La Esmeralda, cuerpos de aguas aportantes y receptores de caudales de la central.", October 24, 2014, 175.* *2. "Programa Uso Eficiente y Ahorro del Agua - Tunjita Valle - Uso de Agua Industrial (Adecuación Y Construcción De Túneles Y PCH)", October 24, 2014.*
		RECOMMENDATIONS Collected hydrological data should be submitted to the the International Stormwater BMP Database.
RA 0.0 Innovate Or Exceed Credit Requirements		*N/A*
	41	

NATURAL WORLD		
	Score	**TUNJITA HYDROELECTRIC PROJECT**
NW1.1 Preserve Prime Habitat	**9**	Superior
		No zones within or adjacent to the Tunjita project site qualify as prime habitat, so the project avoids development in this areas. The surrounding soil is of poor quality, and when used at all by locals, it tends to be for the purposes of animal grazing rather than agriculture. Nevertheless, the vast majority of land within the project site will remain undisturbed.
		Source: *"Plan de Manejo Ambiental de Chivor, numeral 1.6.1 Características generales del entorno ambiental", November 6, 2014.*
		RECOMMENDATIONS None at this time.
NW1.2 Preserve Wetlands and Surface Water	**0**	No Score
		There is no buffer zone between the project and surface water, given that the machine house and Tunjita river are interdependent. Zones in excess of 100 meters generally buffer project activity from natural habitat, however.
		Source: *"Documento Proyecto Premio BID de Infraestructura: Mundo Natural", November 6, 2014, 3.* *"Anexo 8 Guía Ambiental y Social Construcción Proyecto Tunjita", November 6, 2014, 67-70.*
		RECOMMENDATIONS None at this time.
NW1.3 Preserve Prime Farmland	**0**	No Score
		Contractors did not meet the 95% threshold required to attain this credit. Soil in the vicinity is not especially fertile, however, and is used predominantly as pasture for grazing rather than agriculture.
		Source: *"Documento Proyecto Premio BID de Infraestructura: Mundo Natural", November 6, 2014, 3.*
		RECOMMENDATIONS None at this time.
NW1.4 Avoid Adverse Geology	**2**	Enhanced
		AES Chivor has extensively studied geological conditions in the area. Three studies in particular - Environmental Management Plan1, Evaluation of Erosive Activity and Geological Threats of the Chivor Watershed2, and Evaluation of Geology, Geomorphology and Chivor Facility Risk Areas3 - have informed construction-related decision making. The former plan stipulates operating procedures in accordance with these geological conditions and concomitant risks. This is a tectonically stable area and overall risk levels are assessed as low.

		Source: *1. "Plan de Manejo Ambiental", November 6, 2014.* *2. "Evaluación de la actividad erosiva y la amenaza geológica de la cuenca aportante a la central de Chivor", November 6, 2014.* *3. "La Evaluación geológica, geomorfológica y riesgos Central Chivor", November 6, 2014.*
		RECOMMENDATIONS Endeavor to bolster runoff controls, spill prevention mechanisms, and cleanup plans. Focus on risk management equally as much as on research and fact-finding projects.
NW1.5 Preserve Floodplain Functions	**2**	Improved
		The machine house has been constructed at 1282 meters above sea level and five meters above the maximum reservoir level of 1277 meters. In spite of being above floodplain levels, impervious surfaces have been kept to a minimum. Post-construction landscaping and revegetation of the adjacent land further enhances site performance under flooding conditions1 2. Ultimately, the Tunjita Plant will be invulnerable to ocean storms; a cataclysmic one-in-one-hundred year inland storm presents the greatest risk, nominal as it may be.
		Source: *1. "Fichas de manejo ambiental, N° 14", November 6, 2014.* *2. "FIS-TUNJITA conservación obras de control Tunjita Valle", November 6, 2014.*
		RECOMMENDATIONS Enhance riparian and aquatic habitat per Envision guidelines. For example, investigate ways water might be filtered prior to entering the reservoir.
NW1.6 Avoid Unsuitable Development on Steep Slopes	**1**	Improved
		The Tunjita Plant, comprising as it does a dam, requires a substantial gradient in order to function. Contractors have nonetheless maintained existing terrain to the greatest extent possible. Excavated land is being shaped, post-intervention, to best handle water flow. Revegetating disturbed soil adjacent to the site will also serve to minimize runoff and erosion1. Response plans have also been drafted in the event of machine house flooding2.
		Source: *1. "Fichas de manejo ambiental, N° 14", November 6, 2014.* *2. "FIS-TUNJITA conservación obras de control Tunjita Valle", November 6, 2014.*
		RECOMMENDATIONS None at this time.
NW1.7 Preserve Greenfields	**10**	Superior
		Over 75% of construction is taking place on greyfield sites1. Much of project land was developed in the 1980s during construction of civil structures associated with the Chivor Plant, and hence qualifies as greyfield.
		Source: *"Documento Proyecto Premio BID de Infraestructura: Mundo Natural", November 6, 2014, 13.*
		RECOMMENDATIONS

		None at this time.
NW2.1 Manage Stormwater	**9**	Superior
		Stormwater management has been a priority throughout the development process. Excavation has been conducted with stormwater flow in mind, and post-construction landscaping will likewise be carried out to better control flow. The Chivor reservoir is also being upgraded so as to accommodate a one meter water level increase. A 90% storage rate is expected.
		Source: *"SEG-02: Monitoreo de aguas", November 6, 2014.* *"Monitoreo de calidad de agua del embalse La Esmeralda, cuerpos de aguas aportantes y receptores de caudales de la central", November 6, 2014, 37-49.*
		RECOMMENDATIONS Work to implement low impact development measures such that storm runoff quantity returns to pre-dam conditions.
NW2.2 Reduce Pesticides and Fertilizer Impacts	**9**	Conserving
		No pesticides or artificial fertilizers will be applied at the project site1. Species to be planted are all indigenous and hardy, and hence do not require chemicals to grow in the area. Moreover, these species will be planted in combination with natural fibers, organic nutrients, and the seeds of regional plants. The selected plants demonstrate above-average drought and flood tolerance, and can grow in the poor soils surrounding the Tunjita facility.
		Source: *1. "Plan de Mantenimiento de áreas revegetalizadas", November 6, 2014.*
		RECOMMENDATIONS None at this time.
NW2.3 Prevent Surface and Groundwater Contamination	**1**	Improved
		AES Chivor's purchasing policies prioritize non-polluting substances that will not lead to contamination, even in the case of accidental release. Plans have been drafted to assist with an effective response to spills and leaks. The machine house has been designed with leak risk mitigation in mind. Nearby groundwater is at substantially reduced risk in comparison to facilities lacking these safeguards.
		Source: *"FICHA 5 – Manejo de aguas residuales domésticas", November 6, 2014.* *"FICHA 6 – Manejo de aguas residuales industriales", November 6, 2014.* *"FICHA 12 – Manejo adecuado de combustibles, grasas y aceites", November 6, 2014.* *"FICHA 23 – Plan de emergencias y contingencias ambientales", November 6, 2014.*
		RECOMMENDATIONS Institute a water quality monitoring program and ensure that data thereby collected are submitted to the International Best Practices Stormwater Database.
NW3.1 Preserve	**2**	Improved

Species Biodiversity		Project managers have worked to identify and protect habitat. This is a highly biodiverse region with the nearest nature preserve located only four km away. Biodiversity will be maintained due to the landscaping and revegetation initiatives to be conducted upon construction completion. Furthermore, signage has been posted on nearby roads warning motorists that they are entering a wildlife corridor. However, there ought to be minimal traffic surrounding the site once machine house and diversion tunnel assembly are concluded. In sum, habitat surrounding the dam will quickly be restored to pre-intervention levels.
		Source: *"Fichas de manejo ambiental", November 6, 2014.*
		RECOMMENDATIONS None at this time.
NW 3.2 Control Invasive Species	**5**	Superior
		Plant species to be planted post-construction are all indigenous to the region. No noxious weeds, pesticides, or fertilizers will be used to expedite revegetation. Invasive species control has not factored into decision-making or environmental management plans.
		Source: *"Fichas de manejo ambiental", November 6, 2014.*
		RECOMMENDATIONS It is recommended that a biologist be hired to assess whether invasive plant species are found on or around the construction site. If they are indeed present, put in place a plan to remove them and rehabilitate the land to the extent possible.
NW3.3 Restore Disturbed Soils	**0**	No Score
		Only about 20% of disturbed soils will be restored around the footprint of the machine house, which is less than the 100% threshold required to attain this credit. Nevertheless, significant efforts have been made to responsibly manage excavated topsoils and subsoils, including the creation of erosion control zones and a scenic outlook mound composed of excess excavated soils.
		Source: *"Documento Proyecto Premio BID de Infraestructura: Mundo Natural", November 6, 2014, 22.*
		RECOMMENDATIONS It is recommended that a more systematic approach to topsoil reuse be adopted, such that soil restoration is more highly prioritized. Creative landscaping might be used as a tool to accommodate a greater quantity of disturbed soil.
NW3.4 Maintain wetland and surface water functions.	**0**	No Score
		While the project team has worked to minimize impacts on the quality of adjacent water systems, they have not managed to substantively enhance an ecosystem function. Sediment and water quality control efforts have diminished the dam's environmental impact.
		Source: *"Fichas de manejo ambiental", November 6, 2014.*

		RECOMMENDATIONS Improved monitoring of water quality prior to passing through the dam may be a prudent measure. A filtration system for contaminants might consequently be advised. Further thought should be given to how fish and other riparian life could pass through the dam unscathed. Regardless of intervention type, the opportune siting of the plant affords AES Chivor a valuable platform for water quality improvement.
NW 0.0 Innovate Or Exceed Credit Requirements		***N/A***
	50	

CLIMATE AND RISK		
	Score	**TUNJITA HYDROELECTRIC PROJECT**
CR1.1 Reduce Greenhouse Gas Emissions	**18**	Conserving
		This project will contribute to the greenhouse gases reduction GHG) emission reductions, providing renewable energy for Colombia. An estimation of the carbon reduction has been conducted in the (CDM PDD).Project managers estimate that about 32,000 tons of CO2 emissions will be avoided each year the plant runs2, though this estimate is not related to the carbon consumption or emissions released during construction.
		Source: *1. "PROJECT DESIGN DOCUMENT FORM (CDM PDD)", November 6, 2014, 30-41.* *2. "United Nations Clean Development Mechanism Project Design Document Form", last modified October 4, 2010, http://cdm.unfccc.int/filestorage/K/E/3/KE3WLJ1G9FNAQUTSOYRMIB5H680427/PDDAESTunjita.pdf ?t=dnp8bmR3bGVmfDBIBbbbGNrA0wcZFyOGDjbV, 10.*
		RECOMMENDATIONS Undertake a comprehensive life-cycle carbon analysis per Envision guidelines.
CR1.2 Reduce Air Pollutant Emissions	**2**	Improved
		The construction activities were in compliance with Colombia's air quality law - Resolution 0610. This regulation controls some of the six pollutants used on the California Ambient Air quality Standards (CAAQS). The polutants controlled by the colombian regulations are : particulates, ozone, carbon monoxide, sulfur oxides, nitrogen oxides.
		Source: *"Plan de Manejo Ambiental para la Construcción del Proyecto", November 6, 2014.*
		RECOMMENDATIONS Identify where in the project life cycle these six emissions types are likely to take place. Design protocols to mitigate emissions of these types.

CR2.1 Assess Climate Threat	**0**	No Score
		A comprehensive climate impact assessment and adaptation plan was not developed. This plan ought to consist of a vulnerability assessment, risk assessment, and adaptation assessment. It is imperative that such a plan take into account how climate change might manifest specifically in the Tunjita area. Collaboration with those in charge of local emergency management is also a crucial component of this step and this credit.
		Source: *"Documento Proyecto Premio BID de Infraestructura: Clima y Riesgo", last modified November 18, 2014, 3.*
		RECOMMENDATIONS Develop a comprehensive climate impact assessment and adaptation plan per Envision guidelines.
CR2.2 Avoid Traps And Vulnerabilities	**6**	Enhanced
		The project team has worked hand-in-hand with local communities to build a comprehensive action plan that accounts for long-term costs and risks. Resource depletion and infrastructure traps have been assessed. Residents in the adjacent towns of Garagoa and Macanal met in town hall meetings with the project team to discuss project vision and air concerns. A project hotline was established to provide a simple and transparent means of communication and collaboration for all stakeholders. Project risks were incorporated into the latest contingency plan, which is updated every five years to reflect the current risk landscape.
		Source: *"Términos de Referencia para el análisis de estabilidad de la quebrada El Pino", November 18, 2014.* *"Presentación de la integración del PADEC", November 18, 2014.*
		RECOMMENDATIONS Expand work with people in local communities to build a robust and resilient relationship, whence might emerge a more complete framework for vulnerability assessment and response.
CR2.3 Prepare For Long-Term Adaptability	**0**	No Score
		While the project team has worked to assess the nature and scope of threats arising from climate change over the long-term, the machine house and diversion tunnel designs have not been substantially modified as a result.
		Source: *"Términos de Referencia para el análisis de estabilidad del contorno del embalse", November 18, 2014.*
		RECOMMENDATIONS Consider how the form of the civil structures might be adapted to withstand flooding and drought - two climate phenomena to which the Esmeralda basin is vulnerable. Consider also how the new facilities could double-function, i.e. serve a separate and distinct role from power generation in the event water flow cuts out and bringing power to the grid is no longer a mission objective.
CR2.4 Prepare For Short-Term Hazards	**10**	Superior
		AES Chivor has rigorously prepared for one in 50 year hazards. Their Emergency and Environmental

		Contingency Plan outlines in detail possible threats faced by the facility including landslides, floods, dam breaches, electromechanical failure, etc. Threat-specific responses are described in each case. Facility employees will be familiarized with these threats and response protocols.
		Source: *"FICHA 23 – Plan de Emergencias y Contingencias Ambientales", November 18, 2014.* *"Plan de Atención y Prevención de Emergencia y Contingencias PADEC", November 18, 2014, 295-297.*
		RECOMMENDATIONS None at this time.
CR2.5 Manage Heat Island Effects	**0**	No Score
		Nearly all tubing tubing and diversion tunnel infrastructure are located underground and hence do not play a role in generating heat islands1. As the land area to be covered by the machine house totals to less than a few hundred square meters, the heat island effect was not factored into facade and roofing purchasing decisions2.
		Source: *1. "Documento Proyecto Premio BID de Infraestructura: Clima y Riesgo", last modified November 18, 2014, 7.* *2. "MICROCENTRAL EN LA DESVIACIÓN DEL RÍO TUNJITA", last modified November 18, 2014.*
		RECOMMENDATIONS None at this time.
CR0.0 Innovate Or Exceed Credit Requirements		*N/A*
	36	
OVERALL:	**193**	**Tunjita Hydroelectric Project**

APPENDIX E: SOURCES

DOCUMENTATION PROVIDED
General Information.
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"Central Hidroelectrica de Chivor", last modified September 4, 2014, 59.
"Plan de Salud y Guia de Seguridad: AES Corporation", last modified September 26, 2014.
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"Documento Proyecto Premio BID de Infraestructura: Calidad de Vida", last modified October 17, 2014, 19.
"Anexo Iluminación A Estándar para la construcción de instalaciones eléctricas provisionales seguras", last modified September 26, 2014.
"United Nations Global Compact: Participants & Stakeholders", last modified June 20, 2013, https://www.unglobalcompact.org/participant/19548.
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Santos, D. "Optimizamos los recursos para no impactar al medio ambiente," IngeSOCIOS, August - September 2014, 14-15.
"Tunjita Power Plant", last modfied December 21, 2013, http://www.chivor.com.co/en/qui/SitePages/PCH%20Tunjita.aspx
"Informe de Sostenibilidad 2013 - Construyendo un Cambio", last modified June 2014. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCEQFjAA&url=http%3A%2F%2Fwww.chivor.com.co%2Fen%2Fnue%2FInformes%2520de%2520gestin%2FInforme%2520de%2520Sostenibilidad%25202013%2520-%2520Construyendo%2520un%2520cambio.pdf&ei=9q1JVOOkO9SAsQTQm4DIDg&usg=AFQjCNFC_U70QFx4Dtq
Escobar, Arango. "Inventoria y Asesoria Ambiental: Informe N. 16," May 2014.
"Matriz General Aspectos - Impactos Ambientales Chivor - Tunjita," November 8, 2012.
"Informe semanal SISO Tunjita," September 16, 2014.
"Respuesta Incoder Comunidades Etnicas", February 22, 2010.
"Minuta reunion stakeholders ago 2010", September 26, 2014.
"Minuta reunion stakeholders jun 2010", September 26, 2014.
"Concepto MAVDT - Tunjita", September 12, 2014.
"Acta compromiso comunidad Macanal", September 26, 2014.
"Minuta reunion stakeholders ago 2010", September 26, 2014.
"FICHAS DE MANEJO AMBIENTAL OBRA PCH TUNJITA", October 24, 2014, 10.
"ISO 14001:2004 Coninsa R. H. S.A.", October 24, 2014.
"INFORME MENSUAL DE PROGRESO FEBRERO 2014", October 24, 2014, 55.
"Sostenibilidad", last modified last modified October 24, 2014, http://www.argos.co/colombia/sostenibilidad.
"Documento Proyecto BID de Infraestructura de Tunjita: Distribucion de Recursos," October 24, 2014.
"Concepto técnico - Viabilidad ambiental depósitos N2 y N7 Corpochivor", October 24, 2014.
"Programa Uso Eficiente y Ahorro del Agua - Tunjita Valle", October 24, 2014.
"Monitoreo de calidad de agua del embalse La Esmeralda, cuerpos de aguas aportantes y receptores de caudales de la central.", October 24, 2014, 175.
"Anexo 8 Guía Ambiental y Social Construcción Proyecto Tunjita", November 6, 2014, 67-70.
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"Evaluación de la actividad erosiva y la amenaza geológica de la cuenca aportante a la central de Chivor", November 6, 2014.