

Caldera Fialé Geothermal
Exploration Project
**Environmental and Social
Management Plan**

January 2016



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ENVIRONMENTAL, INC.

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Caldera Fialé Geothermal Exploration Project **Environmental and Social Management Plan**

January 2016

Prepared for:

Republic of Djibouti

World Bank

African Development Bank

French Development Agency

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ES.1 PURPOSE

The Republic of Djibouti proposes geothermal exploration of the Caldera Fialé area in Djibouti to evaluate the feasibility of commercial production of geothermal energy. The purpose of this Environmental and Social Management Plan (ESMP) is to specify requirements to minimize and mitigate environmental and social impacts of the Geothermal Exploration project (proposed project).

ES.2 BACKGROUND

Previous geothermal exploration in the Lake Assal region included temperature testing of a potential geothermal resource in the late 1980s. Temperature testing revealed a bottom temperature of 359° C at 2,105 meters below ground surface in the Lake Assal region (Fichtner GmbH & Co. KG 2012), enough to sustain commercial production; however, disagreements on the need for additional geothermal exploration in combination with an economic crisis hindered the development of a commercial geothermal power plant.

The Republic of Djibouti was awarded funding in 2013 from the World Bank, African Development Bank (AfDB), the French Development Agency, OPEC FUND, GEF and ESMAP to finance the exploration of a geothermal resource in the Caldera Fialé area. The proposed exploration area is located approximately 70 kilometers west of Djibouti City in the Tadjoura region.

ES.3 PROJECT SUMMARY

The Republic of Djibouti proposes to construct up to three well pads and may drill four to eight geothermal wells for geothermal resource exploration in the Caldera Fialé area in Djibouti. The project would involve the following steps:

- **Roads.** Rehabilitate existing access roads from the Djibouti – Tadjoura RN9 highway to the drilling sites and construct spur roads to the drilling sites using material from a quarry near the project site
- **Well Pads.** Construct up to three well pads, each with a surface area of 0.6 to 1 hectare, with water tight tanks or open reserve pits for discharge of mud and geothermal fluids produced during the production tests
- **Water Supply.** Obtain water supply for drilling mud from either the Bay of Ghoubet or shallow seawater wells near the project access road
- **Water Pipelines.** Lay pipelines for water supply and discharge of geothermal fluids
- **Worker Camp.** Establish a camp for workers and security officers
- **Storage Area.** Construct a temporary storage area
- **Drill Wells.** Construct and drill test up to four geothermal exploration wells
- **Test.** Flow test wells for up to 2 days for short term test and up to 14 days for the long term test to determine commercial potential

Site preparation would involve grading and laying gravel for the workers camp, temporary storage area, well pads, and access roads; installation of temporary fencing around the storage area; and installation of temporary pipelines.

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Drilling would follow site preparation activities. Full-sized geothermal exploration wells capable of future geothermal production would be drilled to a depth between 2,000 and 2,500 meters, and well and reservoir testing would be conducted to analyze the characteristics of the geothermal resource. If the wells are determined to not have commercial potential, the wells would be abandoned and the site would be returned to approximately its original condition. Construction, drilling, and well testing are expected to last a total of approximately 13 months.

ES.4 OBJECTIVE

The primary objective of the Proposed Project is to evaluate the technical and financial feasibility of using the geothermal resources in the Caldera Fialé area for commercial production of electricity.

ES.5 ORGANIZATION

This ESMP is organized as follows:

- **Chapter 1: Introduction.** Provides an overview of the ESMP, background, and the proposed project
- **Chapter 2: Project Description.** Provides a detailed description of project facilities and construction activities.
- **Chapter 3: Legislative Framework.** Provides a summary of relevant policies, regulations, and guidance applicable to the project; includes information on numeric standards for air, noise, soil, and water quality
- **Chapter 4: Methodology.** Describes the approach to preparation of the ESMP, definition of mitigation measures, and public consultation
- **Chapter 5: Public Consultation/Communication.** Describes stakeholders contacted during the public outreach process, concerns, and methods to address public concerns
- **Chapter 6: Environmental and Social Impacts.** Summarizes the positive and negative impacts of the project include direct, indirect, and cumulative impacts
- **Chapter 7: Mitigation Management and Monitoring Plan.** Includes the detailed mitigation measures, roles and responsibilities for implementing the measures, and reporting procedures.
- **Chapter 8: Institutional Structure and Capacity Building.** Defines the institutional structure and capacity for the PMU and key actions for capacity building.

ES.6 METHODOLOGY

The following actions were taken during preparation of this ESMP to identify mitigation measures to avoid, reduce, and compensate for impacts of the proposed project:

- Perform a literature review to identify the positive and negative impacts of the proposed project
- Perform a detailed review of the measures proposed in the Summary ESMP
- Conduct a site reconnaissance to evaluate site access and environmental constraints
- Conduct public outreach to solicit the concerns of various ministries of the Republic of Djibouti and local communities

ES.6.1 Public Consultations

Public outreach was conducted during preparation of the ESIA Framework in 2012. Additional public outreach was conducted during preparation of this ESMP. Meetings were held with government ministers, the Region of Tadjoura, and the local community on 12, 13, and 14 of December 2015. Key public concerns raised during public outreach and the method to address each concern is summarized in Table ES.6-1. Notes from the public meetings are included in Appendix C.

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Table ES.6-1 Summary of Stakeholder Concerns and Methods to Address those Concerns

Key Concerns	Method to Address Concern
Availability of water for the project and use of water	The contractor is required to provide adequate water for the workers and use of sea water for drilling and dust control rather than fresh water
Protection of fish in Bay of Ghoubet	The intake in Ghoubet will require screening and regular cleaning to avoid intake of fish
Availability of water for the local population	The contractor will need to supply water to the local population during construction
Education for the local population	Educational books on geothermal energy production will be provided to the community
Employment for women and use of women as mediators for project grievances	Women will receive preference in hiring
Health care for the local population	A one-day health clinic will be held in the local community
Employment for the local population and workers in the Tadjoura region	The local population and Tadjoura residents will receive preference in hiring
Protection of the transhumance corridor (east of the project)	The project location and design avoid impact on the corridor
Capacity building and training for workers in Djibouti	Capacity building is discussed in Chapter 8 of the ESMP
Project schedule and need for low cost power in Djibouti	The project schedule has been expedited
Worker exposure to heat	The contractor will need to address heat exposure in the health and safety plan and implement measures to reduce worker exposure to unsafe heat
Cumulative impacts from reconstruction of RN9 highway, construction of arailway between the Port of Tadjoura and Ethiopia, construction of the port at Ghoubet, the salt project at Lake Assal, and the wind development project at Lake Assal	A cumulative impact analysis is included in Chapter 6 of the ESMP
Protection of biodiversity and important bird areas	The project avoids impacts on important bird areas; impacts to vegetation are minimal and will be avoided to the extent feasible
Protection of water quality at Lake Assal, a protected area	Erosion control, hazardous materials control, and wastewater measures will be implemented during construction
Management of wastewater according to Djibouti regulations	Wastewater measures will be implemented to comply with local regulations

ES.7 SUMMARY OF ENVIRONMENTAL AND SOCIAL IMPACTS

ES.7.1 Positive Impacts

Positive impacts of the project include socioeconomic benefits, and benefits to women and tourism. The project would temporarily employ approximately 20 local workers, which would generate income for local peoples. The workers camp would temporarily house workers during their employment and would provide them with a clean, safe, and drug-free environment. Women would be recruited. The worker camp would also provide segregated washing and sanitary facilities for women and men. The project would benefit tourists interested in geothermal energy technology. The improved roads would also benefit tourism in the area by providing better access to and from sites such as Ardoukoba Volcano and Lava Lake and the improved roads would remain in place after the geothermal exploration is completed.

ES.7.2 Negative Impacts

Negative impacts of the project would range from impacts on coastal and marine habitats to safety issues inherent to construction and well testing. The Caldera Fialé area is sloped towards the Bay of Ghoubet, which is proposed for listing as a marine protected area due to the whale shark and dugong that inhabit the bay. The bay would be negatively impacted in the unlikely event that drilling fluid was dumped into its waters. The water intake valve and water pump that may be placed into the Bay

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of Ghoubet for water supply would have the potential to damage or fatally injure fish or other marine organisms. Suction at the intake valve could also increase turbidity of the water surrounding the valve, affecting water quality.

Impacts associated with construction of the access road and well pads include erosion from grading and compaction of fill material, temporary restrictions on road use by tourists, and modifications to the appearance of the lava fields and landscape in the project area. Construction of the access road and wells pads would also generate pollutant emissions from use of construction equipment and dust from equipment traveling on roads.

Workers could be adversely impacted by a variety of sources during construction and well testing. Drilling and well testing could produce pollutant emissions from drilling fluids, which may contain carbon dioxide, hydrogen sulfide, and methane gases at harmful concentrations. Workers would be exposed to significant noise levels during drilling and well testing, which could harm their hearing. Ingestion of drilling and geothermal fluid or exposure to hazardous materials could pose a hazard to workers. Workers would be prone to heat exhaustion in the project area where temperatures can reach above 40 degrees Celsius. Well blowouts, pipeline failures, and seismic and volcanic events could also pose a significant hazard to workers in the unlikely event of their occurrence.

Several other projects are proposed in the same region as the proposed project. These projects include the expansion of a port of the Bay of Ghoubet for the transport of salt mined from Lake Assal, construction of a 60 megawatt wind power plant, and a water supply and sanitation project proposed in rural areas of Djibouti, reconstruction of the RN9 highway, and a railway between the Port of Tadjoura and the Ethiopian border. While physical impacts associated with the proposed project would not combine with impacts of these projects to result in a cumulative impact, socioeconomic impacts could affect the same communities as those affected by the proposed project.

ES.8 MITIGATION AND MONITORING

ES.8.1 Roles and Responsibilities

The Mitigation Management and Monitoring Plan (MMMP) identifies mitigation measures to reduce impacts from the project. The MMMP also describes the roles of participating parties and identifies procedures to ensure that mitigation measures are implemented during all phases of the project.

Electricité de Djibouti is ultimately responsible for overseeing all aspects of the project and implementation of the mitigation measures in the MMMP. A Project Management Unit (PMU) will manage the project and will include an environmental, health, and safety expert and social issue expert who will verify that mitigation measures are implemented adequately. The PMU will submit quarterly monitoring reports to designated members of the World Bank and AfDB and will document implementation of the MMMP and compliance with mitigation measures and applicable regulations. The PMU and GCC are also responsible for the oversight of all contractors hired to construct the project.

A Steering Committee comprised of agencies with a stake in the project or who are responsible for enforcing environmental regulations will provide administrative and financial oversight for the project.

ES.8.2 Mitigation Measures

Mitigation measures included in the MMMP include provisions to avoid, reduce, and compensate for adverse impacts of the project. Mitigation measures are summarized in Table ES.8-1.

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Table ES.8-1 Summary of Mitigation Measures

Potential Impact	Mitigation Measure(s)
Geology	<ul style="list-style-type: none"> • Minimization of impacts to Lava Lake to protect the unique character of the lava beds • Assessment of the risk of geologic hazards to minimize impacts associated with rock falls or seismic events
Water Quality	<ul style="list-style-type: none"> • Erosion control measures to limit soil disturbance, minimize impacts to water quality, and manage infiltration of drilling and geothermal fluids • Specifications regarding the design of soak pits or evaporation ponds to ensure containment of geothermal fluid • Requirement to utilize non-toxic and biodegradable products to manufacture drilling mud where feasible • Testing of drill cuttings and emissions from the well to test for toxic materials such as heavy metals and hydrogen sulfide
Biology	<ul style="list-style-type: none"> • Weed management to prevent establishment of non-native plants • Design specifications of the water intake valve and pump in the Bay of Ghoubet to reduce impacts to marine wildlife • Procedures for reclamation and restoration of the project site
General	<ul style="list-style-type: none"> • Worker training to define worker safety protocols and define worker roles
Hazardous Materials	<ul style="list-style-type: none"> • Preparation of a Spill Prevention Control, and Countermeasure Plan to address hazardous material spills
Waste	<ul style="list-style-type: none"> • Preparation of a Waste Management Plan to define procedures to waste collection and disposal • Maintenance latrines
Safety and Health	<ul style="list-style-type: none"> • Hydrogen sulfide monitoring to ensure workers are not exposed to toxic concentrations • Provision of shade and personal protection to prevent heat exhaustion • Preparation of a Health and Safety Plan to avoid injuries and accidents • Application of water where necessary to suppress dust emissions on unpaved roads and disturbed areas • The supply of personal protective equipment, safety equipment, and first aid supplies for workers to protect them from harm • Use of blowout prevention equipment • First aid training for all workers • Drug and alcohol free workplace
Socioeconomic	<ul style="list-style-type: none"> • Display of informational panels and operation of a kiosk to provide information about the project • Sensitivity training for workers on local community traditions and culture • Support for women through training of women, worker training on respect for women workers, and use of women in the grievance redress procedures • Training on sexually transmitted diseases • Preferential hiring for local residents and women • Water supply for the local population • On-day health clinic for the local community and workers
Well Abandonment	<ul style="list-style-type: none"> • Well abandonment procedures to ensure proper capping of the wells

ES.8.3 Estimated Costs

The cost of each mitigation measure was estimated for the project. Some mitigation measures, such as well abandonment or the provision of safety equipment, contain standard procedures. Costs associated with these tasks were considered to be a standard construction cost and would not require additional funds associated with mitigation implementation. The total estimated mitigation cost would be approximately \$321,440 U.S. dollars.

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ES.8.4 Implementation and Verification Procedures

Mitigation measure requirements, as well as implementation and verification procedures, are applicable during one or more of three construction phases. Implementation phases include:

- Prior to construction (“Pre-construction”)
- During construction (“Construction”)
- Following construction (“Post-construction”)

The actions defined in Table ES.8-2 would be required for successful implementation of mitigation measures.

Table ES.8-2 Actions Required for Successful Implementation of Mitigation Measures

Procedure	Requirements	Implementation Phase
Auditing	Preparation of a pre-construction audit report that documents the detailed status of each project work area prior to project activities and includes photographs of each work area	Pre-construction
	Regular site visits by the project management unit environmental, health, and safety expert to verify compliance	Construction
	Preparation of a post-construction audit report that documents the conditions of all work areas after the completion of construction to compare the conditions of the site pre- and post-construction	Post-construction
Compliance Reporting	Completion of daily compliance checklists that summarize regular and ongoing mitigation requirements	Construction
	Completion of monthly compliance reports that document construction and compliance activities completed during the month	Construction
	Completion of quarterly compliance reports that document construction and compliance activities completed during the quarter and track the resolution of issues that may have occurred	Construction
Contractor Training	Train workers to understand safety protocols and mitigation measure requirements	Pre-construction and construction
Health, Safety, Environmental Incidents, and Non-compliance	Preparation of incident reports in the event of a fire, accident, hazardous material spill, or non-compliance with mitigation measures	Construction
	Preparation of notices of non-compliance if non-compliance with mitigation measure(s) occurs	Construction
Remedial Actions	Response to and addressing notices of non-compliance with corrective actions and implement conditional requirements if triggered	Construction

ES.8.4 Grievance and Redress Mechanism

The social issue expert will act as the key point of contact to resolve project grievances from construction workers, local residents, and community members. The expert is responsible for addressing project grievances and directing contractors to make any appropriate change to their work. The contractor shall take reasonable action to address grievances as required by local laws and this MMMP.

ES.9 INSTITUTIONAL CAPACITY AND CAPACITY BUILDING

The PMU has the primary responsibility for overseeing implementation of the measures in this ESMP. The PMU requires training and equipment to successfully implement the ESMP. In-office training sessions will be held with the PMU employees to provide training in geothermal exploration prior to construction. PMU employees will be paired with comparable GCC staff who are experienced in

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geothermal exploration to provide transfer of knowledge during well drilling and testing. The GCC will train the PMU EHS expert and social expert to implement the PMU monitoring.

The PMU requires the following equipment to fully implement the requirements in the ESMP:

- Carbon dioxide and hydrogen sulfide measurement instruments
- Chemical analysis field kit
- Liquid and gas sampling devices
- Flame ionization detector for gas chromatography equipment

1 INTRODUCTION

1.1 PURPOSE

The Republic of Djibouti proposes geothermal exploration of the Caldera Fialé area to evaluate the feasibility of commercial production of geothermal energy. The purpose of this Environmental and Social Management Plan (ESMP) is to specify requirements to minimize and mitigate environmental and social impacts identified in the Framework Environmental and Social Impact Assessment (ESIAP) and summary ESMP for the Geothermal Exploration Project (proposed project) in Djibouti. This ESMP specifies the mitigation measures that would be applied to construction and geothermal exploration and describes how these measures would be implemented. This ESMP also defines the necessary institutional capacity (including worker training), and financial and physical resources needed to avoid, minimize, or compensate for the environmental and social impacts that may occur as a result of the proposed project.

1.2 BACKGROUND

1.2.1 Project History

Djibouti has been a target of geothermal resource exploration since the 1970s. The French Bureau de Recherches Géologiques et Minières led the first exploration campaign in 1975 when two wells were drilled. A second drilling program partially financed by the World Bank took place in 1987 and 1988. An additional six wells were drilled during this drilling program to test geothermal resources specifically in the Lake Assal region (5 wells) and the Hanle (2 wells) region (REI 2008). Temperature testing revealed a bottom temperature of 359° C at 2,105 meters below ground surface in the Lake Assal region (Fichtner GmbH & Co. KG 2012), enough to sustain commercial production; however, donor disagreement on the need to conduct more exploration activities hindered the development of a commercial geothermal power plant. In the 2000s, the Republic of Djibouti and government of Iceland signed cooperation agreements to revive the effort (ONEC 2013). The 2008 financial crisis in 2008 stymied Iceland's ability to fund a drilling program, and the concession awarded to the Icelandic exploration company, Reykjavik Energy Invest, expired in 2009 (ONEC 2013).

1.2.2 Project Sponsors

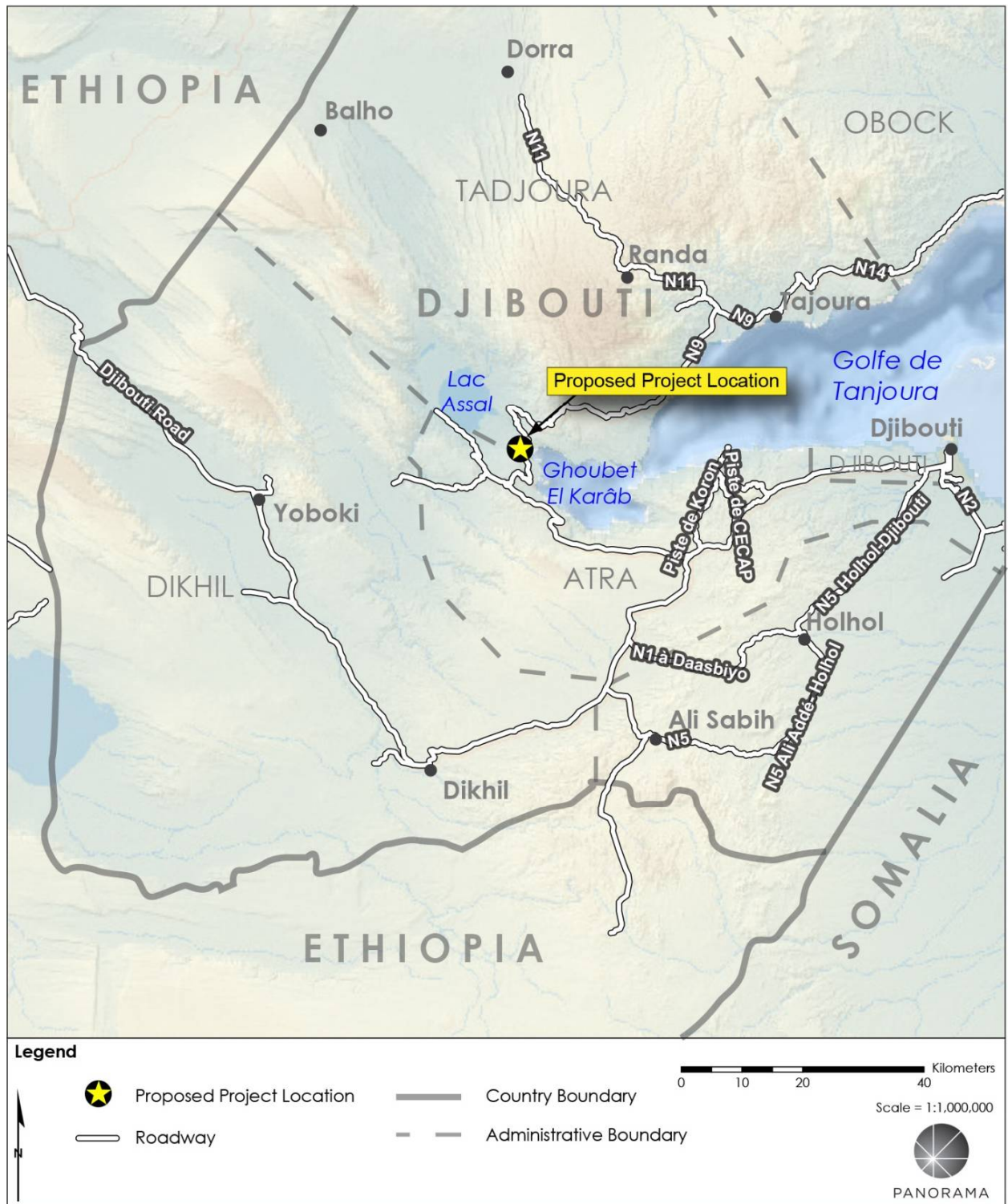
The Republic of Djibouti was awarded funding in 2013 from the World Bank, African Development Bank (AfDB), the French Development Agency, OFID, GEF and ESMAP to finance the exploration of a geothermal resource in the Caldera Fialé area. The project will be implemented by the Electricité de Djibouti. The proposed project would conform to the World Bank, AfDB, and Republic of Djibouti environmental and social policies, guidelines, and ESMP procedures.

1.3 PROJECT LOCATION

The proposed project is located in the Caldera Fialé area on the southwestern edge of the Tadjoura region, approximately 70 kilometers west of Djibouti, Djibouti (Figure 1.3-1). Lake Assal is located approximately 8 kilometers northwest of the proposed project area, and the Bay of Ghoubet is located approximately 2 kilometers east of the area. The drilling locations, described in greater detail below in Section 2, would be located along the fringe of Lava Lake, a circular depression in the center of the Caldera Fialé area.

1 INTRODUCTION

Figure 1.3-1 Proposed Project Location



Source: MapCruzin and OpenStreetMap undated

1 INTRODUCTION

1.4 PROJECT SUMMARY

The Republic of Djibouti proposes to construct up to three well pads and may drill four to eight geothermal wells for geothermal resource exploration in the Caldera Fialé area in Djibouti. The wells would range from 4 to 48 inches in diameter at the well bore. Figure 1.4-1 shows the project components. The project would involve the following major steps:

- **Roads.** Rehabilitate existing access roads from the Djibouti – Tadjoura RN9 highway to the drilling sites and construct spur roads to the drilling sites using material from a quarry near the project site
- **Well Pads.** Construct up to three well pads, each with a surface area of 0.6 to 1 hectare, with water tight tanks or open reserve pits for discharge of mud and geothermal fluids produced during the production tests
- **Evaporation Ponds or Soak Pits.** Evaporation ponds or soak pits may be constructed, as needed for the discharge of geothermal fluid from the long-term well tests
- **Water Supply.** Obtain water supply for drilling mud from either the Bay of Goubet or shallow seawater wells near the project access road
- **Water Pipelines.** Lay pipelines for water supply and discharge of geothermal fluids
- **Worker Camp.** Establish a camp for workers and security officers
- **Storage Area.** Construct a temporary storage area
- **Drill Wells.** Construct and drill test up to four geothermal exploration wells
- **Test.** Flow test wells for up to three months to determine commercial potential

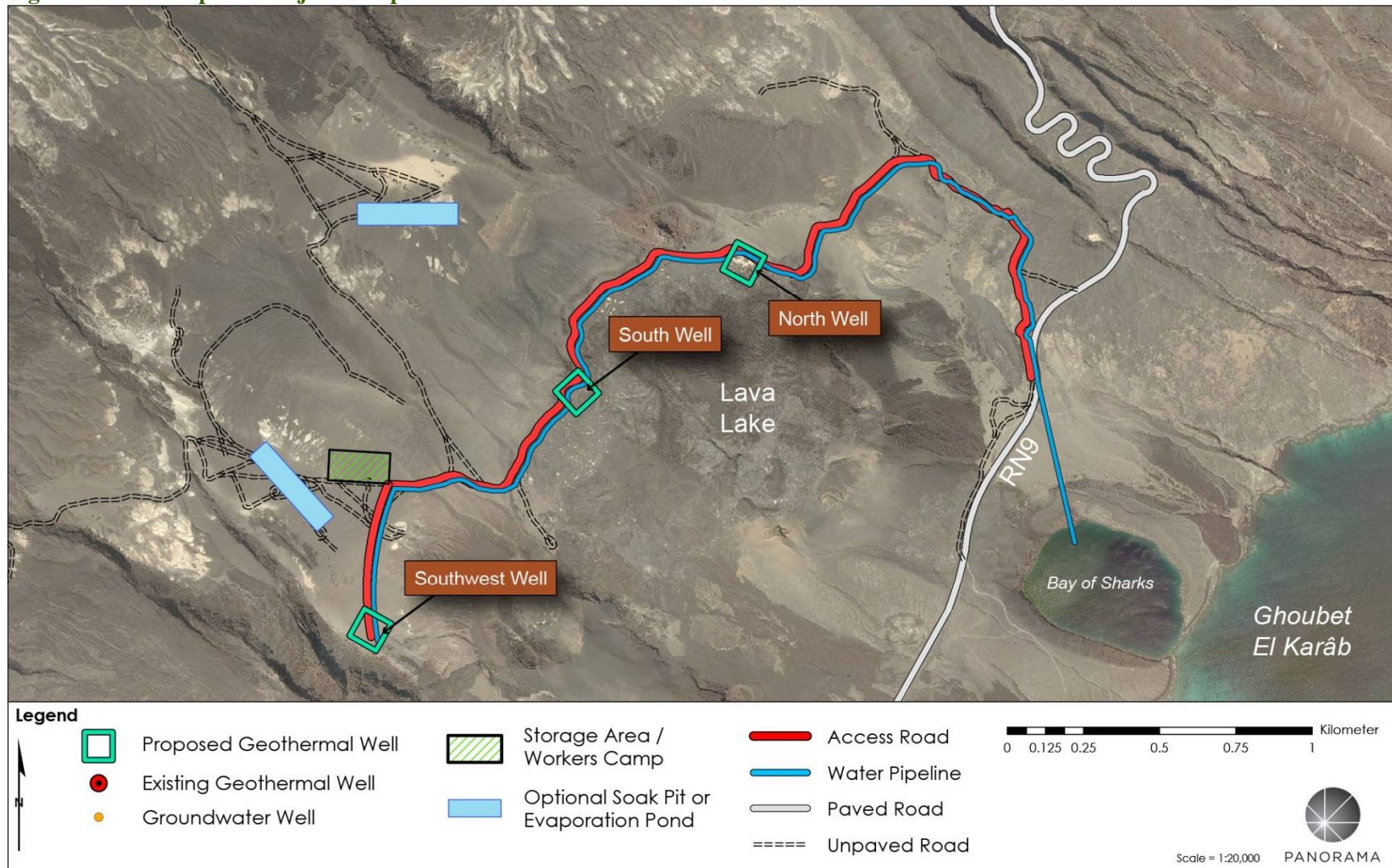
Construction and well testing are expected to last a total of approximately 13 months.

1.5 PROJECT OBJECTIVE

The primary objective of the proposed project is to evaluate the technical and financial feasibility of using the geothermal resources in the Caldera Fialé area for commercial production of electricity.

1 INTRODUCTION

Figure 1.4-1.5 Proposed Project Components



Source: Photomap International undated

2 PROJECT DESCRIPTION

2.1 PROJECT FACILITIES AND CONSTRUCTION METHODS

Detailed descriptions of project facilities are provided in Section 2.1.1 through 2.1.6. Figure 2.4-1 shows the location of project facilities. Site preparation activities are described first followed by well drilling activities.

2.1.1 Site Preparation

2.1.1.1 Access Roads

The project area would be accessed from the Tadjoura RN9 highway via new and existing roads (Figure 1.4-1). An existing unpaved access road from the Tadjoura RN9 highway to the Caldera Fialé area would be improved to provide access for large construction equipment, such as drill rigs. The new gravel access road would follow the alignment of the existing Lava Lake access road and the existing road would be widened and/or covered with gravel to support construction traffic and equipment. Sections of new access road would be constructed from the existing access road to the well pads.

Improvements to existing access roads and construction of new access roads would involve grading the road surface and application of a road base to support construction equipment (i.e., trucks transporting drill rigs). Blasting may be required in areas with abundant rocks to create a flat road surface or to avoid rock injuries and damage. Road base would be mined and transported from an existing quarry located approximately 10 kilometers west of the project area and along a new road that is currently under construction from the RN9 highway to Lake Assal. This existing quarry is being used to provide materials for the construction of the road to Lake Assal. Another quarry may be used as designated by local authorities. Access roads would be constructed to approximately 4 to 5 meters wide with passing locations placed every 200 to 400 meters. Passing locations would be approximately 7 to 8 meters wide. Construction of new access roads would occur immediately before well pad construction.

A total of approximately 4.3 kilometers of access roads would be constructed and improved, resulting in a total disturbance area of approximately 1.75 to 2.15 hectares. Roughly 90 percent of the roads would follow existing unpaved roads, and the remaining 10 percent would be newly constructed roads in undisturbed areas.

Improvements to existing access roads and new access roads would also serve tourist traffic in the area. There may be temporary closures during construction for safety purposes.

2.1.2 Storage Area

A storage area would be constructed near the worker camp on a flat area west of Lava Lake (Figure 1.4-1). The storage area/worker camp would be approximately 160 meters by 200 meters (approximately 3.2 hectares). Drilling material and equipment would be staged in the storage area and would be transported to the well pads or other project facilities as needed.

2 PROJECT DESCRIPTION

A security fence and lighting would be installed around the storage area. Hazardous materials, such as oil and lubricants for construction equipment, would be stored in the storage area. Used oil would be gathered and stored in tanks at the storage area until it could be transported off site and disposed of at a facility that can accept hazardous materials¹. A roof would be installed over a portion of the storage area to protect construction materials from the sun.

2.1.2.1 Worker Camp

A worker camp would be established for the duration of the project to house workers during construction, drilling, and testing. The worker camp would be located within a 160 meter by 200 meter area along with the storage area. The camp would be established on the site in a flat area west of Lava Lake. The worker camp would house between 50 and 100 workers and would include temporary housing for men and women, latrines for men and women, safe food and drinking water, air conditioning, first aid/medical facility, water storage, generators for electricity, and access to communication (e.g., satellite if needed).

2.1.2.2 Security and Fences

Security staff would monitor the site 24 hours per day, 7 days per week. There would be a shaded area for security workers within the material storage area. The material storage area would be enclosed with an approximately 2.4-meter-tall chain-link security fence.

2.1.2.3 Sea Water Wells or Intake and Pipeline

Water Sources for Drilling and Dust Control

Water for drilling and dust control would be obtained from either shallow groundwater wells or directly from the Bay of Ghoubet. Water would be pumped from the groundwater wells or Bay of Ghoubet to sumps at the well pads via pipelines located primarily along access roads. The sumps would be lined with bentonite to reduce groundwater infiltration.

Three to five shallow groundwater wells (up to 250 meters deep) may be drilled northeast of Lava Lake immediately adjacent to the access road (Figure 1.4-1). The wells would be constructed on a level pad approximately 100 square meters in size.

Alternatively, water may be supplied via a water supply intake in the Bay of Ghoubet and pumped to the project area. The intake would be placed below the tidal area and be constructed to minimize the intake of aquatic life and debris.

Seawater Supply Pipeline

Temporary pipelines would be installed along the new access roads described in Section 2.1.1 and potentially along a segment of RN9 highway if water is supplied directly from the Bay of Ghoubet. The pipelines would transport water from the shallow groundwater wells or Bay of Ghoubet to the well pads to supply water for drilling. If water is supplied from the Bay of Ghoubet, the pipeline would cross under the RN9 highway using jack and bore drilling methods. The temporary water supply pipelines would be removed from the project site after drilling.

2.1.3 Geothermal Exploration Wells

Three proposed well pad sites are identified for drilling locations:

- North site,
- South site, and
- Southwest site.

¹ There are no facilities within Djibouti that are authorized to accept hazardous waste. This material would need to be collected and shipped out of Djibouti to a hazardous waste treatment facility.

2 PROJECT DESCRIPTION

These sites have been identified for drilling to reach drilling targets. The proposed well pad locations were chosen for their proximity to the most promising temperature gradient and structural features for geothermal development², and to minimize surface disturbance and civil construction (such as avoiding the need for large retaining walls). Sites were selected to have minimal slope and to avoid drainages and hill slopes. These locations minimize the amount of grading necessary to level the sites and stabilize the area for the drill rig.

2.1.3.1 Well Pad Construction

Each well pad would be approximately 0.6 to 1.0 hectare in size (Figure 2.1-1). Well pad preparation would include grading, compacting if appropriate, and laying gravel. The drill pads would then be covered with gravel trucked from an existing quarry west of the project area that is currently in use for construction of a road to Lake Assal. Other existing quarries may be used depending on availability of material. The total amount of gravel required for drill pad and access road construction is estimated to be 15,000 cubic meters.

It is possible that multiple wells will be drilled at each well pad. The total number of wells may change based on initial drilling results; however, no more than three wells would be constructed at each pad. The well pads would either be constructed directly adjacent to the existing access road or outside of Lava Lake to minimize impacts on Lava Lake.

2.1.3.2 Soak Pit or Evaporation Pond

If required, a soak pit or evaporation pond would be constructed north of the south well as shown on Figure 1.4-1. The soak pit or evaporation pond would be approximately 15,000 m³.

The purpose of the soak pit or evaporation pond is to allow for on-site disposal of geothermal water during the long-term well tests. A soak pit would allow rapid infiltration of geothermal water to the reservoir. The soak pit would be constructed by excavating a pit of adequate size and laying approximately two feet of crushed native rock at the base of the pit to allow for rapid infiltration of water. In contrast, an evaporation pond would allow geothermal water to evaporate into the atmosphere. If needed, an evaporation pond would be excavated and lined with clay or bentonite to minimize infiltration. The need for soak pit or evaporation ponds would be determined during initial well testing.

2.1.3.3 Well Drilling

Each exploration well would be drilled using a typical large rotary drill rig. Diesel engines, water storage tanks or sumps, fuel storage tanks, drilling mud storage, mud pumps, reserve pit, pipe rack, and other typical ancillary equipment as shown on Figure 2.1-1 would be located at the well pad. Exploration wells would be approximately 23 inches in diameter at the top of the well and narrow (telescope) to approximately 13 inches at the bottom of the well. The exploration wells would be full-sized wells capable of future geothermal production. In the event that an exploration well is found to be capable of commercial production, the well would be ready for use with little additional construction necessary to prepare the well for production. Figure 2.1-2 depicts a typical cross-section of an exploration well.

The exploration wells would be drilled to a depth between 2,000 and 2,500 meters; casing would be installed down to 1,000 to 1,200 meters to prevent the sides of the well column from collapsing. Directional drilling (i.e., drilling a non-vertical well) would be used to access the geothermal resource below Lava Lake.

² Temperature testing in the late 1980s revealed a bottom temperature of 359 °C at 2,105 meters below ground surface at the wells drilled in the Lake Assal region.

2 PROJECT DESCRIPTION

Drilling would require between 30 and 120 liters of water per second to cool the drill and wash drill cuttings from the drill.

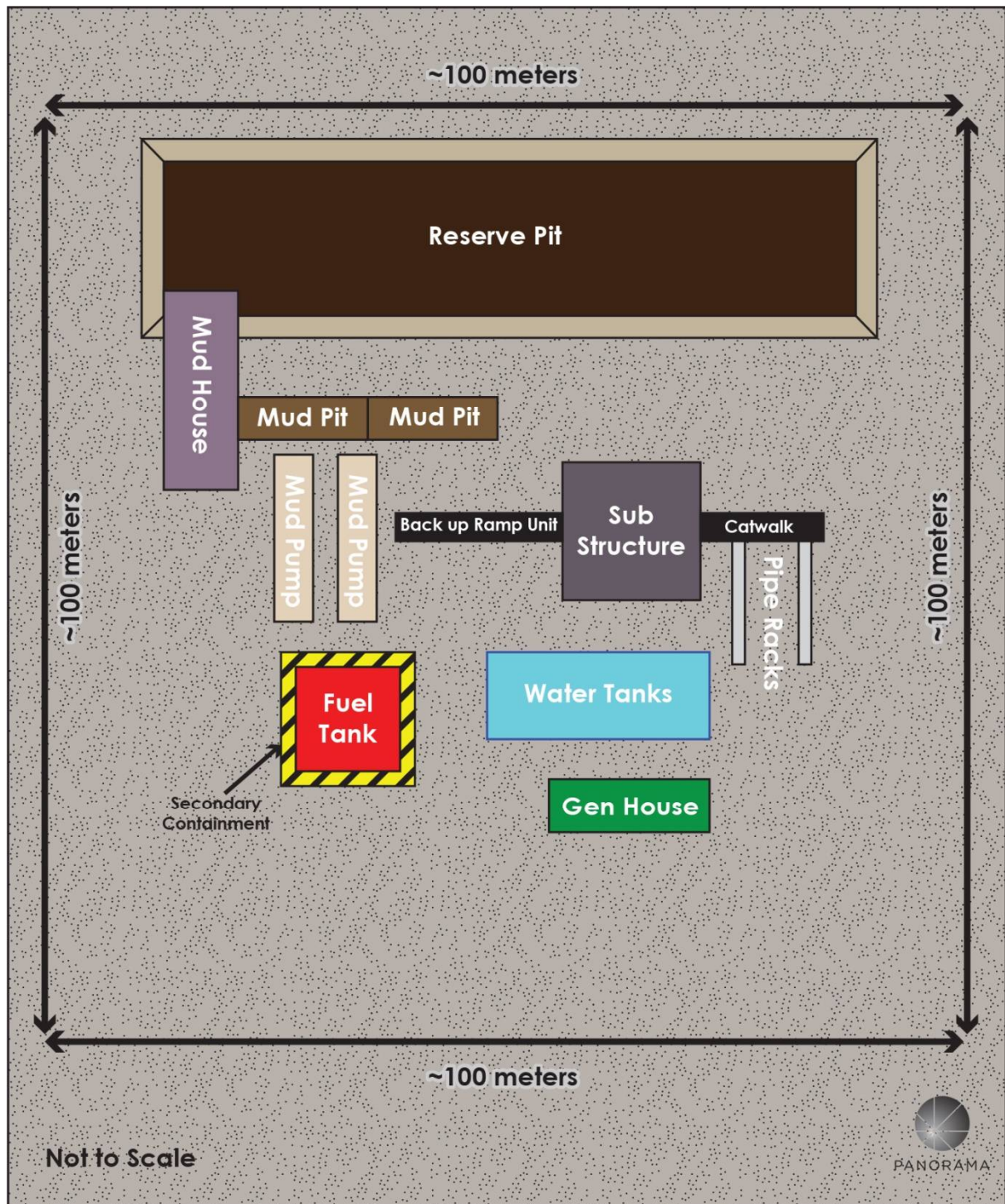
The well bore would be drilled using salt water, non-toxic drilling mud, and/or foam. Variable concentrations of non-toxic additives would be introduced to the drilling mud as needed to prevent corrosion, increase mud weight, and prevent mud loss. Additional drilling mud would be mixed and added to the mud system as needed to maintain the required mud quantities. Compressed air may be added to the drilling mud to reduce the weight of the drilling fluids and help carry drill cuttings to the surface if areas of low pressure are encountered during drilling.

All drill cuttings and drilling fluid would be discharged to a reserve pit; after drill cuttings settle, the drilling fluid would be disposed of in a shallow well or open reserve pits. Drill cuttings would be left in the reserve pit³. An estimated 43,200 to 108,000 tonnes of waste (drilling fluid and drill cuttings) would be produced during drilling for each exploration well.

³ The drill cuttings would be tested for heavy metals and volatile and non-volatile organics. Cuttings would be removed from the site and disposed of as hazardous waste if the cuttings exceed thresholds for toxicity (refer to Section 6 mitigation measures for further details).

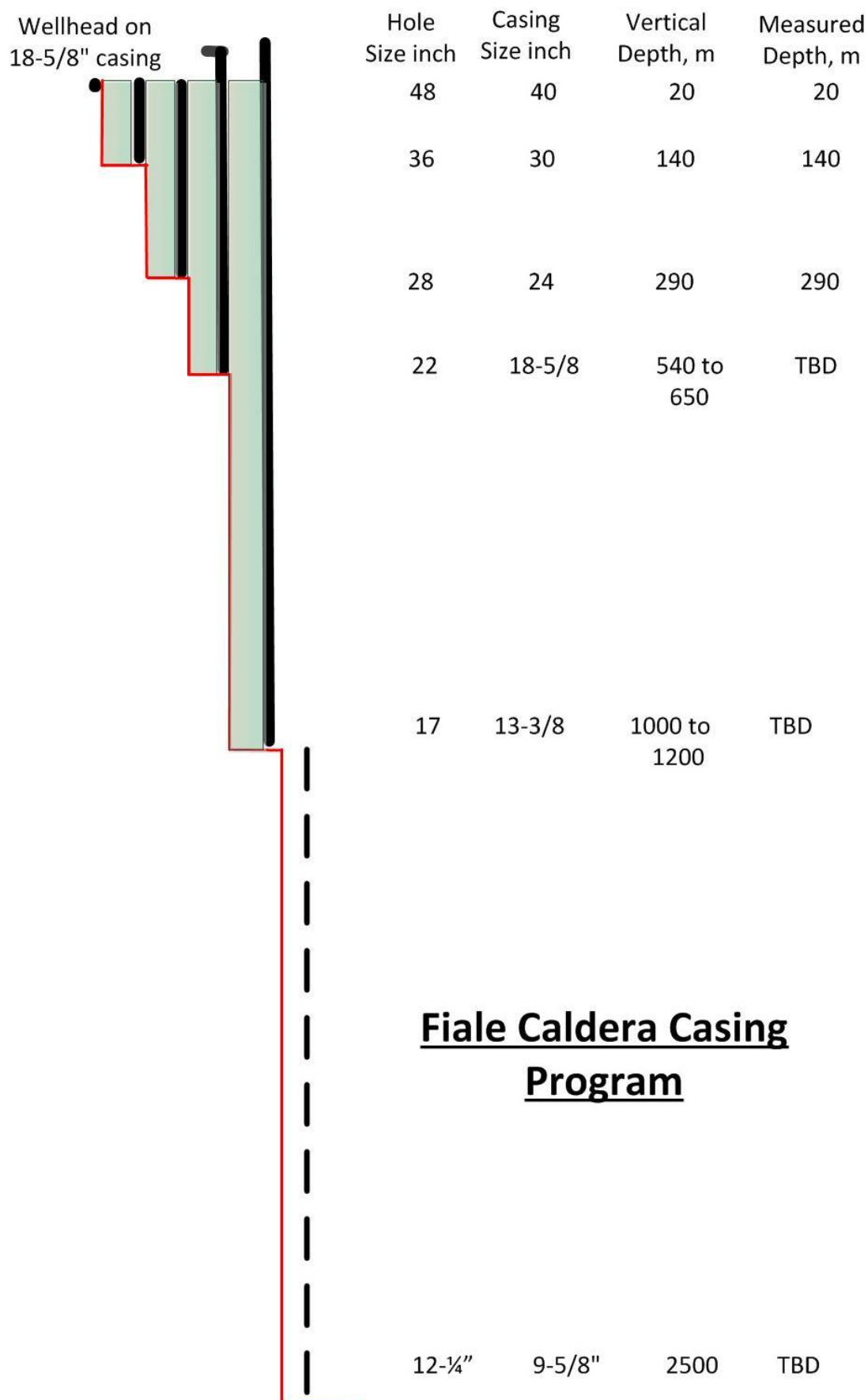
2 PROJECT DESCRIPTION

Figure 2.1-1 Typical Well Pad Layout



2 PROJECT DESCRIPTION

Figure 2.1-2 Typical Exploration Well Using Directional Drilling



2 PROJECT DESCRIPTION

An exploration well may need to be re-drilled or worked over if problems occur that prevent completion of the well. Potential problems may include mechanical malfunctions, difficulty setting the casing, or limited permeability, productivity, or injectivity. Depending on the problem encountered, the well may be:

- Worked over by lifting the drilling fluid in the well column using air or gas, or by stimulating the rock formation using a dilute acid or rock fracturing techniques⁴; or
- Re-drilled by:
 - Re-entering and re-drilling the existing well bore,
 - Re-entering the existing well bore and drilling and casing a new well bore, or
 - Moving the position of the drill rig on the well pad and drilling a new well through a new conductor casing.

After drilling is complete, well head equipment would be installed on top of the wells.

2.2 WELL AND RESERVOIR TESTING

If the exploration well successfully encounters the geothermal reservoir, well and reservoir testing would be conducted to analyze characteristics of the resource. One or more initial, short-term flow tests would occur at each exploration well and one or more long term flow tests will occur after the achievement of all wells to assess the productivity of the geothermal reservoir and sample the geothermal fluid. One or more short term test will occur on the shallow reservoir.

To perform both short- and long-term testing, the well bore would be cleared of all residual drilling mud and drill cuttings and a silencer would be installed and connected to the well via a temporary pipeline. To perform the flow tests, geothermal fluid would flow from the exploration well into the silencer where the geothermal fluid would be separated into steam and water at atmospheric pressure while the temperature, pressure, flow rate, chemical composition, and other parameters of the geothermal fluid are monitored. The separated water would be discharged to a reserve/soak pit, or evaporation pond. The soak pit or evaporation pond would approximately 15,000 m³. An injectivity test may also be performed by injecting the extracted geothermal fluid back into the geothermal reservoir. Long-term flow test(s) would be performed after the short-term flow test(s). Tests would typically last for less than 14 days, but could last up to 3 months.

2.3 WORKFORCE AND SCHEDULE

2.3.1 Workforce

Approximately 50 to 100 workers would be on the site during construction and well testing.

2.3.2 Schedule

Construction, drilling, and testing are expected to last a total of approximately 13 months.

2.3.2.1 Construction

Construction of the access roads and well pads is expected to take approximately 3 months and well drilling would last approximately 6 months. Drilling will occur 24 hours per day. The total duration for the surface improvements and well drilling would last approximately 9 months.

⁴ No rock fracturing will be allowed without prior approval of the PMU. The project occurs in a seismically active area and rock fracturing will need to be properly planned and implemented.

2 PROJECT DESCRIPTION

2.3.2.2 Well Testing

Testing of the geothermal reservoir is expected to take not more than 2 months. The testing would begin after the first well is completed and testing would continue at subsequent wells. Each well test would last 2 to 4 days. The testing would be conducted concurrently with the well drilling and the total duration testing would not exceed 2 months.

2.4 WATER REQUIREMENTS AND SOURCES

2.4.1 Drinking Water

Up to approximately 3,000 liters of water per day would be necessary to supply the workers (assumes up to 100 workers using 30 liters per day per person for washing). Water for washing would be brought to the project site in a water truck and drinking water would be supplied in containers/bottles for the workers. Alternatively, the contractor may purchase a device to convert humidity into water or a small scale desalination plant to supply water for the project, if these options are cost-effective. The necessary drinking water is estimated at up to 600 liters per day (assumes up to 100 workers drinking 6 liters per day per person).

2.4.2 Water for Drilling and Dust Control

An estimated 6 million liters on average per day (250,000 liters per hour) would be required for drilling, primarily for the production of drilling mud. Water would be pumped from the groundwater wells or Bay of Ghoubet (refer to Sections 2.1.5). Water for drilling would have the same composition as sea water. This water would not be suitable for drinking or washing, but would be used for drilling and dust control.

2.4.3 Cement

Up to 10,000 liters of water would be required per day during cementing of the wells (approximately 8 days). Fresh water would be trucked to the site in a water tanker to supply the needs for cement.

2.5 WASTE AND EFFLUENT DISPOSAL

All drill cuttings and drilling fluid would be discharged to the reserve pit. After drill cuttings settle, the drilling fluid would be disposed of in a reserve pit. Drill cuttings would be left in the reserve pit. Fluids and solids would be tested to determine the chemical composition and identify any materials that may be hazardous. Any drill cuttings that exceed the toxicity threshold for hazardous waste would be treated as hazardous waste and disposed of off-site.

Used oil would be gathered and stored in tanks at the storage area until it could be transported off site and disposed of at a facility that accepts hazardous waste.

Latrines would be constructed on the project site and would be maintained in a clean condition. A septic tank system would be installed to manage the wastewater from the worker camp.

Trash would be maintained in covered receptacles at the well pads, storage area, and worker camp. Non-hazardous waste would be disposed of at a municipal landfill in Tadjoura.

2.6 WELL ABANDONMENT AND PAD RECLAMATION

Following completion of exploration drilling and flow testing, the commercial potential of each exploration well would be assessed. If the well is determined to have commercial potential, well operations would be suspended pending completion of environmental review and receipt of all necessary approvals and funding. Monitoring of the well would likely continue until the start of production.

2 PROJECT DESCRIPTION

If a well is not determined to have commercial potential, monitoring of the well may continue or the well may be abandoned. Well abandonment typically involves plugging the well bore with enough cement to ensure that fluid in the reservoir would not flow into different aquifers; the casing would remain in place. Any wellhead equipment would be removed from the well, and a metal cap would be welded to the casing.

The well pads would be scarified and the aggregate would be dispersed on site or used on roads. The well pad sites would then be graded as necessary to restore the sites to the approximate original topography.

3 LEGISLATIVE FRAMEWORK

This section provides a legal context for the ESMP and includes descriptions of Djibouti's legal requirements, and the World Bank and AfDB's policies and guidance on environmental assessments and mitigation plans. This ESMP has been prepared to fully comply with environmental and social legislation and procedures in the Republic of Djibouti and with the World Bank and AfDB environmental and social safeguard policies.

3.1 WORLD BANK ENVIRONMENTAL POLICIES

The World Bank environmental and social safeguard policies define requirements for environmental assessment, protection and conservation of natural habitats, pest management, and preservation of physical cultural resources. These policies are further defined in the operational principles (OPs) below.

3.1.1 OP 4.01, Environmental Assessment

OP 4.01 requires that an Environmental Assessment be prepared for projects submitted for World Bank funding. The Environmental Assessment must include an assessment of the risks that the project may present to the environment, identify alternatives to the project, define methods to enhance the positive impacts of the project, and define mitigation to avoid, minimize, and compensate for negative impacts of the project. The Environmental Assessment must take into account the natural environment (i.e., air, land, and water); the health and safety of the population; social aspects including involuntary displacement of peoples, indigenous peoples, and cultural heritage; and transboundary and global environmental issues.

OP4.01 requires public consultation prior to preparation of the Environmental Assessment and dissemination of information in the Environmental Assessment. All Category A and Category B⁵ projects must take into account views of any group that may be affected by the project. Information about the project should be disseminated prior to consultation and in a language that the group understands.

Appendix C of OP 4.01 defines the requirements for the Environmental Management Plan (EMP). The EMP:

- Identifies and summarizes all anticipated significant adverse environmental impacts (including those involving indigenous people or involuntary resettlement);

⁵ Projects submitted for World Bank funding must be categorized to determine the level of environmental review necessary to analyze the environmental impacts of the project. "Projects are assigned to one of [three] categories on the basis of the nature, magnitude and sensitivity of the environmental issues" (World Bank 1999):

- **Category A.** Project that may have diverse and significant environmental impacts. Requires a full Environmental Assessment.
- **Category B.** Project may have specific environmental impacts. Full Environmental Assessment not required, but environmental analysis is appropriate.
- **Category C.** Project is unlikely to have significant environmental impacts. Environmental analysis is normally unnecessary.

3 LEGISLATIVE AND INSTITUTIONAL FRAMEWORK

- Describes – with technical details – each mitigation measure, including the type of impact to which it relates and the conditions under which it is required (e.g., continuously or in the event of contingencies), together with designs, equipment descriptions, and operating procedures, as appropriate;
- Estimates any potential environmental impacts of these measures; and
- Provides linkage with any other mitigation plans (e.g., for involuntary resettlement, indigenous peoples, or cultural properties) required for the project.

The EMP must provide the following information:

- A description of environmental monitoring during project implementation
- Capacity development and training to support implementation of the environmental requirements and mitigation measures
- Implementation schedule and cost estimates for mitigation, monitoring, and capacity development
- Assignment of institutional responsibilities and integration of the EMP into the project development

3.1.2 OP 4.04, Natural Habitats

OP 4.04 recognizes that the conservation of natural habitats is essential to safeguard their unique biodiversity and to maintain ecosystem services for long-term use. Natural habitats are defined as terrestrial, freshwater, coastal, and marine ecosystems, including areas that have been slightly modified by human activities, but have kept their ecological functions and majority of their biodiversity.

3.1.3 OP 4.11, Physical Cultural Properties

OP 4.11 emphasizes the need to protect historical and cultural heritage. Cultural resources are defined as objects, sites, physical structures, or landscapes that have historical, cultural, aesthetic, or religious importance. The OP requires that the destruction of known resources be avoided. If there are previously undiscovered resources, the OP recommends consulting national experts or institutions for the protection of the cultural heritage.

3.1.4 Environmental, Health, and Safety Guidelines for Geothermal Power Generation

The World Bank's *Environmental, Health, and Safety Guidelines for Geothermal Power Generation* provides specific recommendations for management of environmental health and safety (EHS) issues associate with geothermal power generation (IFC and World Bank Group 2007b). The guidelines were designed to be used in tandem with *Environmental, Health, and Safety General Guidelines*, which provides guidance on common EHS issues for all industry sectors (IFC and World Bank Group 2007a). Although this project does not include power generation, the guidelines provide recommendations for management of drillings fluids and cuttings, air emissions (i.e., H₂S), solid waste, well blowouts and pipeline failures, and water consumption and extraction. The guidelines also specify worker protection requirements for confined spaces, heat, noise, and infrastructure safety.

3.2 AFRICAN DEVELOPMENT BANK POLICIES

3.2.1 African Development Bank Integrated Safeguard System

The AfDB Integrated Safeguard System (ISS) requires an ESIA for all AfDB public and private sector lending operations (AfDB 2013). The ISS sets out the basic tenets that guide and underpin AfDB's approach to environmental safeguards. The ISS outlines five Operational Safeguards (OS):

- **OS 1: Environmental and social assessment.** Governs the process of determining a project's environmental and social category and the resulting environmental and social assessment requirements.

3 LEGISLATIVE AND INSTITUTIONAL FRAMEWORK

- **OS 2: Involuntary resettlement: Land acquisition, population displacement and compensation.** Consolidates the policy commitments and requirements set out in AfDB's policy on involuntary resettlement, and incorporates a number of refinements designed to improve the operational effectiveness of those requirements.
- **OS 3: Biodiversity and ecosystem services.** Aims to conserve biological diversity and promote the sustainable use of natural resources; also translates the commitments in AfDB's policy on integrated water resources management into operational requirements.
- **OS 4: Pollution prevention and control, hazardous materials and resource efficiency.** Covers the range of key impacts of pollution, waste, and hazardous materials for which there are agreed international conventions, as well as comprehensive industry-specific and regional standards, including greenhouse gas accounting, that other multilateral development banks follow.
- **OS 5: Labour conditions, health and safety.** Establishes AfDB's requirements for its borrowers or clients concerning workers' conditions, rights and protection from abuse or exploitation; also ensures greater harmonization with most other multilateral development banks.

OS 1 requires that the ESIA cover all relevant direct and indirect cumulative and associated facility impacts from the project. The ESIA must include an assessment of impacts and define mitigation measures consistent with only the OSs that would be required to achieve the goals and optimal functioning of the ISS. The following OSs apply to the proposed project:

- OS 3: Biodiversity, Renewable Resources and Ecosystem Services:
- OS 4: Pollution Prevention and Control, Hazardous Materials and Resource Efficiency
- OS 5: Labour Conditions, Health and Safety

OS-2 is not triggered because the project does not require land acquisition or resettlement.

The level of assessment and management should be proportional to the level of environmental risk posed by the project (AfDB 2015). The proposed project is classified as a Category 2 project because: 1) the project would not require land acquisition or resettlement, and 2) the adverse environmental impacts would be site-specific, are largely reversible, and could be minimized by applying appropriate management and mitigation measures. Category 2 projects require preparation of an ESIA.

The ESIA leads to the development of a comprehensive ESMP, which contains implementable environmental and social mitigation measures. The ISS specifies requirements for community outreach and public consultation during preparation of the ESIA and requires that a summary ESMP is made available to the public in the borrowing country.

OS 1 requires screening for climate change risk. The project would qualify as a Category 3 project for climate change risk because it is not vulnerable to climate change. The Integrated Safeguard System recommends voluntary consideration of low-cost risk management and adaptation measures for climate change, but no further action is required.

3.2.2 Poverty Reduction Policy

The AfDB poverty reduction policy aims to reduce poverty in Africa through strategies to promote national ownership and participation as well as actions to improve the welfare of the poor. The policy states that the establishment of transportation, electricity, water, sanitation, and telecommunications infrastructure is essential to provide basic social services and promote equitable economic growth, particularly in rural areas of Africa. The policy also maintains that investing in infrastructure is important in advancing the cause of gender equality and female participation in income-generating activities. To promote the expansion of infrastructure, the AfDB intends to:

- Support the development of basic infrastructure and community facilities, especially in rural areas;

3 LEGISLATIVE AND INSTITUTIONAL FRAMEWORK

- Promote efficient, reliable and affordable access to infrastructure for the poor;
- Ensure the participation of the poor in the establishment and maintenance of critical infrastructure;
- Increase access to basic infrastructure;
- Explore ways to promote public-private partnerships for the establishment and maintenance of infrastructure.

3.2.3 Gender Policy

The AfDB gender policy codifies the commitment of the AfDB to the integration of gender issues in its operations. Development operations are expected to respond to the priority needs of both men and women in an efficient and effective manner. Consideration for gender issues is a key strategy to fight against the exclusion of women from decision-making and women's lack of access to resources and benefits provided by development.

3.2.4 Framework for Enhanced Engagement with Civil Society Organizations

The AfDB cooperation with civil society policy promotes participation of civil society organizations, including NGOs and community-based organizations, in the project development process. The AfDB is particularly interested in cooperation with groups that represent women and the poor. The purpose of the Framework for Enhanced Engagement with Civil Society Organizations (AfDB2012) is to help AfDB achieve greater results and impacts by strengthening its mechanisms for participation and coordination with civil society organizations. The objectives of the framework are to a) strengthen AfDB's capacity to build cooperative working modalities with civil society organizations; b) promote staff interactions with civil society organizations in a way that enhances AfDB's work and contributes to the effectiveness of support to Regional Member Countries; and c) provide operational guidance for AfDB's headquarters, Regional Resource Centers, country offices, and project staff.

3.2.5 Disclosure and Access to Information Policy

Information concerning the AfDB and its activities and funded projects must be made available to the public with limited exceptions. Disclosure commences early in project preparation to allow the public to participate in project design and implementation beyond the mandatory consultation process.

3.2.6 Policy for Integrated Water Resources Management

The main objective of this policy is to promote an integrated approach in the management of water resources in order to achieve economic development and attain the goals of poverty reduction in the region. The integrated approach takes into consideration the increasing scarcity and competition between different uses of water resources in Africa.

3.3 DJIBOUTI ENVIRONMENTAL LEGISLATION AND DECREES

3.3.1 Environmental Code, Law No. 51/AN/09/6L Chapter VII: Mechanisms of Integration of the Environment

Djibouti environmental code outlines the required contents of an ESIA. The ESIA must include, at a minimum:

- Analysis of the baseline environmental conditions of the project site
- Project description
- Environmental impacts of the project and the measures to eliminate, reduce, or compensate for adverse impacts on the environment and public health
- Estimated cost to implement the measures
- Environmental management plan
- Results of a public hearing

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3.3.2 Decree No. 2001-029/PR/MHUEAT, Environmental Impact Assessment Procedures

Decree No. 2001-0011/PR/MHUEAT (Ministère de l'Habitat, de l'Urbanisme, de l'Environnement et de l'Aménagement du Territoire) requires environmental impact assessment including an ESMP for all activities capable of causing negative impacts on the environment. The environmental impact study, including the environmental and social management plan, is a requirement prior to granting an environmental permit by the Ministry for the Environment. The environmental permit is issued for a period of 5 years and may be renewed after completion of an environmental audit.

The Decree requires a detailed ESMP, including a detailed budget, as part of the ESIA. The Decree also requires that the ESIA and ESMP be prepared in French.

A Technical Evaluation Committee has 20 days to provide its opinion on the environmental impact study and the conditions for granting an environmental permit. The Ministry for the Environment has 20 days after the findings of the Technical Evaluation Committee to make a decision on granting the environmental permit. Articles 35 to 38 require the project proponent to carry out an environmental audit and submit a report to the Ministry for evaluation and issuance of environmental compliance. Article 38 also specifies the required contents of the audit report.

3.3.3 Environmental Code, Law No. 51/AN/09/6e

The Environmental Code defines the national policy for environmental protection and management. The Environmental Code is based on basic principles for managing and protecting the environment against degradation or deterioration to ensure sustainable development. The Environmental Code defines requirements for protection of the following resources:

- Water resources (Articles 16 to 26)
- Soils and geologic resources (Articles 27 to 32)
- Air and atmosphere (Articles 33 to 44)
- Human settlements (Articles 45 to 51)
- Hazardous materials management (Articles 71 to 73)
- Waste disposal and management (Articles 75 to 88)

The Environmental Code also prohibits noise or vibration that is harmful to human health or an excessive nuisance (Article 74).

3.3.4 Land and Marine Protected Areas, Law No. 45/AN/04/5L

Protected areas in Djibouti include:

- Day Forest
- Mabla Forest
- Lake Abbé
- Lake Assal

The Minister of Energy and Resources confirmed that the Caldera Fialé area is not protected (REI 2008). The Bay of Ghoubet is a potential future protected area (ONEC2013).

3.3.5 Protection of Biodiversity, Decree No. 2004-0065/PR/MHUEAT

The decree defines animal and plant species that are endemic or endangered within Djibouti. The hunting, capture, trade, export, or import of endemic or endangered animal species is prohibited. The removal or uprooting of endangered or endemic plant species is prohibited. MHUEAT is required to periodically update the list of endangered and endemic species.

The decree allows for capture and collection of protected species under a scientific permit through the Director of Physical Planning and the Environment and the Center for Studies and Scientific Research of Djibouti. Tree removal without prior authorization from the MHUEAT is prohibited.

3 LEGISLATIVE AND INSTITUTIONAL FRAMEWORK

3.3.6 Mining Code, Law No. 66/AN/94/3L and Decree No. 97-0064/PR/MIEM

The Mining Code establishes that the state has exclusive ownership over all resources contained in terrestrial soil and marine subsoil. There are three types of permits granting specific mineral rights:

- Research permit (maximum area of 2,500 square kilometers)
- Exploration permit (maximum area of 100 square kilometers and rectangular area is oriented north-south or east-west)
- Operation permit (maximum area of 10 square kilometers where the area is set according to the scale of operations)

The mining law establishes regulations for protection and restoration of the environment, including fines (maximum of 2 million Djiboutian Francs) for violations of these regulations. Decree No. 97-0064/PR/MIEM supplements the mining law by defining the taxation of mining activities related to research, exploration, and operation.

3.3.7 Environmental Code Article 29 and Decree No. 2003-0212/PRE/MHUEAT

Article 29 of the Environmental Code prohibits discharge of toxic or hazardous substances in the soil or subsoil.

Decree No. 2003-0212/PRE/MHUEAT defines requirements for the transportation of hazardous good/materials and wastes including health care and infectious wastes. The transit of dangerous products is subject to special authorization issues by the Ministry of the Environment. Hazardous materials include explosives, gases, flammable liquids, oxidizers and organic peroxides, radioactive material, corrosive substances, and other hazardous waste. Drivers must have signs and documentation for transport of hazardous wastes.

3.3.8 Integrated Coastal Zone Management Plan

The Integrated Coastal Zone Management Plan (ICZM) is a tool for planning sustainable development of coastal areas of Djibouti, which are defined as all continental areas 15 kilometers from the coast (MHUEAT 2005). The ICZM provides a framework for coordinating the actions of public authorities and socio-economic actors who are involved in the management and use of coastal and marine areas.

The main goals of the ICZM include:

- Goal 1: Improvement of water resource management
- Goal 2: Control of economic development in the coastal zone
- Goal 3: Management of urbanization
- Goal 4: Improvement of waste management and fight against pollution
- Goal 5: Preservation of ecosystems and species

The plan proposes to designate the Director of Environment and Land Planning through MHUEAT to facilitate implementation of the ICZM.

3.3.9 Approval of the Economic and Social Policy of the Republic of Djibouti, Law No. 149/AN/02/4L

The Strategic Framework for Combating Poverty outlines the approach to economic and social development in Djibouti. The framework includes provision of water for domestic and agricultural use in rural areas and improving public facilities including educational and health facilities.

The National Initiative for Social Development is a social program aimed at improving the social conditions in Djibouti. The initiative proposes to consolidate growth and create jobs, increase access to social services, and reduce extreme poverty while reducing social vulnerabilities.

3 LEGISLATIVE AND INSTITUTIONAL FRAMEWORK

3.4 STANDARDS AND THRESHOLDS

3.4.1 Geothermal Fluid

There are no standards that would apply to the proposed approach of discharging the geothermal effluent to upland areas with rapid infiltration to the groundwater table through a soak pit. There is no risk to surface water quality or groundwater quality from the proposed disposal method because the geothermal fluid will not enter any surface waters and the groundwater is expected to be of similar quality to the geothermal fluid. There is no beneficial use of the groundwater and no risk to impact a beneficial use of groundwater with the proposed infiltration method. The IFC and World Bank Group Environmental, Health, and Safety General Guidelines (2007a) have developed guidelines for effluent discharge to waters such as lakes, streams, rivers, or the ocean. The IFC and World Bank effluent standards for mining, which has similar processes to geothermal drilling, is presented in Table 3.4-1 for informational purposes.

Table 3.4-1 IFC and World Bank Effluent Standards for Mining

Parameter	Unit ¹	Standard
Total suspended solids	mg/L	50
pH	--	6 to 9
Chemical oxygen demand	mg/L	150
Five-day biological oxygen demand	mg/L	50
Oil and grease	mg/L	10
Arsenic	mg/L	0.1
Cadmium	mg/L	0.05
Chromium (hexavalent)	mg/L	0.1
Copper	mg/L	0.3
Cyanide (total)	mg/L	1.0
Cyanide (free)	mg/L	0.1
Cyanide (weak acid dissociable)	mg/L	0.5
Iron	mg/L	2.0
Lead	mg/L	0.2
Mercury	mg/L	0.002
Nickel	mg/L	0.5
Phenols	mg/L	0.5
Zinc	mg/L	0.5
Temperature	°C	Less than 3°C differential

Note:

¹ mg/L = milligrams per liter

Source: IFC and World Bank Group 2007c

3.4.2 Soil Toxicity Standards

The Republic of Djibouti, World Bank and AfDB have not developed toxicity standards for soils. The toxicity standards codified in the U.S. Code of Federal Regulation Title 40 Section 261.24 are used here because these standards underwent substantial study of impacts on human health during their adoption. Table 3.4-2 provides the toxicity standards.

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Table 3.4-2 Toxicity Standards

Pollutant	Standard (mg/L)
Arsenic	5.0
Barium	100.0
Benzene	0.5
Cadmium	1.0
Carbon tetrachloride	0.5
Chlordane	0.03
Chlorobenzene	100.0
Chloroform	6.0
Chromium	5.0
o-Cresol	4200.0
m-Cresol	4200.0
p-Cresol	4200.0
Cresol	4200.0
1,4-Dichlorobenzene	7.5
1,2-Dichlorobenzene	0.5
1,1-Dichloroethylene	0.7
2,4-Dinitrotoluene	30.13
Endrin	0.02
Heptachlor (or its epoxide)	0.008
Hexachlorobenzene	30.13
Hexachlorobutadiene	0.5
Hexachloroethane	3.0
Lead	5.0
Lindane	0.4
Mercury	0.2
Methoxychlor	10.0
Methyl ethyl ketone	200.0
Nitrobenzene	2.0
Pentachlorophenol	100.0
Pyridine	35.0
Selenium	1.0
Silver	5.0
Tetrachloroethylene	0.7
Toxaphene	0.5
Trichloroethylene	0.5

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Pollutant	Standard (mg/L)
2,4,5-Trichlorophenol	400.0
2,4,6-Trichlorophenol	2.0
2,4,5-TP (Silvex)	1.0
Vinyl chloride	0.2

Source: U.S. Code of Federal Regulation Title 40 §261.24

3.4.3 Air Emissions

The World Health Organization maintains air quality guidelines designed to “offer guidance in reducing the health impacts of air pollution” (WHO 2005). Table 3.4-3 summarizes the World Health Organization air quality standards. These standards, including H₂S emissions, are applicable to the project.

Table 3.4-3 World Health Organization Air Quality Standards

Pollutant	Averaging Period	Standard (µg/m ³) ¹
Sulfur dioxide (SO ₂)	Annual mean	125 (interim target 1) 50 (interim target 2) 20 (guideline)
	10-minute mean	500
Nitrogen dioxide (NO ₂)	Annual mean	40
	1-hour mean	200
Particulate matter with particle size between 2.5 µm and 10 µm (PM ₁₀)	Annual mean	70 (interim target 1) 50 (interim target 2) 30 (interim target 3) 20 (guideline)
	24-hour mean	150 (interim target 1) 100 (interim target 2) 75 (interim target 3) 50 (guideline)
Particulate matter with particle size smaller than 2.5 µm (PM _{2.5})	Annual mean	35 (interim target 1) 25 (interim target 2) 15 (interim target 3) 10 (guideline)
	24-hour mean	75 (interim target 1) 50 (interim target 2) 37.5 (interim target 3) 25 (guideline)
Ozone (O ₃)	8-hour mean	160 (interim target 1) 100 (guideline)
Hydrogen sulfide (H ₂ S)	24-hour mean	150
	30-minute mean	7

Note:

¹ The standards for SO₂, NO₂, PM₁₀, PM_{2.5}, and O₃ are listed in the “WHO Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide and Sulfur Dioxide” (2005). The standards for hydrogen sulfide are listed in the “Air Quality Guidelines for Europe” (WHO 2000). While these standards apply to Europe, the analysis of the effects of hydrogen sulfide on human health is universally applicable; therefore, the standards in this document are applied to the proposed project.

Sources: WHO 2000, WHO 2005

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3.4.4 Noise Standards

The World Bank and IFC provide guidelines for project-related noise. Table 3.4-4 presents the outdoor noise levels that should not be exceeded during the duration of a project.

Table 3.4-4 World Bank and IFC Outdoor Noise Standards

Receptor	Maximum 1-Hour L_{eq}^1 (dBA)	
	Daytime 7 AM to 10 PM	Nighttime 10 PM to 7 AM
Residential, institutional, educational	55	45
Industrial, commercial	70	70

Note:

¹ Equivalent sound level (L_{eq}): the average A-weighted sound level during the entirety of a stated time period (in this case, 1 hour).

Source: IFC and World Bank Group 2007a

4 METHODOLOGY

The impacts of the proposed project, including concerns of local communities and government entities, must first be identified in order to design effective and implementable mitigation measures. This section describes the approach to identify significant impacts of the proposed project.

4.1 2013 SUMMARY ESMP

An ESIAF was prepared for the project in 2012 (Fichtner GmbH & Co. KG 2012). The 2012 ESIAF identified impacts and general minimization and mitigation strategies. A Summary ESMP was prepared for the proposed project after the ESIAF was completed. The Summary ESMP defined the environmental and social impacts of the proposed project and mitigation required to reduce impacts (ONEC 2013). This document:

- Provides a summary description of the proposed project;
- Describes the project site and environmental and social conditions where the proposed project would be constructed;
- Identifies the environmental and social impacts of the project;
- Defines mitigation measures to reduce significant environmental and social impacts; and
- Outlines a monitoring strategy to ensure the implementation of mitigation measures.

The Summary ESMP does not contain the detail necessary to constitute a full ESMP; it does not include a detailed mitigation management plan and a detailed description of the institutional capacity needed to implement the project. Information provided in the Summary ESMP was used in the preparation of this ESMP to provide background information on the project and identify existing conditions and impacts of the project. Mitigation measures proposed in the Summary ESMP were evaluated for their feasibility, practicality, and appropriateness for the project. The measures in this ESMP parallel the general requirements provided in the Summary ESMP and add to those requirements where necessary to address AfDB, World Bank, and Djibouti requirements. There are some measures contained in the Summary ESMP that were found to be unnecessary or ineffective for this stage of geothermal development and those measures were subsequently dismissed as explained in this ESMP.

4.2 LITERATURE REVIEW

A literature review was conducted to identify positive and negative impacts of the proposed project and define appropriate mitigation measures to avoid, reduce, and compensate for impacts. The following documents were reviewed:

- African Development Bank Energy, Environment and Climate Change Department, *Summary Environmental and Social Management Plan: Geothermal Exploration Project* (ONEC2013)
- Reykjavik Energy Invest, *Drilling and Testing of Geothermal Exploration Wells in the Assal Area, Djibouti: Environmental Management Plan* (REI 2008)
- Fichtner GmbH & Co. KG, *Projet d'évaluation des ressources géothermiques: Etude-Cadre d'Impact Environnemental et Social (ECIES)* (Fichtner GmbH & Co. KG 2012)

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4.3 SITE RECONNAISSANCE

Laurie Hietter and Susanne Heim of Panorama Environmental, Inc. conducted a site reconnaissance on October 27, 2015 to evaluate site access and environmental constraints in the proposed exploration area and vicinity.

4.4 PUBLIC CONSULTATION

The methodology for public consultation involved a number of steps:

1. Identifying AfDB, World Bank, and Djibouti requirements for public consultation
2. Reviewing the results of the 2012 public consultation for the project
3. Meeting with local Ministers to understand their concerns
4. Defining stakeholders based on the project location and previous consultations
5. Meeting with local stakeholders
6. Documenting concerns and results of stakeholder outreach
7. Incorporating results of stakeholder meetings into the ESMP and mitigation measures

Information obtained during consultation with government officials and representatives of the local population was used in the definition of social impacts and mitigation measures. The approach to public consultation is discussed further in Section 5, below.

5 PUBLIC CONSULTATION/COMMUNICATION

5.1 OBJECTIVES OF CONSULTATION

The public consultation process serves many purposes. The goals of public consultation and communication for the geothermal project are to:

- Provide ongoing information on the project to the public and government agencies
- Provide timely and appropriate information prior to and during construction to enable informed participation in the project and definition of appropriate mitigation measures
- Encourage equal participation of all affected groups in the consultation process
- Disclose the impacts of the project and proposed mitigation measures
- Obtain public input on the mitigation measures
- Provide ongoing information on the implementation of the mitigation measures
- Facilitate open and continuous communication and consultation between various groups including the PMU, construction contractors, stakeholders, and the general public

The public consultation and communication process is ongoing throughout the life of the project. The consultation process includes formal scheduled consultations and meetings. Information will also be disseminated as needed to address significant changes in schedule or other important project developments. The public consultation and communication process includes two key aspects:

- Early and ongoing outreach to key stakeholders to provide information on the project
- A grievance redress process will be established to address public complaints during implementation of the project (Refer to Section 7.5)

5.2 KEY STAKEHOLDERS

5.2.1 Stakeholder Definition

The approach to public consultation begins with the identification of stakeholders who may be affected by the proposed project. Stakeholders may be located near the project, in neighboring towns or villages, or local cities, including Djibouti City. Project effects may be direct, indirect, or cumulative. The towns near the project area include Ghoubet, DabaGahar, and Tadjoura, with additional villages at Lake Assal. The local people, as well as government officials, are considered stakeholders.

The stakeholders were determined after reviewing previous consultation records and in consultations with:

- World Bank and African Development Bank environmental representatives
- EdD
- CERD
- Djibouti Ministers
- Préfet of Tadjoura

Key stakeholders include the following entities:

- Djibouti Government Ministries
 - Ministry of Energy and Natural Resources
 - Electricité de Djibouti

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- MHUEAT
- Ministry of Higher Education and Research
- Ministry of the Interior
- Ministry of National Solidarity
- Ministry of Transport
- Ministry of Agriculture and Fish
- Ministry for the Promotion of Women and Social Affairs
- Djibouti Studies and Research Center (CERD)
- TadjouraPréfet
- Tadjoura and Lake Assal sultans and chiefs
- Djibouti Nature
- SaltInvest
- The local population in the project region
- Tourists visiting the project area
- Nomadic people who travel through the project area
- Geologists

5.3 METHODS OF PUBLIC CONSULTATION

5.3.1 2012 Consultation during Preparation of ESIAF

A number of stakeholders were consulted during preparation of the EISAF, namely:

- Ministry of Environment and Natural Resources
- EdD
- MHUEAT
- Ministry of Higher Education and Research
- Ministry of the Interior
- Ministry for the Promotion of Women and Social Affairs
- CERD
- Institute of Social Sciences – Archaeology
- ADDS
- Tadjoura Regional Administration
- Djibouti Nature (NGO)
- Representatives of the local people

A meeting was held with the local population on 8 January 2012 in the village of DabaGahar, the nearest inhabited area to the proposed geothermal drilling site. Fifteen to 20 people attended the meeting including representatives of different social groups in the area, five members of the technical team, the Ministry of Energy and EDD, and three members of the consultant team. The discussion focused on the potential impacts of the project on the local population and socio-economic development priorities for the region.

Representatives of the local population were also interviewed individually during three additional visits of the area in January and February 2012.

A public consultation workshop organized by the PMU was held on 12 May 2012 to present the ESIAF to interested stakeholders. Approximately 50 stakeholder representatives were in attendance. Comments and recommendations were obtained from workshop participants. These comments and recommendations are summarized in Section 5.2, below.

5.3.2 2015 Consultation during Preparation of this ESMP

Agency consultation and public outreach included:

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- Meetings with MHUEAT on 25 October 2015
- Meeting with AfDB and World Bank environmental specialists on 25 October 2015
- Interview with local community member on 27 October 2015
- Meetings with representatives of the following Djibouti Ministries on 12 and 13 December 2015
 - Ministry of Energy and Natural Resources
 - Ministry of the Interior
 - Ministry of Transport
 - Ministry for the Promotion of Women and Family
 - Ministry of Agriculture and Fish
 - Ministry of Transport
 - Ministry of Higher Education and Research
- Meeting with Tadjoura Regional Administration and chiefs and elders of the local population on 13 December 2015

The notes from each meeting are included as Appendix C.

Additional meetings will be held in 2016 with entities not available to meet in October and December 2015.

5.4 KEY PUBLIC CONCERNS AND RECOMMENDATIONS

Public concerns and recommendations for mitigation were defined during consultation efforts. Meeting notes are included in Appendix C. Key public concerns include:

- Availability of water for the project and use of water
- Protection of fish in Bay of Ghoubet
- Availability of water for the local population
- Education for the local population
- Health care for the local population
- Employment for women and appointing women as mediators for project grievances
- Employment for the local population and workers in the Tadjoura region
- Protection of the transhumance corridor (east of the project)
- Capacity building and training for workers in Djibouti
- Project schedule and need for low cost power in Djibouti
- Worker exposure to heat
- Cumulative impacts from reconstruction of RN9 highway, construction of a railway between the Port of Tadjoura and Ethiopia, construction of the port at Ghoubet, the salt project at Lake Assal, and the wind development project at Lake Assal
- Protection of biodiversity and important bird areas
- Protection of water quality at Lake Assal, a protected area
- Management of wastewater according to Djiboutian regulations

5.5 METHOD TO ADDRESS CONCERNS

The public concerns listed above were considered during the project design phase. The project was designed to avoid development within the transhumance corridor and avoid discharges to the Bay of Ghoubet or Lake Assal. The design also includes on-site mitigation measures defined in Table 7.2-1, including measures to:

- Reduce impacts on fish and wildlife (Mitigation Measures Biology-1, Biology-2, and Reclamation-1)

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- Protect water quality at Lake Assal and the Bay of Ghoubet (Mitigation Measures Water Quality-1, Water Quality-2, Water Quality-3, Water Quality-4, Hazardous Materials-1, and Waste-2)
- Provide safe drinking water for workers (Mitigation Measure Safety and Health-2)
- Provide water to the community (Mitigation Measure Socio-economic-6)
- Provide health services to worker families (Mitigation Measure Socio-economic-7)
- Preferentially hire women and people from the Tadjoura region (Mitigation Measure Socio-economic-5)
- Provide a health clinic in the local community (Mitigation Measure Socio-economic-7)
- Provide training for workers (refer to capacity building in Section 8)

Project implementation will require capacity building in the form of staff training, acquisition of monitoring and testing supplies, and use of online tracking and monitoring tools. Capacity building is discussed further in Section 8.

5.6 CONSULTATION DURING PROJECT IMPLEMENTATION

Public outreach will continue throughout the project implementation phase. The PMU will continue to coordinate with stakeholders and government ministries and representatives on the status of the project and any changes to the project, should they occur. Public consultations, including any complaints and resolutions to those complaints, will be documented in quarterly reports described in 7.4.4.

Public outreach during implementation will include a kiosk at the project site that provides information to the public about the project and contact information to file complaints. A sensitivity training will also be held with the local community to provide information to the contractor on local customs and traditions. A lunch will be coordinated with the local people and Préfet of Tadjoura at the start of construction. The PMU social expert will be the main point of contact responsible for coordinating with the local population and Préfet of Tadjoura. The PMU will be responsible for responding to complaints as described in the grievance redress procedures in Section 7.5, below.

6 ENVIRONMENTAL AND SOCIAL IMPACTS

This section includes a summary of the positive and negative environmental and social impacts that would occur from the proposed project. Mitigation measures intended to avoid, reduce, or compensate for the negative impacts of the proposed project are provided in Section 6: Mitigation Management and Monitoring Plan.

6.1 POSITIVE IMPACTS

6.1.1 Socioeconomics

The project will have positive benefits on the local economy due to payment of project salaries, purchases of supplies, and establishing and operating the camp for workers. If successful, the project could lead to development of a geothermal power plant that would add 20 MW or more to the Djibouti national grid. The addition of geothermal power to the national grid could result in an overall reduction in energy costs.

6.1.1.1 Recruitment of Local Labor

Approximately 20 local workers would be recruited as manual laborers, security personnel, kitchen staff, and to perform general upkeep of the workers camp. These jobs would last for up to 9 months. Priority hiring would be given to those who live near the project site and women.

The recruitment of local labor would be a positive impact on the communities near the project area because jobs would generate income for local peoples. Generation of even temporary jobs in Djibouti would be a positive impact given the high unemployment rate in the country, which reached a high of 59.5 percent in 2002 (Ministère de l'Économie des Finances 2002).

6.1.1.2 Social Services at Workers Camp and Local Community

The workers camp would temporarily house workers during construction of the proposed project. The workers camp would have a positive impact on the workers because it would provide a clean, safe, and drug-free environment for project personnel. Meals and potable water would be provided onsite. Segregated bathing facilities, restrooms, and sleeping quarters for men and women would be provided for workers. Limited medical supplies would also be provided onsite. Additionally, a one-day health clinic will be held in the local community.

6.1.2 Gender Equality

Gender inequality would be reduced as a result of the creation of jobs for the local communities. Women would be recruited and employed on a preferential basis and receive equal pay as men. Contribution to an employment training program for women could help reduce gender inequality and poverty in communities near the proposed project.

6.1.3 Tourism

Geothermal development could be a benefit to tourists interested in renewable energy technology. The improved access roads will benefit any tourism in the area.

6.1.4 Infrastructure

The project activities will include improving the local roads to support the heavy trucks that will bring supplies and equipment to the site, including the drill rig. The improved roadways would remain at the completion of construction.

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6.2 NEGATIVE IMPACTS

6.2.1 Biological Resources

The proposed project is not located within the Lake Assal protected area, and surface water from the project area does not drain to Lake Assal; there would be no impact on biological resources in Lake Assal.

The Caldera Fialé area is sloped towards the Bay of Ghoubet. The Bay of Ghoubet is proposed for listing as a Marine Protected area, but the listing has not yet been approved by the Republic of Djibouti. While the Bay of Ghoubet is not yet listed as a protected area by the Republic of Djibouti, whale shark and dugong found within the Bay are listed as endangered species by the International Union for the Conservation of Nature.

The concentration of heavy metals and other toxic substances in the drilling fluid will likely exceed concentrations in the seawater in the Bay of Ghoubet. The coastal and marine habitats of Bay of Ghoubet could be negatively affected in the unlikely event that drilling mud and fluids flowed 1.6 km from the project area into the Bay or were intentionally dumped into the waters.

The soil in the project area (lithosols) supports little vegetation. It would be infeasible to avoid all vegetation because the flat areas suitable for well pad construction contain sparse grasses. Construction of the proposed project would likely impact some vegetation on the project site.

If water is pumped directly from the Bay of Ghoubet, the water intake valve and water pump would have the potential to damage or fatally injure fish or other marine organisms that may be sucked into the pipeline. Partial blockages of the intake valve may also increase suction on the unclogged section of the valve, which could increase the potential to draw organisms into the pipeline. The intake and pipeline are located in an area with divers and swimmers and the intake could potentially injure swimmers or divers.

6.2.2 Tourism

The road that would provide access to the geothermal drilling locations is currently used by tourists to visit Lava Lake and Ardoukoba Volcano. Use of the access road during construction and operation of the proposed project might temporarily prevent tourists from accessing the road, Lava Lake, and Ardoukoba. Any temporary road closures would still allow tourists to view Lava Lake.

6.2.3 Traffic

Current traffic in the project area is limited to tourists and technicians who maintain a nearby seismograph station; it is estimated that no more than 10 vehicles visit the site per month. The proposed project would generate traffic as a result of transporting workers, materials, and equipment to the project site and maintaining the access roads. Traffic from the proposed project is anticipated to generate 30 to 50 vehicles per day, which would increase traffic in the area. However, the project area is accessed by RN9, a national highway, which has low traffic volume and sufficient capacity for the additional vehicles. The 30 to 50 vehicles per day from project-related cars and trucks on the road would therefore not cause traffic because there is no other use of the area.

6.2.4 Aesthetics

Tourists traveling to Lava Lake and Ardoukoba Volcano, and motorists traveling on the RN9 highway would be subject to views of the project during construction, drilling, and well testing. The project would have a temporary negative impact on the visual quality of the area for visitors coming to the area to see natural views. Views of large drill rigs with lights, well pads, and temporary water pipelines would contrast with the visual character of Lava Lake and environs. The presence of infrastructure and equipment could negatively affect the tourist experience by creating a

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discontinuous view of the natural landscape in an area where tourists may expect a view free of development.

6.2.5 Geology, Soils, and Mineral Resources

6.2.5.1 Erosion

Grading and compaction of fill materials to construct the access road and well pads could result in erosion of any soils present in the project area. Soils in the project area are limited to lithosols found within wadis (i.e., valleys and channels that are dry except during rain events); given their paucity in the project area, erosion of soils would be a significant impact. Covering the access roads and well pads with gravel material would protect the ground surface from erosion by providing a sufficient base for vehicular traffic and drill rig foundation. Erosion could occur as a result of vehicles and equipment traveling off of the access road or well pads.

Erosion could also occur as a result of the accidental release of water through a pipeline leak or rupture, overflow of the sump, or uncontrolled discharge of drilling fluids.

6.2.5.2 Geologic Features

Lava Lake, a geologically unique feature, is located within the project area. The existing access road crosses over a portion of Lava Lake, and increased traffic from construction vehicles and equipment could modify the appearance of the lava fields along this portion of road. Construction of the well pads may also change the appearance of the lava bed. The well pads must be located along the margin of Lava Lake to access the drilling targets. The well pads would be located directly adjacent to the existing access road to minimize impacts on Lava Lake; however, it is infeasible to avoid all impacts on Lava Lake and achieve the drilling targets for the geothermal exploration.

6.2.5.3 Quarry Management

Approximately 15,000 cubic meters of material would be required to construct the access road and well pads. An existing quarry site located approximately 4.1 kilometers south of the project area could provide the needed materials. Use of the quarry would not impede access for other projects or deplete resources in the quarry. There would be no project impacts associated with use of the quarry because the quarry is currently in operation, and material extraction for the proposed project would not vary from current use of the quarry.

6.2.6 Air Quality

Greenhouse gases (carbon dioxide [CO₂], nitrous oxide [N₂O], and methane [CH₄]) and other air pollutants including carbon monoxide [CO], nitrogen oxides [NO_x], sulfur oxides [SO_x], volatile organic compounds, and fugitive dust would be produced from obtaining gravel for the roads and well pads, and from vehicles and equipment during transport of materials, workers, and equipment. The increase in traffic during construction of the proposed project would generate dust from travel on unpaved roads.

Pollutant emissions would also be produced during drilling and testing of the geothermal resource. Drilling fluids may contain CO₂, H₂S, and CH₄ gases. H₂S is toxic to many wildlife as well as humans at concentrations at or exceeding approximately 20 parts per million. High concentrations of H₂S could be emitted during testing, which would adversely impact workers and any wildlife in the project area.

6.2.7 Noise

Noise would be produced from drill rigs, generators, water pumps, and construction vehicles during construction of the proposed project. During site preparation, noise would temporarily be produced from construction vehicles and the movement of gravel to construction access roads and well pads. Blasting may be required during road or well pad construction, which can produce high noise levels for a very short duration (i.e., fractions of a second).

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Noise in the project area would significantly increase during drilling and testing of the geothermal resource; drilling is anticipated to produce noise at or above 100 a-weighted decibels⁶ (dBA) at the drilling site, which would exceed the World Bank's threshold of 85 dBA for heavy industrial construction. Onsite workers would be adversely impacted by the loud noise at the drilling site.

Tourists and other people near the project area would not experience significant noise levels from construction, drilling, or testing because people not associated with the project would not be granted access to the project site. Noise levels attenuate at a rate of 6 dBA for each doubling of distance from the source. Noise levels would be reduced to approximately 75 dBA at a distance of 25 meters and further attenuate to 30 dBA at a distance of 400 meters from the noise source. Additionally, high winds characteristic of the project area would mask some of the noise produced during drilling and testing.

Operation of the quarry would also temporarily produce noise from the use of machinery and explosives to mine materials; however, material would be obtained from an existing quarry and the noise levels will be the same as existing conditions because the use of the quarry would not change. There would be no noise impact associated with use of the quarry.

6.2.8 Water Quality and Water Supply

Water would be required for four purposes: wash water, drinking water for workers' needs, water for drilling, and dust control. It is anticipated that approximately 3,000 liters of water would be required per day to meet workers' needs for washing. Water would be trucked to the workers camp from offsite. Additional drinking water would be required (approximately 300 to 600 liters per day). Approximately 80,000 gallons of water would be required to manufacture cement for the wells. The use of water for washing, drinking, and cement could strain water supplies in the region where the existing communities already lack adequate water.

Water for drilling would either be pumped from the Bay of Ghoubet via a temporary pipeline or from shallow seawater wells within the project area. The volume of water required for drilling would be up to 6 million liters per day. Local groundwater is hot seawater. There are no local uses for this shallow groundwater. The use of groundwater from shallow wells would have no effect on water quantity or quality because water would continue to flow in from the ocean and be of the same quality.

Water extraction from the Bay of Ghoubet could affect the turbidity of the water; if water is pumped too quickly. The flow of the water may stir up sediments on the bottom of the Bay and decrease the water quality in the area surrounding the intake valve.

During drilling and testing, drilling and geothermal fluids would be injected either into a nearby testing well, a nearby open fissure in the lava, or fluids would be collected in a reserve pit and allowed to infiltrate into the ground. However, adverse impacts to nearby waterbodies could occur if the reserve pit is not properly constructed or the pipes to the wells or fissures are not monitored. If water levels in the reserve pit are not monitored to maintain at least 3 feet of freeboard, drilling fluids and/or produced geothermal fluids could drain outside of the project area. It is unlikely that fluid flow could reach the Bay of Ghoubet 1.6 kilometers to the south because fluids would percolate into the ground prior to reaching the Bay. Concentration of heavy metals and other toxic substances in the drilling and geothermal fluids will likely exceed of the concentrations in seawater. Thus, the Bay of Ghoubet could become contaminated if the drilling mud and fluids were not properly contained on

⁶ The A-weighted sound level (dBA) is a noise measurement that deemphasizes the very low- and very high-frequency components of the sound, which reflects how the human ear perceives sound.

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site. Fluid from a well blowout or pipeline failure, if they occurred, would not likely affect Bay of Ghoubet due to the distance to the Bay and the likely percolation between the wells and the Bay.

There is the potential for a water supply pipeline to leak or rupture and cause runoff to the Bay of Ghoubet. A water supply pipeline rupture would have the potential to temporarily flood access roads and transport sediment to Ghoubet if the pipeline is not fixed and the fluid is not contained.

Construction equipment would use hazardous materials such as diesel, hydraulic oils, lubricants, and coolants. An accidental spill could occur during equipment and vehicle servicing and refueling. While a spill would be unlikely, spilled or leaking hazardous materials could contaminate the groundwater if allowed to infiltrate into the ground; however, there is no beneficial use of the groundwater. The contamination of soil and groundwater could affect worker health and could cause lasting impacts on the environment if hazardous materials are not properly contained and discarded.

6.2.9 Hazards, Hazardous Materials, and Public Health and Safety

6.2.9.1 Well Blowout

Well blowouts and pipeline failures are very rare occurrences during well drilling and testing; however, their occurrence could pose a significant hazard to workers, visitors to the project site, and the environment. Rapid rise of extremely hot geothermal fluids during a well blowout could cause severe burns on workers, and steam containing trace amounts of heavy metals, acids, mineral deposits, and other pollutants would be released and potentially inhaled by workers.

There is very little vegetation that would be affected by a blowout.

6.2.9.2 Seismic and Volcanic Events

The project would be located in an area that is currently geologically active; thus, there is a risk of seismic (earthquakes) and volcanic incidents during construction and well testing (approximately one year). Due to the short duration of construction, the risk of a seismic event or volcanic eruption during construction is low. While seismic events in the area have historically been of low magnitude⁷, there is still a risk that a seismic or volcanic event could result in worker injury or death.

6.2.9.3 Hazardous Materials

Hazardous materials used and produced during drilling and testing could pose a health and safety threat to workers. Construction equipment would use hazardous materials such as diesel, hydraulic oils, lubricants, coolants, and blasting materials. Approximately 50,000 liters of fuels are expected to be used for the proposed project. An accidental spill could occur during equipment and vehicle servicing and refueling; while a spill would be unlikely, ingestion or inhalation of volatilized hazardous materials would pose a threat to workers. Improper use or storage of blasting materials could result in worker injury or death.

Similarly, inhalation of high concentrations of CH₄, H₂S, or CO₂ potentially emitted within steam during geothermal testing would threaten worker health. Geothermal fluids could also contain hazardous materials such as heavy metals and radiological elements. Ingestion or exposure to these hazardous materials would also threaten worker health. Prolonged exposure to these elements would not occur during the timeframe of the proposed well testing (a few months); however, short-term exposure could have adverse health effects.

⁷ An earthquake with a magnitude exceeding 5 on the Richter scale has an average occurrence interval of 16 ± 5 years in this region. The estimated maximum earthquake magnitude for the Gulf of Tadjoura is 6 (ONEC 2013).

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6.2.9.4 Heat

The project would be located in a hot environment where temperatures can reach above 40 degrees Celsius. Heat contributed by the steam and hot water from geothermal wells would increase temperatures in the immediate vicinity of the wells. Extreme and prolonged heat can lead to heat stroke and dehydration, which, if left untreated, can lead to death.

6.2.9.5 Worker Injury

The use of large equipment including drill rigs and trucks and vehicles on the site would increase the risk of injury. Workers on the drill rig would be exposed to heights and would risk injury in the case of falls. Vehicles would be accessing the site on steep terrain and workers could be injured if a vehicle overturned.

6.2.9.6 Well Abandonment

Wells would be abandoned if they were determined to not have commercial potential for either production or injection. Both temporary and permanent abandonment of the wells could be a significant hazard to workers or the public if the wells are not properly sealed and capped. Steam escaping from improperly abandoned wells could cause burns or exposure to H₂S if wells are not properly abandoned. World Bank guidance encourages the preparation of well abandonment procedures prior to well abandonment (IFC and World Bank Group 2007b).

6.2.10 Sociocultural Environment

6.2.10.1 Transhumance Corridor

Part of a transhumance corridor runs along the western edge of the project area for approximately two to three kilometers along the approximate location of the access road from the RN9 highway to where the access road turns east toward Lava Lake. Animals generally require a corridor that has a minimum width of 2 meters when the corridor is limited to a short distance; on flat land, animals require a larger corridor between 1 and 2 kilometers wide. Herders from the northern part of the Tadjoura region and from the southern part of the Dikhil region use the transhumance corridor a minimum of twice a year (often three to four times a year), depending on the prevalence of rainfall. Under the customary law of the Afars, the Sultan of Tadjoura defines the rite of passage. The project would avoid development within the transhumance corridor.

6.2.10.2 Impacts on Women

Women are often subject to sexual harassment, prostitution, and sexually transmitted infections (i.e., human immunodeficiency virus [HIV]) in workers camps; they are often left vulnerable to other workers living without their families and should be protected against all forms of abuse. While the proposed project would employ a limited number of workers for a short duration of time, it is possible that impacts to women may still occur if no protections were in place.

6.2.10.3 Involuntary Resettlement

The project does not require land acquisition. No communities would be involuntarily displaced by the proposed project. The nearest communities are located approximately 5 kilometers from the project area.

6.2.11 Cumulative Impacts

Several other projects are already built or are scheduled to be built near the project area. These projects include:

- **Salt Investment SA Salt Operation.** A current operation that extracts salt from Lake Assal (a protected area) stores salt on the shore of the Bay of Ghoubet has proposed to expand a port on the Bay of Ghoubet to transport salt from the mining site. A new road is currently being constructed between the Bay of Ghoubet and Lake Assal. A worker camp has been constructed near the port to house construction workers for the Port expansion and the new road construction. The company that is constructing the road has

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also opened a quarry along the roadway to supply materials for the road construction and potentially the Port expansion.

- **60 megawatt wind power project.** A Djibouti Memorandum of Understanding with Shanghai Electric describes a project to build up to 60 megawatts of wind power and two 230-kV transmission lines in northern Djibouti. Potential development areas include Assal, Ghoubet, GaliMaaba, and Bada Wein (African Review 2015).
- **Water Supply and Sanitation project in rural areas of Tadjoura, Arta, and Ali Sabieh Districts of Djibouti.** This social development initiative intended to install water tanks and water supply systems to supply rural populations with potable water (AfDB Group 2012).
- **RN9 Rehabilitation.** The Ministry of Transportation has begun the planning and design for rehabilitation of RN9, located adjacent to the project area,
- **Railway from Tadjoura Port.** A railway is planned from the new Tadjoura Port to the border.

The cumulative projects in the region are physically separated from the proposed project by 3.2 kilometers or more with the exception of the RN9 highway rehabilitation. The RN9 highway rehabilitation is still in the planning stages and reconstruction of the road is expected to occur after completion of the civil works and road improvements for the project. The biological, geological, traffic, noise, air quality, water quality and hazards impacts of the proposed project would not combine with impacts of these cumulative projects because the proposed project impacts would be limited in extent. Socio-economic impacts on surrounding communities could extend to the same populations as the impacts of the proposed project.

7 MITIGATION MANAGEMENT AND MONITORING PLAN

7.1 OVERVIEW

The purpose of the Mitigation Management and Monitoring Plan (MMMP) is to identify mitigation measures to reduce impacts from the project, describe the roles of participating parties and key personnel responsible for implementation the mitigation measures, and identify procedures to ensure that the mitigation measures are implemented adequately during all phases of construction.

Mitigation measures for the project are identified in Table 7.2-1. Parties responsible for implementing or overseeing implementation of mitigation measures, as well as their roles and responsibilities, are described in Section 7.3. Implementation and verification procedures are described in Section 7.4.

7.2 MITIGATION MEASURES

7.2.1 Summary ESMP Mitigation and Detailed Requirements

Table 7.2-1 lists the general mitigation measure requirements included in the ESIAF and ESMP on the left column with the detailed mitigation measures defined in this ESMP. Each detailed mitigation measure is numbered and organized by environmental impact. Required mitigation plans are listed in Table 7.2-2. Performance standards with thresholds/trigger levels are specified in Table 7.2-3. Roles and responsibilities for each mitigation measure are addressed in Table 7.2-3 and described further in Section 7.4. These mitigation measures may be subject to minor modification during project implementation to clarify or improve effectiveness of a measure.

Table 7.2-1 Mitigation Measures from Summary ESMP and Detailed Mitigation Measures

Summary ESMP Mitigation Measure	Detailed Mitigation Measure
Access Road and Civil Works	
Design the road alignment in such a way as to limit impact on the landscape and geology to a strict minimum.	Geology-1: Avoid Lava Lake. <ol style="list-style-type: none"> The improved access road shall follow the route of the existing road within Lava Lake. Roads and well pads shall avoid extending into the lava field to the extent feasible. Any relocation of pads from that shown on the project design plans must be reviewed by the PMU. The limits of project activities and surface disturbance adjacent to Lava Lake shall be demarcated in the field to ensure that inadvertent damage to the lava field does not occur. The limits of surface disturbances shall be marked by stakes and flags prior to construction. Vehicles and personnel shall only be permitted within construction work areas and on access roads or existing paths. Grading and vegetation clearing shall be kept to the minimum required. Existing areas of disturbance and access roads shall be used to the extent feasible.
Carry out minimum excavation works to protect the geology, soils, topography, landscape and vegetation.	

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Summary ESMP Mitigation Measure	Detailed Mitigation Measure
Take appropriate erosion-control measures and avoid vegetation areas.	<p>Water Quality-1: Erosion Control. The following erosion control measures shall be implemented during construction.</p> <ol style="list-style-type: none"> a. Soil disturbance shall be limited to the minimum amount necessary for construction and access. b. Vehicular traffic associated with the project shall be restricted to access roads and construction work areas. c. Grading and other surface disturbance activities shall cease during rain events. d. Pipelines shall be monitored for leaks and any leaks shall be repaired immediately. e. A minimum of 1 foot of freeboard shall be maintained on all reserve pits to avoid overflow. f. Discharge containment shall be installed downgradient of any discharge of geothermal effluent or drilling fluids to manage infiltration of the discharge, avoid geothermal effluent runoff out of the Lava Lake area, and ensure there is no discharge to the Bay of Ghoubet. <hr/> <p>Note: There is very limited vegetation on site; however, it is infeasible to avoid all vegetation because the flat areas that are suitable for construction and outside of the lava field are sparsely vegetated. There is insufficient area for construction of the well pads in areas that are completely devoid of vegetation and within the range of the drilling target; therefore, some vegetation will be impacted.</p>
Follow the alignment of the existing road where possible. For the areas where the current road crosses over Lava Lake, there are plans to change the alignment and avoid the lava area.	Refer to Geology-1
Alignments of the current road that have been replaced should be closed.	Refer to Geology-1
The construction/erection of the planned facilities in such a fashion that they will resist earthquakes as much as possible.	<p>Geology-2: Geologic Hazard Risk Assessment and Design Standards.</p> <ol style="list-style-type: none"> a. The civil works contractor shall assess the risk of hazards from rock slides where the roadway and/or well pads are located near the edge of the caldera. Slope protection/rock slide protection measures shall be installed to protect the project facilities and workers from falling rocks and boulders, as needed. b. All project facilities shall be designed and constructed in accordance with the International Building Code seismic design standards.
No weed control measures were included in Summary ESMP or ESIAF.	Biology-1: Weed Management. All equipment and vehicles shall arrive at the project site clean and free of weeds. Vehicles shall be inspected prior to entering the site.

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Summary ESMP Mitigation Measure	Detailed Mitigation Measure
Training of personnel	<p>General-1: Worker Training. The drilling and civil contractors shall prepare worker training programs that define worker safety protocols, address worker roles in implementing the ESMP, and respect for women and local workers.</p> <p>The worker training programs shall be submitted to the GCC and PMU for review and approval at least 14 days prior to construction. All workers shall receive the worker training prior to conducting any work on the site. The contractors shall provide evidence that all workers have received environmental, health, and safety training.</p> <p>The construction contractors shall hold weekly meetings with all workers on the site. Safety protocols and any environmental issues that need to be addressed on the site shall be discussed during the weekly tailgate meetings.</p>
Quarry Operation	
Establish a general safety and health plan (GSHP) for the operation of the quarry.	Refer to Safety and Health-3
Optimize the planning of proposed extractions to minimize impacts on geology, topography, vegetation, etc.	Not applicable. The project will obtain aggregate from an existing quarry.
Choose adequate extraction equipment and techniques to minimize impacts on noise levels and air quality and reduce the risk of accidents;	Not applicable. The project will obtain aggregate from an existing quarry.
Accurately plan extraction works to avoid all types of accidents caused by rockslides, landslides, etc. especially after the use of explosives.	Not applicable. The project will obtain aggregate from an existing quarry.
Regulate access of quarry trucks to national highways (road signs, speed limits, etc.)	Refer to Safety and Health-4
Reduce noise by using appropriate equipment	Not applicable. The project will obtain aggregate from an existing quarry.
Provide for noise protection gear	Refer to Safety and Health-5
Reduce dust generation	Refer to Safety and Health-4
Provide protective respiratory masks for workers	Refer to Safety and Health-3
Ensure proper transportation and storage of explosives	Not applicable. The project will obtain aggregate from an existing quarry.
Secure the quarry site against all types of accidents or subsequent damage, and rehabilitate the site upon completion of the works.	Not applicable. The project will obtain aggregate from an existing quarry.
Drilling	
Use of storage tanks or special basins lined with a water-tight membrane for collection and storage of fluids, mud and spoils	<p>Water Quality-2: Drilling Fluid Storage. Drilling fluids, mud and spoils shall be stored in either storage tanks or soak ponds adjacent to the well. Drilling fluids shall be reused to the extent feasible.</p> <p>Note: There is no beneficial use of groundwater beneath the project site that could be contaminated by the infiltration of geothermal fluids; therefore, a water-tight membrane is unnecessary. The shallow seawater reservoir is hydrologically connected to the geothermal reservoir as evidenced by the presence of hot water in the shallow aquifer.</p>
Re-utilisation of drilling fluids to the extent possible	

7 MITIGATION MANAGEMENT AND MONITORING PLAN

Summary ESMP Mitigation Measure	Detailed Mitigation Measure
Use of water-tight casing to line the walls right down to the appropriate depth of the geological formation to avoid leakage of drilling fluids at levels far above the geothermal reservoir	The geothermal well shall be designed according to best industry practices. Note: There is no shallow, fresh groundwater aquifer that could be contaminated by the geothermal fluid because there is no beneficial use of the shallow seawater aquifer and it is likely that the shallow seawater is hydrologically connected to the geothermal aquifer.
Preference for biodegradable products when manufacturing drilling mud Classification of the excavated material and the mud based on a chemical analysis of the eluate (a solution obtained by elution).	Water Quality-3: Drilling Mud. Non-toxic and biodegradable products shall be used to manufacture drilling mud where feasible. If foams are applied to the drilling fluid, the drilling contractor shall cover any reserve pits containing drilling cuttings or line the downwind perimeter of the reserve pits with hay bales or equivalent to prevent the foam from being transported offsite via wind. Cuttings from wells shall be tested for heavy metals, volatile, and semi-volatile organic properties. If the samples exceed the standards for toxicity ⁸ , the toxic soils would be capped with two feet of clean fill material.
Where a decision has been taken to dispose of the liquid resulting from separation, the quality of effluents must be up to standards; this could imply treating fluids prior to disposal	Refer to Water Quality-4
The quality of liquids to be disposed of must be controlled regularly	Refer to Water Quality-4
Where foam would be used, special measures must be taken to protect against wind	Refer to Water Quality-3

⁸ The maximum concentration of contaminants for toxicity characteristics defined in U.S. Code of Federal Regulation Title 40 Section 261.24 shall be used to define soils that meet are toxic and need to be treated as hazardous wastes. The World Bank standards for effluent reflect discharge to a surface water body and are overly restrictive for the proposed discharge to uplands and infiltration to the groundwater table.

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Summary ESMP Mitigation Measure	Detailed Mitigation Measure
<p>The drilling mud treatment facilities and water intake and/or drilling fluid disposal pipes must be dismantled upon completion of works</p>	<p>Reclamation-1: Site Reclamation. The following reclamation and restoration activities shall be completed following construction:</p> <ul style="list-style-type: none">a. The drilling mud treatment facilities and water intake and/or drilling fluid disposal pipes shall be dismantled upon completion of the exploration phase and removed from the project site.b. Where applicable, the temporary treatment facilities and pipes for disposal of geothermal fluids produced during the well tests shall be dismantled after completion of the tests and the temporary treatment facilities and pipes shall be removed from the project site.c. The drilling fluid and mud reserve pits and any water supply sumps shall be filled in (if they were excavated) and graded to match the grade of the surrounding area.d. The worker camp and storage area, including all aggregate and materials and any latrines, shall be dismantled and removed from the site. The worker camp and storage area shall be resurfaced as necessary to match the surrounding conditions.e. All excess materials shall be recycled where possible.

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Summary ESMP Mitigation Measure	Detailed Mitigation Measure
<p>The Summary ESMP did not include any measures for the water supply intake at Ghoubet.</p>	<p>Biology-2: Water Supply Intake at Bay of Ghoubet. The water intake system shall be designed to limit impacts to fish and aquatic organisms. The system shall be designed to ensure reduction of impingement and entrainment of fish and shellfish by the installation of technologies such as barrier nets (seasonal or year-round), screens, and aquatic filter barrier systems. The water supply intake shall be marked with a buoy and signage warning any swimmers or divers in the area to avoid the intake.</p> <p>The water intake structure shall be designed to allow unimpeded movement of fish and other aquatic organisms and to prevent adverse impacts on water quality. At a minimum, the following measures shall be implemented:</p> <ol style="list-style-type: none">Any water supply intake within the Bay of Ghoubet shall be screened with mesh to prevent fish entrapment. The fish screen shall have a fully functioning cleaning system capable of removing debris from the entire mesh surface, or the screen shall be inspected every 24 hours.Trash racks shall be installed on the inlet pipe and the racks shall be cleaned daily to prevent build-up of larger debris and damage of the fish screen.The intake at the Bay of Ghoubet shall be located off shore, outside of the tidal range, and at a depth where a lower density of fish is expected. The intakes should be located where sufficient flow exists to minimize sediment accumulation in and around the screen, facilitate debris removal, and encourage fish movement away from the screen face.The intake pipes and pipeline shall be removed if the wells are determined to be non-commercial, or at the direction of the PMU upon completion of the exploration project.
<p>The Summary ESMP did not include any measures for the water supply.</p>	<p>Water Supply-1: The civil contractor shall notify the PMU of the source of water for construction prior to use. Use of non-potable water for construction is preferred.</p>

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Summary ESMP Mitigation Measure	Detailed Mitigation Measure
Geothermal Fluid Management	
<p>If all the geothermal fluids are not re-injected into their reservoir of origin, the quality of effluents must be up to standard. This may imply bringing the temperature and concentrations of effluent down to the prescribed limits. The quality of water that is disposed of must be controlled regularly.</p> <p>Complete analysis of the untreated geothermal fluids. The analysis parameters must include at a minimum: pH, temperature, Na, K, Mg, Ca, Li, Ba, Sr, Cl, SO₄, H₃BO₃, SiO₂, Fe, Mn, F, Zn, Cu, Cd, Hg, Pb, Cr, Ni, Co, U, As, V, Ag, Au.</p>	<p>Water Quality-4: Water Quality Testing and Discharge.</p> <ol style="list-style-type: none"> a. All geothermal fluids produced during the well test would be discharged into soak pits or left to evaporate in an evaporation pond. b. The contractor shall conduct water quality sampling and analysis prior to discharge of geothermal fluids to soak pits or evaporation ponds. Water quality shall be sampled for the following analytes to define water quality in the geothermal aquifer: <ul style="list-style-type: none"> • pH • Temperature • Boron • Bicarbonate • Calcium • Chloride • Sulfide • Iron* • Fluoride • Copper • Cadmium • Mercury • Lead • Chromium (hexavalent* and total) • Nickel • Arsenic • Vanadium • Silver c. The geothermal water shall also be tested for the following radiological elements: <ul style="list-style-type: none"> • Radium 226/228 (Combined) • Gross Alpha (Adjusted) • Uranium d. Workers shall be notified of the water quality results and any potential health risks associated with the constituent levels in the fluid. The discharge shall be managed to minimize worker exposure. <p>Note: * Elements require testing within 24 hours due to short hold times. It is not feasible to transport the samples to a certified lab within the specified hold times for these constituents. Sampling will need to be conducted on site or in country.</p>
<p>Where it is decided that the fluids be re-injected into their reservoir of origin, the groundwater contamination potential must be reduced to a minimum by lining the injection wells with water-tight case right down to the level where the geological formation containing the geothermal reservoir is located</p>	<p>Note: Wells will be cased according to industry standards. There is no beneficial use of the groundwater underlying the project site. The shallow seawater (approximately 250 meters) encountered below the project site is approximately 100 degrees Celsius indicating that there is hydrologic connection with the geothermal aquifer. There is very limited potential for groundwater contamination because the groundwater aquifer is likely already hydrologically connected to the geothermal aquifer.</p>

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Summary ESMP Mitigation Measure	Detailed Mitigation Measure
<p>Where applicable, the temporary treatment facilities and pipes for disposal of geothermal fluids produced during the tests must be dismantled after completion of works</p>	<p>Refer to Reclamation-1</p>
Spill Control and Hazardous Materials Management	
<p>Regular maintenance of machines</p> <hr/> <p>Proper transportation and storage of fuels</p> <hr/> <p>Collection and proper disposal of used and potentially polluting fluids (oils, break fluids, etc.)</p>	<p>Hazardous Materials-1: Hazardous Materials Storage, Disposal, and Spill Containment Plan.</p> <p>The drilling services contractor and civil contractor shall prepare Hazardous Materials Storage, Disposal, and Spill Containment Plans that addresses safe storage of hazardous materials, proper disposal solutions for hazardous waste, and contingencies for geothermal and hazardous materials spills. At a minimum the following shall be addressed in the Hazardous Materials Storage, Disposal, and Spill Containment Plan and implemented on the project site:</p> <ol style="list-style-type: none"> a. Spill kits shall be available at locations where hazardous materials are stored and used. b. Should any hazardous materials (e.g., oil, fuel, hydraulic fluid) spills or leaks occur, the contaminated soil and any materials used to absorb the fluid shall be removed and disposed of in a manner acceptable to MHUEAT and consistent with the Djibouti Environmental Code. c. Blasting materials must be stored in appropriate magazines and separated from other flammable materials or sources. d. All hazardous materials shall be stored away from natural drainages. e. Containment berms or straw bales shall be installed around all hazardous material storage areas. f. Stormwater flows shall be directed away from hazardous material storage areas. g. All vehicles and equipment shall be fueled and maintained in a designated fueling and maintenance area. The fueling and maintenance area shall be inspected daily for spills or leaks of oil and gas. h. A minimum of 1 foot of freeboard shall be maintained on all reserve pits to avoid overflow. i. Any leaks or accidental discharges of geothermal fluids shall be contained immediately. <p>All personnel shall receive training on proper handling and storage of hazardous materials prior to working on the project site. The contractors shall provide evidence that all personnel have been adequately trained.</p>

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Summary ESMP Mitigation Measure	Detailed Mitigation Measure
Solid Waste and Wastewater Management	
<p>Onsite waste collection and transportation of the waste to a household garbage dump</p>	<p>Waste-1: Solid Waste Management. The drilling services contractor and civil works contractor shall each prepare a Waste Management Plan that includes the sources of waste, methods and locations for waste collection, locations of waste disposal, methods for minimizing waste, and opportunities for reuse and recycling. The Waste Management Plan shall be submitted to the GCC and PMU for review and approval at least 14 days prior to construction. The Waste Management Plan shall meet the following minimum standards:</p> <ol style="list-style-type: none"> a. All solid waste generated on the project site (e.g., food waste) shall be contained in covered bins. b. Trash bins shall be accessible at all points where waste is generated. c. The project area shall be kept clean and free of litter and no litter shall be allowed to disperse to the surrounding area. d. Solid waste shall be removed from the site and transported to a municipal landfill (e.g., Tadjoura). e. No dumping of solid waste shall be allowed in the project area or surrounding environment and no waste shall be buried or burned. <p>All personnel shall receive training on proper disposal of all wastes prior to working on the project site.</p>
<p>Installation of mobile toilets on the project site and regular evacuation to a wastewater treatment plant.</p>	<p>Waste-2: Wastewater. Latrines shall be constructed on site. Latrines for male and female workers shall be positioned in all construction areas. Latrines shall have adequate capacity and shall be maintained in a sanitary condition.</p>

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Summary ESMP Mitigation Measure	Detailed Mitigation Measure
Worker Safety and Health	
<p>As regards the risk of exposure to dangerously high concentrations of hydrogen sulphide, it is necessary to envisage the following measures:</p> <ul style="list-style-type: none"> • install a non-stop surveillance and early-warning system; where the H₂S concentration exceeds the WHO guideline value of 10 ppm, the drilling works or testing should be halted; • prepare an emergency intervention plan in case of accidental hydrogen sulphide emission, covering all the necessary aspects from evacuation to resumption of normal operations; • install hydrogen sulphide detectors or distribute personal detectors, and also install autonomous respiratory equipment in areas with high risk of exposure; • install adequate ventilation mechanisms to prevent a build-up of hydrogen sulphide; • distribute brochures or any other information medium to workers on the chemical composition of liquid and gaseous phases, explaining their potential risks to health and safety. 	<p>Safety and Health-1: Hydrogen Sulphide (H₂S) Monitoring and Abatement.</p> <ol style="list-style-type: none"> a. Hydrogen Sulphide (H₂S) emissions shall be minimized through the use of properly weighted drilling mud to keep the well from flowing during drilling. b. H₂S monitoring devices shall be installed and operated at each well during all phases of drilling and testing. H₂S levels shall not exceed 10 ppm. H₂S detectors shall be installed or personal detectors shall be provided to drillers. c. Autonomous respiratory equipment shall be provided in areas with high risk of H₂S exposure (such as the cellar of the drill rig). d. The EHS Plan shall specify safety procedures to protect worker health. e. The contractor shall provide workers with brochures or any other information medium on the chemical composition of liquid and gaseous phases of H₂S, explaining the potential risks to health and safety. The contractor shall also provide training to workers operating the drill rig on potential exposure to unsafe levels of CO₂. f. An H₂S abatement plan shall be developed and implemented during long-term flow-testing if it becomes apparent during drilling operations that H₂S abatement is necessary to protect worker health. g. Measures to reduce H₂S during flow testing, if necessary, could include but are not limited to: <ol style="list-style-type: none"> i. Reducing the number of wells venting simultaneously, as applicable ii. Implementing additional wellhead abatement measures, such as caustic injection between the flash tank and the portable silencer iii. Equipping all drill rigs with alarms to detect unsafe levels of non-condensable gases (NCGs)
<p>Accidental exposure to heat may occur during drilling in case of well blowouts and malfunction of heat confinement and conveyance mechanisms. Recommendations on controlling exposure to heat include the following:</p> <ul style="list-style-type: none"> • Reduce work time in high temperature environments and provide access to drinking water points; • Establish protective surfaces in areas where workers work near hot equipment, especially pipes; • Use appropriate individual protection gear, especially insulated gloves and shoes; • Follow appropriate safety procedures during drilling works 	<p>Safety and Health-2: Limit Heat Exposure. The contractor shall prepare an EHS Plan to protect worker health that defines specific protocols for heat exposure and work in hot environments. At a minimum, the following measures shall be implemented to avoid unsafe exposure to heat:</p> <ol style="list-style-type: none"> a. Reduce work time in high temperature environments and provide access to drinking water at all work sites. b. Provide access to shade at all work sites. c. Provide appropriate personal protection equipment including insulated gloves and shoes as appropriate for workers handling hot equipment. d. Train workers on procedures to avoid unsafe heat exposure.

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Summary ESMP Mitigation Measure	Detailed Mitigation Measure
<p>Establishment of a general health and safety plan. Preparation of an Emergency/Crisis Intervention Plan.</p>	<p>Safety and Health-3: Environmental, Health and Safety (EHS) Plan. The contractor shall prepare a detailed EHS Plan that defines safety risks and contingencies for the proposed project. At a minimum, the plan shall address risks from:</p> <ol style="list-style-type: none"> a. Hazardous materials handling including blasting materials b. H₂S c. Fugitive dust d. Heat exposure e. Well blowout f. Hot fluids g. Hot equipment h. Fire i. Volcanic eruption j. Earthquakes k. Vehicle and equipment accidents l. Workplace injuries m. Quarry operation safety <p>The EHS Plan should provide an overview of the safety risks and requirements and identify specific staff training requirements to avoid injuries and accidents. The plan shall be submitted to the GCC and PMU for review and approval no less than 14 days prior to construction. All personnel shall receive health and safety training prior to working on the project site.</p>
<p>Speed limits on the trail/path in order to limit the creation of dust</p>	<p>Safety and Health-4: Dust Control. The following fugitive dust source controls shall be implemented on the project site:</p> <ol style="list-style-type: none"> a. Water shall be applied to disturbed areas and unpaved roads as needed to control visible dust plumes. b. Vehicle speeds shall not exceed 25 kilometers per hour on unpaved roads. c. Work areas and the worker encampment shall be stabilized to minimize dust generation.
<p>Requirements for fencing of pits were not included in the summary ESMP or ESIAF.</p>	<p>Safety and Health-5: Fence Open Pits. All open pits shall be fenced to avoid workers and wildlife from accidentally entering a pit.</p>

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Summary ESMP Mitigation Measure	Detailed Mitigation Measure
Noise/Health and Safety	
<p>Workers operating in the drilling area should use individual protective gear such as ear defenders if the noise level exceeds 85 dB (A).</p>	<p>Safety and Health-6: Personal Protective Equipment. The civil works and drilling contractors shall supply all workers with personal protective equipment (PPE), including, but not limited to:</p> <ul style="list-style-type: none"> • Safety headgear • Steel toed boots • Safety glasses or impact-resistant eye protection • Ear protective devices • Harnesses for workers operating at heights • Respirators • High visibility clothing or vests • Other specialized protective equipment for the drill rig, welding, or blasting <p>All PPE shall be properly fitted for each employee and personnel shall be trained in the proper use of PPE prior to working on the project site.</p>
Well Blowout	
<p>The drilling consultant should cover these risks in his emergency intervention plan (EIP). The plan should specify the following:</p> <ul style="list-style-type: none"> • Define measures for controlling a blowout; using a blowout preventer stack; and stocking of material for quelling the blowout (water, baryta); • Define personal safety measures; • Define other emergency measures; • The staff working on the drilling site should be trained on the measures to be adopted. 	<p>Safety and Health-7: Blowout Prevention. Each well shall be fitted with blow out prevention equipment (BOPE) of industry standard. The drilling contractor shall prepare and implement a blowout prevention and containment plan as part of the EHS Plan that will define specific measures for preventing and controlling a blowout (e.g., using a blowout preventer stack and stocking of material for quelling the blowout). The drilling services contractor shall have a qualified individual(s) certified in well control on site at all times during operation of the drill rig.</p> <p>Refer to Safety and Health-3 and General-1 regarding safety measures for personnel and worker training requirements.</p>
Volcanic Eruptions and Earthquakes	
<p>The following mitigation measures should be taken:</p> <ul style="list-style-type: none"> • Establish an evacuation plan; • Develop emergency measures; • Train staff on the risks and the measures to be adopted. 	<p>Safety and Health-8: Evacuation Plan. The contractor shall prepare an evacuation plan as part of the EHS Plan that defines the routes and means for evacuation in the case of volcanic eruption or emergency. The contractor shall provide all workers with a map and description of the emergency evacuation routes.</p> <p>Refer to Safety and Health-3 for emergency measures and staff training.</p>
<p>Requirements for safety equipment were not included in the summary ESMP or ESIAF.</p>	<p>Safety and Health-9: Safety Equipment. The contractor shall ensure that adequate safety equipment is located at drilling sites and maintained in good working order, such as firefighting equipment, protective suits, respirators, and other breathing apparatuses.</p>
<p>Requirements for First Aid/CPR training were not included in the summary ESMP or ESIAF.</p>	<p>Safety and Health-10: First Aid. The contractor shall provide first aid training to all workers on the project site. The contractor shall also furnish emergency medical equipment and supplies on the site and train workers in the use of emergency medical supplies and accident and injury response procedures as described in the EHS Plan. An Emergency Medical Technician shall be available on the project site to provide medical assistance to workers and respond to injuries.</p>

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<p>The summary ESMP and ESIAF did not include requirements for a drug free work environment.</p>	<p>Safety and Health-11: Drug and Alcohol Free Workplace. The worker camp and all work sites shall be maintained as a drug and alcohol free work environment. The contractor shall prepare a Drug and Alcohol Free Workplace Program that specifies the approach to drug testing and management of the work site as a drug and alcohol free environment. There will be a zero tolerance policy for drug and alcohol use. Failure of a drug test would be means for permanent dismissal from the project.</p>
Socio-Economic	
<p>It is recommended that the technical drilling study should select drilling sites in such a way as to maintain a safe distance without closing the route used by transhumant livestock. Where possible, the transhumance route should be slightly modified, but it must still pass through Fialé in order to guarantee access to pastureland and the traditional right to the transhumance route. The specific ESMP of the drilling contractor should specify mitigation measures, where necessary.</p>	<p>No fences are proposed along the roadways for the geothermal exploration. If needed, the fences around the well pads (100 meters by 80 meters) would not block access to the Lava Lake and Ardoukoba Volcano area or affect livestock movement. The GCC and PMU shall consult with the local chiefs and sultans at the project site to determine the routes used by the local population. The contractor shall ensure that access is not impeded. The drilling sites are located west of the primary transhumance corridor, which is located east of the project area. No further action is required.</p>
<p>Similarly, the project should not block the route that leads to Lava Lake and Ardoukoba Volcano. The passage should remain open, but a safe distance must be maintained during construction of the drilling platforms. If this is not possible, an alternative route should be constructed. It would be appropriate to install display and information panels.</p>	<p>Socio-Economic-1: Display and Informational Panels: The contractor shall erect an informational kiosk at the northeast corner of the project and adjacent to the access road. The kiosk shall provide information about the geothermal drilling and testing, including the project schedule and any road closures or other public safety precautions that are in place on the site.</p> <p>Socio-economic-2: Sensitivity Training. Prior to the start of drilling, the PMU shall coordinate a project sensitivity training with the local community elders and leaders. The sensitivity training shall include information on local customs, traditions, and uses of the project area. All DSC workers shall attend the sensitivity training. The PMU shall provide the community with information on restricted access areas on the site that are defined to protect the safety of the community.</p>
	<p>No fences are proposed along the roadways for the geothermal exploration. If needed, the fences around the well pads (100 meters by 80 meters) would not block access to Lava Lake or Ardoukoba Volcano.</p>

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Summary ESMP Mitigation Measure	Detailed Mitigation Measure
<p>Under the drilling project, a small-scale NGO programme has been suggested to promote the organisation of women:</p> <ul style="list-style-type: none"> • Support for the women’s association, including a receipt of registration of the organisation at the Ministry of the Interior. Stakeholders responsible: MI, ADDS, UNFD. No cost. • Organisation of training for the women’s association on the development of income-generating activities conducted by the NGO. 15 days, 2 facilitators, USD 7,500. • Awareness-raising drive for workers on sexually-transmitted diseases conducted by an NGO (5 days, 3 facilitators = USD 6,000, including material and transport costs), to be specified during preparation of the specific ESMP (changes depending on the number of workers). <p>The two potential NGOs for this programme will be the National Union of Djibouti Women (UNFD) and Atuyofan, the association of Afar women. Cooperation with ADDS and the Ministry of Women’s Advancement is encouraged.</p>	<p>Socio-Economic-3: Support for Women.</p> <ol style="list-style-type: none"> a. Fund up to three five-day training sessions on income-generating activities, which shall be organized for women in the project region. The trainings shall be organized through local non-governmental organizations in Tadjourasuch as the National Union of Djibouti Women (UNFD), if it has a local Tadjoura office. The training shall be funded by the project. The PMU shall consult with the Préfet of Tadjoura and UNFD regarding appropriate local NGOs and training needs. b. The project worker training program shall include training on respect for women and local workers. c. The GCC and PMU shall define a grievance redress team to address any concern or conflict with workers or the community. One or two women shall be included on the grievance redress team specified in Section 7.5: Grievance and Redress Mechanism. The women should be leaders in their community. The PMU shall consult with the Préfet of Tadjoura regarding unresolved conflicts with the community. <p>Socio-Economic-4: Sexually Transmitted Diseases. Workers shall receive awareness training on sexually-transmitted disease prevention and treatment. The training shall be provided at the beginning of the project construction and follow-up trainings shall be provided monthly to any new workers on the project. Two training sessions on sexually transmitted disease prevention and treatment shall be extended to the local populations.</p> <p>Socio-Economic-5: Preferential Hiring for Locals and Women. Preference shall be given to local residents and women in the hiring process.</p>

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Summary ESMP Mitigation Measure	Detailed Mitigation Measure
<p>Sea Water Desalination Structure:</p> <p>In order to propose a more sustainable solution, it is suggested that a pilot project for the desalination of saline waters (appropriate simple technology such as "Water Pyramid") be implemented to produce drinking water for the local population. It will be set up in Dankalêlo on the shores of Ghoubbet sea, whose waters will be tapped. The structure is estimated to cost USD 120,000 (including transport costs). This measure is considered to be a local development priority and is consistent with the priorities of the local population. For the local population in the study area, this structure will provide approximately 25 litres per household per day. At Daba le Gahar, this will double the daily ration of water that SALTINVEST currently supplies by tank truck.</p> <p>Although the initial investment will be paid for by the project, the maintenance and operational costs incurred by a local contractor can be defrayed through user contributions. A contribution of approximately DJF 0.05 to DJF 0.1 per litre will be enough to ensure maintenance (USD 700 to USD 1,400 per year). Maintenance costs will be clearly cheaper than the cost of gasoil for the tank truck. The capacity to pay largely depends on salt mining and other economic activities available. At the moment, the population is waiting for the commencement of activities; in the present uncertain situation, no one was ready to express an opinion on the willingness to pay. This measure remains dependent on relentless public consultation of the local populations throughout the project.</p>	<p>Socio-Economic-6:Supply Water for Local Population. The drilling contractor shall provide water to the local population that is equal in volume to the water supplied for the worker camp. Alternatively, the project may purchase a machine that converts humidity in the air to fresh water. Should the project purchase a machine to supply fresh water for the project, the machine would be supplied to the local population at the completion of the exploration phase of the project.</p> <p>Sea water desalination is not appropriate for the 1-year long exploration phase of the project because the facility will require maintenance. It should be considered as part of a future production phase of the project. The need for water supply was stressed by the community and short-term supply during implementation of the exploration phase was acceptable to the community.</p>
<p>Community Funds for Women and Men's Associations. A revolving fund ("tontine") for the women's association will provide considerable support to women in the project area. One woman is selected to receive a sum of money (initially a grant to the association) for a business venture and will repay the money to the next beneficiary, plus a small interest rate of 2 to 3% maximum (for the association). Micro-credits are not recommended because of high monthly interest rates of 2% (degressive model, 18% per year) and the resulting vicious circle of debt that is generated in many cases. Traditionally, this collective savings mechanism exists under the appellation "hagba" or "tontine". These are groups of ten persons (mostly women) who take turns to receive and repay micro-credits (at 0% interest). Guidance of the women's association by ADDS or by an NGO is recommended to ensure selection of sound business ventures and support for the programme with training in "business planning" and management of repayments to the association. A similar measure could be tried with other associations that are not necessarily women's associations. The fund may also be used for community activities. The suggested endowment for this fund is DFJ 2,666,000 per year (or USD 15,000).</p>	<p>This measure cannot be reasonably implemented during the short duration of the well construction and testing. It would take considerable time to set up the lending mechanism, screen potential applicants and review business plans. This measure or similar could be implemented during a future production phase.</p>

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Summary ESMP Mitigation Measure	Detailed Mitigation Measure
<p>Instead of establishing a dispensary solely for workers, it is recommended to extend the new healthcare facilities to the local population and ensure transfer of emergency cases by ambulance. Discussions can be held on whether to use the Saltinvest health centre (once it becomes operational) or Karta health centre (which is in the final construction phase). Under the drilling project, it will not be viable in the long-term to build a health centre near the site because it will not be possible to finance the operating costs on a sustainable basis. Cooperation mechanisms between the regions (for example, the ambulance service of the nearest hospital) should be developed. The policy decision to include the project area in the ambulance service of Karta instead of Tadjoura (longer distance for Tadjoura) must be promoted. ADDS and the Ministry of Interior could facilitate this task.</p>	<p>Socio-Economic-7: Health Clinic for Local Community and Workers. The on-site medical staff shall support a two-day free medical clinic in the local community. Free medical services shall be offered to the local community and worker families during the clinic. The clinic shall include free vaccinations for diphtheria-pertussis-tetanus for individuals who are not currently vaccinated.</p> <p>Establishing a new healthcare facility for the local population and guaranteeing ambulance transport cannot be implemented sustainably during the short-duration of construction because there will be a trained EMT on site but no ambulance. This measure or similar could be implemented during a future production phase.</p>
Cultural Resources	
<p>A procedure for “chance finds” has been suggested for use during the eventual modification of the current alignment of the access road, the selection of a quarry, etc. The proposed sites should be inspected by an archaeologist from CERD prior to commencement of construction works. In case of a chance find during the project, all works should be suspended and an archaeologist called in.</p>	<p>Not required. The project will use an existing quarry and will not open a new quarry. The project is located in an area that has a high frequency of volcanic activity. Any archaeological resources would likely have been buried under volcanic material. Previous surveys of the area found no evidence of archaeological resources.</p>
Temporary Abandonment	
<p>In case of temporary abandonment of the site, the following measures should be envisaged:</p> <ul style="list-style-type: none"> • Installation of a blowout preventer to reduce the risk of blowout; • Regular surveillance of temporarily abandoned wells; • Construction of a fence around the drilling site to prevent access by unauthorized persons or animals. • Temporary abandonment is possible only when: <ul style="list-style-type: none"> • The casings are properly installed; • Cementation between the casing and the soil ensures the insulation of the permeable levels. • The duration of temporary abandonment should be agreed upon with the competent authorities. 	<p>Abandonment-1: Temporary Abandonment. The contractor shall implement the wells at the project site following measures for any temporary abandonment of the site:</p> <ol style="list-style-type: none"> a. Installation of blowout prevention to reduce the risk of blowout b. Monthly surveillance of the temporarily abandoned wells and well pads until permanently closed <p>Temporary abandonment is only possible when the casings are properly installed and cemented. The duration of temporary abandonment shall be consistent with all permits. If at any time during the temporary abandonment phase the well shows signs of weakness and potential failure (e.g., due to seismic activity or damage), the well shall be subject to permanent closure.</p>
Permanent Abandonment	
<p>Where a well turns out to be unproductive or where the risk of blowout is too high, the geothermal well should be abandoned permanently.</p> <p>Once such a decision is taken, the products needed to insulate the permeable levels should be used to cover the entire initially drilled section of the well.</p> <p>After complete closure of the well, a closure file should be prepared by the drilling consultant giving an exhaustive and precise description of the status of the well and all details of the closure procedure. After completion of the works, the drilling site should be rehabilitated.</p>	<p>Abandonment-2: Well Closure. If any wells are determined to not have commercial potential for either production or injection, the wells may be used for data collection or may be closed. Any well that has a high risk of blowout must be closed. Well closure involves plugging the well bore with cement and removing all aggregate or concrete from the well pad. The well pad shall be resurfaced to achieve a more natural appearance.</p> <p>After complete closure of the well, a closure file shall be prepared by the contractor and filed with the PMU and MHUEAT. The closure file shall provide a description of the well status and the details of the closure procedure.</p>

7.2.2 Mitigation Plans

Table 7.2-2 summarizes required mitigation plans described in the detailed mitigation measures listed in Table 7.2-1 and specifies which contractor is responsible for preparing each plan. Additional information about plan preparation, review, and approval is addressed in Table 7.2-3.

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Table 7.2-2 Mitigation Plans

Mitigation Plan	Mitigation Measure	Applicable to Contractor?	
		Civil	Drilling
EHS Plan	Required EHS Plan Measures		
	Safety and Health-1: Hydrogen Sulfide (H ₂ S) Monitoring and Abatement	--	Yes
	Safety and Health-2: Limit Heat Exposure	Yes	Yes
	Safety and Health-3: Environmental, Health, and Safety Plan	Yes	Yes
	Safety and Health-6: Blowout Prevention	--	Yes
	Safety and Health-7: Evacuation Plan	Yes	Yes
	Safety and Health-9: First Aid	Yes	Yes
	Measures Related to the EHS Plan⁹		
	Geology-2: Geologic Hazard Risk Assessment and Design Standards	Yes	--
	General-1: Worker Training	Yes	Yes
	Water Quality-3: Drilling Mud	--	Yes
	Water Quality-4 : Discharge Standards and Water Quality Testing	--	Yes
	Hazardous Materials-1: Hazardous Materials Storage, Disposal, and Spill Containment Plan	Yes	Yes
	Waste-2: Wastewater	Yes	Yes
	Safety and Health-4: Dust Control	Yes	Yes
	Safety and Health-5: Personal Protective Equipment	Yes	Yes
Safety and Health-8: Safety Equipment	Yes	Yes	
Socio-Economic-3: Sexually Transmitted Diseases	Yes	Yes	
Worker Training Plan	General-1 Worker Training	Yes	Yes
Hazardous Materials Storage, Disposal, and Spill Containment Plan	Hazardous Materials-1: Hazardous Materials Storage, Disposal, and Spill Containment Plan	Yes	Yes
Waste Management Plan	Waste-1: Solid Waste Management	Yes	Yes

7.2.3 Detailed Mitigation Measures with Responsibilities

Table 7.2-3 acts as a guide for parties responsible for implementing the detailed mitigation measures listed in Table 7.2-1. These parties include the civil contractor, drilling contractor, PMU, GCC, and CERD (water quality and soils sampling and analysis). Table 7.2-3 provides the following information:

- Potential impacted resource

⁹ Some mitigation measures are relevant to procedures that would be addressed in contractor EHS Plans, but a specific requirement is not included in the mitigation measure description. Measures relevant to environmental, community, and worker health and safety, or that address hazards and emergency response, should be addressed in contractor EHS Plans.

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- Full text of the detailed mitigation measures from Table 7.2-1
- Performance standards, triggers for the mitigation, and additional requirements that would be implemented if the performance standard is not met
- Timing or phase for implementation of the mitigation
- Location for implementation of the measure
- Implementation and monitoring roles and responsibilities

7.2.4 ESMP Implementation Cost

Table 7.2-4 defines the costs for implementation of the mitigation measures included in this ESMP. The costs are defined by responsible entity.

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Table 7.2-3 Mitigation Measure Implementation

Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
Geology/ Lava Lake	<p>Geology-1: Avoid Lava Lake.</p> <ul style="list-style-type: none"> a. The improved access roads shall follow the route of the existing road within Lava Lake. b. Roads and well pads shall avoid extending into the lava field to the extent feasible. Any relocation of the pads from that shown on the project design plans must be reviewed by the PMU c. The limits of project activities and surface disturbance adjacent to Lava Lake shall be demarcated in the field to ensure that inadvertent damage to the lava field does not occur. d. The limits of surface disturbances shall be marked by stakes and flags prior to construction. Vehicles and personnel shall only be permitted within construction work areas and on access roads or existing paths. e. Grading and vegetation clearing shall be kept to the minimum required. Existing areas of disturbance and access roads shall be used to the extent feasible. 	<p>Performance Standards: Roads avoid new impacts within the lava field at lava lake.</p> <p>Construction minimizes damage to the lava field at Lava Lake to the extent feasible.</p>	<p>Pre-construction: The road shall be designed to avoid the lava field at Lava Lake and the road and areas of surface disturbance in proximity to the lava field shall be staked and flagged in the field.</p> <p>Construction: Avoid vehicle and personnel travel in areas outside of the defined project disturbance areas.</p>	Roads and well pads	<p>Civil and Drilling Contractors: Define areas of surface disturbance and flag as necessary.</p> <p>PMU: Verify that the measure has been implemented.</p>

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Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
Water Quality	<p>Water Quality-1: Erosion Control. The following erosion control measures shall be implemented during construction.</p> <ol style="list-style-type: none"> a. Soil disturbance shall be limited to the minimum amount necessary for construction and access. b. Vehicular traffic associated with the project shall be restricted to access roads and construction work areas. c. Grading and other surface disturbance activities shall cease during rain events. d. Pipelines shall be monitored for leaks and any leaks shall be repaired immediately. e. A minimum of 1 foot of freeboard shall be maintained on all reserve pits to avoid overflow. <p>Discharge containment shall be installed downgradient of any discharge of geothermal effluent or drilling fluids to manage infiltration of the discharge, avoid geothermal effluent runoff out of the Lava Lake area, and ensure there is no discharge to the Bay of Ghoubet.</p>	<p>Performance Standards:No visible erosion or sedimentation caused by the project.</p> <p>No discharge to Bay of Ghoubet.</p> <p>Pipelines maintained free of leaks.</p> <p>Conditional Requirements:If erosion or discharges occur, sediment must be collected and contained to the greatest extent feasible and addition controls will be installed to prevent the issue from reoccurring.</p>	<p>Construction: minimize disturbance area, keep traffic on defined roads, cease construction during rain, maintain pipelines, and contain discharges.</p> <p>Well testing: Maintain pipelines and contain discharges.</p>	<ul style="list-style-type: none"> • Well pads and access roads • Pipelines • Mud reserve pits • Surface discharge locations 	<p>Civil Contractor: Implement measures regarding minimizing disturbance, restricting vehicle traffic, and cessation of work during rain</p> <p>Drilling Contractor: Implement containment controls and maintain pipelines.</p> <p>EHS Officers: Monitor implementation of erosion control measures.</p> <p>PMU: Verify implementation of erosion control practices.</p>

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Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
Geology	<p>Geology-2: Geologic Hazard Risk Assessment and Design Standards.</p> <p>a. The civil works contractor shall assess the risk of hazards from rock slides where the roadway and/or well pads are located near the edge of the caldera. Slope protection/rock slide protection measures shall be installed to protect the project facilities and workers from falling rocks and boulders, as needed.</p> <p>b. All project facilities shall be designed and constructed in accordance with the International Building Code seismic design standards.</p>	<p>Performance Standards:Design meets seismic standards and avoids significant loss from rock fall hazards.</p> <p>Conditional Requirement. In the case of rock fall on the road or in a work area, additional rock and boulder containment shall be implemented to protect workers from rock fall hazards.</p>	<p>Pre-construction: Assess rock fall hazards and design facility in compliance with standards.</p> <p>Construction: Implement design measures.</p>	Roads and project facilities	<p>Civil Contractor: Design consistent with standards.</p> <p>GCC and PMU: Verify that the design meet standards and avoid substantial risks.</p>
Biology	<p>Biology-1: Weed Management. All equipment and vehicles shall arrive at the project site clean and free of weeds. Vehicles shall be inspected prior to entering the site.</p>	<p>Performance Standards:Vehicles and equipment are free of weed seed, accumulated soil, and plant material.</p> <p>Conditional Requirements:If vehicles are inspected and have not been cleaned properly, the vehicle must be rejected from the site until it is clean because cleaning the vehicle at the site may contaminate adjacent areas with weed seeds.</p>	<p>Construction: Clean vehicles and equipment prior to transport to the project site; inspect vehicles upon arrival.</p>	At entrance to project site	<p>Civil and Drilling Contractors: Clean vehicles and equipment prior to arrival at site.</p> <p>EHS Officers: Inspect vehicles and equipment for cleanliness upon arrival.</p> <p>PMU: Verify that the EHS Officers have completed inspections of vehicles.</p>

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Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
General	<p>General-1: Worker Training. The drilling and civil contractors shall prepare worker training programs that define worker safety protocols, address worker roles in implementing the ESMP, protection of the environment, and respect for women and local workers.</p> <p>The worker training programs shall be submitted to the GCC and PMU for review and approval at least 14 days prior to construction. All workers shall receive the worker training prior to conducting any work on the site. The contractors shall provide evidence that all workers have received environmental, health, and safety training.</p> <p>The construction contractors shall hold weekly meetings with all workers on the site. Safety protocols and any environmental issues that need to be addressed on the site shall be discussed during the weekly tailgate meetings.</p>	<p>Performance Standards: Approved worker training program.</p> <p>All workers on the project site have received training and can provide proof of training.</p> <p>Weekly discussions of environmental and safety issues.</p>	<p>Pre-construction: Worker training program prepared and approved. Initial worker training completed.</p> <p>Construction and Well Test: Training of new workers on an on-going basis. Weekly tailgate meetings.</p>	N/A	<p>Civil and Drilling Contractors: Prepare training program and hold weekly worker meetings.</p> <p>GCC and PMU: Review training program and provide feedback within 1 week.</p> <p>EHS Officers: Train workers and discuss environmental and safety issues on a weekly basis.</p> <p>PMU: Verify that workers have received training.</p>
Water Quality	<p>Water Quality-2: Drilling Fluid Storage. Drilling fluids, mud and spoils shall be stored in either storage tanks or reserve pits adjacent to the well. Drilling fluids shall be reused to the extent feasible.</p>	<p>Performance Standards: Drilling muds and fluids are contained in storage tank or reserve pits.</p>	<p>Pre-construction: Define storage method and locations for drilling muds and fluids.</p> <p>Construction: Discharge drilling muds, fluids, and spoils to the designated area.</p>	Well pad	<p>Drilling Contractor: Select discharge method for drilling muds, fluids, and spoils. Discharge drilling muds, fluids, and spoils as defined in the measure.</p> <p>PMU: Verify that drilling muds, fluids and spoils are properly contained.</p>

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Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
Water Quality	<p>Water Quality-3: Drilling Mud. Non-toxic and biodegradable products shall be used to manufacture drilling mud where feasible. If foams are applied to the drilling fluid, the drilling contractor shall cover any reserve pits containing drilling cuttings or line the downwind perimeter of the reserve pits with hay bales or equivalent to prevent the foam from being transported offsite via wind.</p> <p>Cuttings from wells shall be tested for heavy metals, volatile, and semi-volatile organic properties. If the samples exceed the standards for toxicity¹⁰, the toxic soils would be capped with two feet of clean fill material.</p>	<p>Performance Standards:Drilling mud with foams is contained and protected from wind transport.</p> <p>Cutting sampled for heavy metals, volatile and semi-volatile organic properties.</p> <p>Conditional Requirements:If the drilling mud exceeds toxicity standards the materials shall be covered on site with two feet of clean fill material.</p>	<p>Pre-construction: Select and order materials for manufacture of drilling mud consistent with the measure.</p> <p>Construction: Apply erosion control protection to reserve pits containing drilling mud.</p> <p>Sample cuttings and remove and toxic soils to an appropriate landfill.</p>	Well pad	<p>Drilling Contractor: Select and order appropriate materials for drilling muds. Install hay bales to avoid transport of foams. Import clean fill materials to cap drilling mud, if necessary.</p> <p>EHS Officer: Monitor use of non-toxic materials and containment of any foams that are used.</p> <p>PMU: Verify that measure is implemented and soils and drilling cuttings and fluids are properly tested and managed.</p> <p>CERD: Perform laboratory analysis of soil samples.</p>

¹⁰ The maximum concentration of contaminants for toxicity characteristics defined in U.S. Code of Federal Regulation Title 40 Section 261.24 shall be used to define soils that meet are toxic and need to be treated as hazardous wastes.

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Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
Biology	<p>Reclamation-1: Site Reclamation. The following reclamation and restoration activities shall be completed following construction:</p> <ol style="list-style-type: none"> a. The drilling mud treatment facilities and water intake and/or drilling fluid disposal pipes shall be dismantled upon completion of the exploration phase and removed from the project site. b. Where applicable, the temporary treatment facilities and pipes for disposal of geothermal fluids produced during the well tests shall be dismantled after completion of the tests and the temporary treatment facilities and pipes shall be removed from the project site. c. The drilling fluid and mud reserve pits and any water supply sumps shall be filled in (if they were excavated) and graded to match the grade of the surrounding area. d. The worker camp and storage area, including all aggregate and materials and any latrines, shall be dismantled and removed from the site. The worker camp and storage area shall be resurfaced as necessary to match the surrounding conditions. e. All excess materials shall be recycled where possible. 	<p>Performance Standards:All temporary facilities and equipment are removed from the site.</p> <p>Areas of temporary disturbance have been returned to natural grade and match surrounding conditions.</p>	<p>Post-construction: Dismantle temporary pipes fill in temporary reserve pits and remove worker camp. Clean the site and regrade as needed.</p>	All work sites/project areas	<p>Drilling Contractor: Dismantle and remove equipment and resurface areas as needed.</p> <p>EHS Officers: Monitor reclamation activities.</p> <p>PMU: Verify completion of reclamation.</p>

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Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
Biology	<p>Biology-2: Water Supply Intake at Bay of Ghoubet. The water intake system shall be designed to limit impacts to fish and aquatic organisms. The system shall be designed to ensure reduction of impingement and entrainment of fish and shellfish by the installation of technologies such as barrier nets (seasonal or year-round), screen, and aquatic filter barrier systems. The water supply intake shall be marked with a buoy and signage warning any swimmers or divers in the area to avoid the intake.</p> <p>The water intake structure shall be designed to allow unimpeded movement of fish and other aquatic organisms and to prevent adverse impacts on water quality. At a minimum, the following measures shall be implemented:</p> <ol style="list-style-type: none"> a. Any water supply intake within the Bay of Ghoubet shall be screened with mesh to prevent fish entrapment. The fish screen shall have a fully functioning cleaning system capable of removing debris from the entire mesh surface, or the screen shall be inspected every 24 hours. b. Trash racks shall be installed on the inlet pipe and the racks shall be cleaned daily to prevent build-up of larger debris and damage of the fish screen. c. The intake at the Bay of Ghoubet shall be located off shore, outside of the tidal range, and at a depth where a lower density of fish is expected. The intakes should be located where sufficient flow exists to minimize sediment accumulation in and around the screen, facilitate debris removal, and encourage fish movement away from the screen face. d. The intake pipes and pipeline shall be removed if the wells are 	<p>Performance Standards:The water intake structure is protective of fish and aquatic organisms and contains proper screening to avoid fish entrapment and unimpeded movement of fish.</p> <p>Conditional Requirements:If issues are observed with the water intake system design, the design will be modified or the frequency of cleaning may be adjusted until the system is functioning properly.</p>	<p>Pre-Construction: Design water intake structure and screen consistent with the measure.</p> <p>Construction: Install water intake structure and screen as defined in the measure. Clean screen and trash rack daily to avoid fish entrapment.</p>	Water intake in Bay of Ghoubet	<p>Drilling Contractor: Properly install and screen any intake in Bay of Ghoubet. Clean the screens and trash rack daily. Diesel water pump shall be placed on a plastic mat surrounded by berms to contain potential spills.</p> <p>EHS Officer: Monitor the intake screen for fish entrapment and adjust the intake as needed to minimize impacts on fish and aquatic organisms.</p> <p>PMU: Verify that the screen is protective of fish and aquatic organisms in Ghoubet.</p>

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Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
Water Supply	Water Supply-1: The civil contractor shall notify the PMU of the source of water for construction prior to use. Use of non-potable water for construction is preferred.	Performance Standards: Contractor notifies PMU of source of water for construction, including whether it is potable or non-potable.	Pre-construction: Prior to use of water.	Work areas	<p>Civil Contractor: Identify source of water and whether it is potable or non-potable.</p> <p>PMU: Review and approve source and type of water.</p>

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Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
Water Quality	<p>Water Quality-4: Water Quality Testing and Discharge.</p> <p>a. All geothermal fluids produced during the well test would be discharged into soak pits or left to evaporate in evaporation ponds.</p> <p>b. The contractor shall conduct water quality sampling and analysis prior to discharge of geothermal fluids to soak pits or evaporation ponds. Water quality shall be sampled for the following analytes to define water quality in the geothermal aquifer:</p> <ul style="list-style-type: none"> • pH • Temperature • Boron • Bicarbonate • Calcium • Chloride • Sulfide • Iron* • Fluoride • Copper • Cadmium • Mercury • Lead • Chromium (hexavalent* and total) • Nickel • Arsenic • Vanadium • Silver <p>c. The geothermal water shall also be tested for the following: geothermal Power Generation Project Environmental and Social Management Plan • January 2016</p> <p>radiological elements:</p> <ul style="list-style-type: none"> • Radium 226/228 	<p>Performance Standards: Geothermal fluid is discharged into the lava field via soak pits or left to evaporate in evaporation ponds.</p> <p>Water quality is analyzed for the constituents listed. Water quality is disclosed to workers and worker exposure is minimized or avoided.</p>	<p>Well Test: Discharge geothermal fluids appropriately.</p>	<p>Production and reinjection wells or reserve pits</p>	<p>Drilling Contractor: Discharge geothermal fluids either through injection or to reserve pits. Reinject any fluids that are toxic.</p> <p>EHS Officer: Collect samples of geothermal fluid for lab analysis and monitor discharge of geothermal fluids.</p> <p>PMU: Verify that geothermal fluids are properly discharged.</p> <p>CERD: Conduct laboratory analysis of geothermal fluids.</p>

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Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
Hazardous Materials	<p>Hazardous Materials-1: Hazardous Materials Storage, Disposal, and Spill Containment Plan. The drilling services contractor and civil contractor shall prepare Hazardous Materials Storage, Disposal, and Spill Containment Plans that addresses safe storage of hazardous materials, proper disposal solutions for hazardous waste, and contingencies for geothermal and hazardous materials spills. At a minimum the following shall be addressed in the Hazardous Materials Storage, Disposal, and Spill Containment Plan and implemented on the project site:</p> <ul style="list-style-type: none"> a. Spill kits shall be available at locations where hazardous materials are stored and used. b. Should any hazardous materials (e.g., oil, fuel, hydraulic fluid) spills or leaks occur, the contaminated soil and any materials used to absorb the fluid shall be removed and disposed of in a manner acceptable to MHUEAT . c. Blasting materials must be stored in appropriate magazines and separated from other flammable materials or sources. d. All hazardous materials shall be stored away from natural drainages. e. Containment berms or straw bales shall be installed around all hazardous material storage areas. f. Stormwater flows shall be directed away from hazardous material storage areas. g. All vehicles and equipment shall be fueled and maintained in a designated fueling and maintenance area. The fueling and maintenance area shall be inspected daily for spills or leaks of oil and gas. 	<p>Performance Standards:Hazardous materials are properly contained. A Hazardous Materials Storage, Disposal and Spill Containment Plan is prepared by the contractor prior to construction.</p> <p>Conditional Requirements:If hazardous material spills occur, contaminated material and soils shall be contained, collected, and removed from the site and properly disposed of.</p> <p>If geothermal fluid leaks or accidental discharges occur, the leak source must be contained immediately. Impacts to the environment from hazardous material spills or discharge shall be evaluated and remediated appropriately on a case-by-case basis.</p>	<p>Pre-construction: Prepare Hazardous Materials Storage, Disposal, and Spill Containment Plan and define hazardous materials storage area.</p> <p>Construction: Implement containment for hazardous material storage area. Have spill kits available. Contain and clean any spills or leaks of hazardous materials.</p> <p>Well Test: Contain any accidental releases of geothermal fluids.</p>	<p>Hazardous materials storage area(s)</p> <p>Discharge reserve pits</p> <p>Geothermal pipelines</p>	<p>Civil and Drilling Contractors: Prepare Hazardous Materials Storage, Disposal, and Spill Containment Plan and implement hazardous materials containment and spill clean-up on the site.</p> <p>EHS Officers: Monitor for spills or leaks of hazardous materials and implement containment and clean-up procedures, where needed. Train workers.</p> <p>PMU: Verify that hazardous materials are properly stored and all leaks or spills of hazardous materials are properly contained and treated.</p>

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Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
Waste	<p>Waste-1: Solid Waste Management. The drilling services contractor and civil works contractor shall each prepare a Waste Management Plan that includes the sources of waste, methods and locations for waste collection, locations of waste disposal, methods for minimizing waste, and opportunities for reuse and recycling. The Waste Management Plan shall be submitted to the GCC and PMU for review and approval at least 14 days prior to construction. The Waste Management Plan shall meet the following minimum standards:</p> <ol style="list-style-type: none"> a. All solid waste generated on the project site (e.g., food waste) shall be contained in covered bins. b. Trash bins shall be accessible at all points where waste is generated. c. The project area shall be kept clean and free of litter and no litter shall be allowed to disperse to the surrounding area. d. Solid waste shall be removed from the site and transported to a municipal landfill (e.g., Tadjoura). e. No dumping of solid waste shall be allowed in the project area or surrounding environment and no waste shall be buried or burned. <p>All personnel shall receive training on proper disposal of all wastes prior to working on the project site.</p>	<p>Performance Standards: Solid waste is properly contained and removed to a landfill.</p> <p>The area is maintained free of litter and debris.</p>	<p>Pre-construction: Prepare solid waste management plan including methods for minimizing waste or recycling.</p> <p>Construction: Dispose of all solid waste in appropriate bins. Make trash bins accessible to all work areas and remove solid waste to a landfill.</p>	All work areas where solid waste is generated	<p>Civil and Drilling Contractors: Provide covered waste bins and arrange for proper disposal of solid waste.</p> <p>EHS Officers: Train workers on solid waste disposal methods.</p> <p>PMU: Verify that the work site is maintained clean and solid waste is properly managed.</p>

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Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
Waste	Waste -2: Wastewater. Latrines shall be constructed on site. Latrines for male and female workers shall be positioned in all construction areas. Latrines shall have adequate capacity and shall be maintained in a sanitary condition.	Performance Standards: Latrines are available on site for male and female workers and latrines are kept in a clean condition and meet Djibouti requirements for disposal of wastewater..	Construction: Construct latrines with adequate capacity for the number of workers. Clean latrines regularly throughout duration of construction	Work areas	<p>Civil Contractor: Construct latrines with adequate capacity for male and female workers. Regular cleaning of latrines during construction.</p> <p>Drilling Contractor: Regular cleaning of latrines during construction.</p> <p>EHS Officers: Monitor that the mobile toilets are regularly serviced.</p> <p>PMU: Verify that mobile toilets are available and regularly serviced.</p>

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Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
Safety and Health	<p>Safety and Health-1: Hydrogen Sulfide (H₂S) Monitoring and Abatement.</p> <ul style="list-style-type: none"> a. H₂S emissions shall be minimized through the use of properly weighted drilling mud to keep the well from flowing during drilling. b. H₂S monitoring devices shall be installed and operated at each well during all phases of drilling and testing. H₂S levels shall not exceed 10 ppm. H₂S detectors shall be installed or personal detectors shall be provided to drillers. c. Autonomous respiratory equipment shall be provided in areas with high risk of H₂S exposure (such as the cellar of the drill rig). d. The EHS Plan shall specify safety procedures for H₂S to protect worker health. e. The contractor shall provide workers with brochures or any other information medium on the chemical composition of liquid and gaseous phases of H₂S, explaining the potential risks to health and safety. The contractor shall also provide training to workers operating the drill rig on potential exposure to unsafe levels of CO₂. f. An H₂S abatement plan shall be included as part of the EHS Plan and implemented during long-term flow-testing if it becomes apparent during drilling operations that H₂S abatement is necessary to protect worker health. g. Measures to reduce H₂S during flow testing, if necessary, could include but are not limited to: 	<p>Performance Standards:H₂S monitoring devices installed and operating at each well.</p> <p>Respiratory equipment available at drill rigs.</p> <p>Workers are trained on risk of hydrogen sulfide exposure.</p> <p>H₂S abatement plan is prepared and implemented, if necessary.</p> <p>Conditional Requirements: If unsafe H₂S levels are encountered, workers will immediately utilize adequate safety equipment and respirators, or evacuate the area of high H₂S. Once safely protected with emergency equipment, trained personnel shall implement stabilization measures to ensure ongoing worker safety before resuming work.</p>	<p>Well Drilling and Testing: Implement H₂S monitoring and abatement strategies.</p>	Well pads	<p>Drilling Contractor: Install H₂S monitoring devices and provide respiratory equipment. Prepare H₂S abatement plan if needed.</p> <p>EHS Officer: Train workers and verify that the appropriate equipment is installed during monitoring.</p> <p>PMU: Verify that H₂S monitoring is occurring and abatement measures are implemented as needed.</p>

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Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
Safety and Health	<p>Safety and Health-2: Limit Heat Exposure. The contractor shall prepare an EHS Plan to protect worker health that defines specific protocols for heat exposure and work in hot environments. At a minimum, the following measures shall be implemented to avoid unsafe exposure to heat:</p> <ol style="list-style-type: none"> a. Reduce work time in high temperature environments and provide access to drinking water at all work sites. b. Provide access to shade at all work sites. c. Provide appropriate personal protection equipment including insulated gloves and shoes as appropriate for workers handling hot equipment. d. Train workers on procedures to avoid unsafe heat exposure. 	<p>Performance Standards: Worker health is protected from unacceptable heat exposure.</p>	<p>Pre-construction: Prepare health and safety plan.</p> <p>Construction and Well Test: Reduce work times and implement heat exposure controls consistent with the health and safety plan.</p>	All areas with workers	<p>Civil and Drilling Contractors: Address heat exposure in the health and safety plan. Limit work periods and provide water to avoid unsafe exposure to heat.</p> <p>EHS Officers: Train workers. Monitor that health and safety measures for heat are implemented.</p> <p>PMU: Verify that protocols to protect workers from heat exposure are implemented.</p>

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Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
Safety and Health	<p>Safety and Health-3: Environmental Health and Safety (EHS) Plan. The contractor shall prepare a detailed EHS Plan that defines safety risks and contingencies for the proposed project. At a minimum, the plan shall address risks from:</p> <ul style="list-style-type: none"> a. Hazardous materials handling including blasting materials b. H₂S c. Fugitive dust d. Heat exposure e. Well blowout f. Hot fluids g. Hot equipment h. Fire i. Volcanic eruption j. Earthquakes k. Vehicle and equipment accidents l. Workplace injuries m. Quarry operation <p>The EHS Plan should provide an overview of the safety risks and requirements and identify specific staff training requirements to avoid injuries and accidents. The plan shall be submitted to the GCC and PMU for review and approval no less than 14 days prior to construction. All personnel shall receive health and safety training prior to working on the project site.</p>	<p>Performance Standards: Health and safety plan is prepared to the approval of the GCC and PMU. Implement the health and safety plan and address health and safety risks for workers.</p>	<p>Pre-construction: Prepare, review, and approve health and safety plan. Provide health and safety training to all workers.</p> <p>Construction and Well Test: Provide training to all workers and implement all health and safety measures as appropriate consistent with the plan.</p>	All work areas	<p>Civil and Drilling Contractors: Prepare health and safety plan and implement all safety measures throughout the duration of construction and well testing. Each contractor shall prepare a plan that addresses health and safety conditions relevant to their respective scope of work.</p> <p>GCC: Review health and safety plan for adequacy.</p> <p>EHS Officers: Train workers and monitor implementation of health and safety measures on the project site.</p> <p>PMU: Review health and safety plan and verify that health and safety measures are being implemented.</p>

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Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
Safety and Health	<p>Safety and Health-4: Dust Control. The following fugitive dust source controls shall be implemented on the project site:</p> <ul style="list-style-type: none"> a. Water shall be applied to disturbed areas and unpaved roads as needed to control visible dust plumes. Over-application of water and runoff from dust control activities shall be avoided. b. Vehicle speeds shall not exceed 25 kilometers per hour on unpaved roads. <p>Work areas and the worker encampment shall be stabilized to minimize dust generation.</p>	<p>Performance Standards: Visible dust plumes are controlled.</p>	<p>Construction: Implement dust control measures where needed to reduce generation of visible dust.</p>	<p>Access roads</p> <p>Disturbed soils</p>	<p>Civil Contractor: Apply water and stabilize surfaces to control dust.</p> <p>Civil and Drilling Contractors: Limit speeds on access roads.</p> <p>EHS Officers: Monitor dust generation and dust control activities.</p> <p>PMU: Verify that fugitive dust is controlled.</p>
Safety and Health	<p>Safety and Health-5: Fence Open Pits. All open pits shall be fenced to avoid workers and wildlife from accidentally entering a pit with water or hot fluids.</p>	<p>Performance Standard: All open pits containing water or hot fluids are fenced off.</p>	<p>Construction: Install and maintain fence along the perimeter of open pits</p>	<p>Open pits</p>	<p>Civil Contractor: Install fence at edge of open pits</p> <p>Civil and Drilling Contractors: Maintain fence during project implementation.</p> <p>EHS: Check that fences are installed and maintained. Report any required repairs or maintenance</p> <p>PMU: Verify that fences are installed and maintained.</p>

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Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
Safety and Health	<p>Safety and Health-6: Personal Protective Equipment (PPE). The civil works and drilling contractors shall supply all workers with personal protective equipment, including, but not limited to:</p> <ul style="list-style-type: none"> • Safety headgear • Steel toed boots • Safety glasses or impact-resistant eye protection • Ear protective devices • Harnesses for workers operating at heights • Respirators • High visibility clothing or vests • Other specialized protective equipment for the drill rig, welding, or blasting <p>All PPE shall be properly fitted for each employee and personnel shall be trained in the proper use of PPE prior to working on the project site.</p>	<p>Performance Standards: Workers are supplied with PPE and trained in the proper use of PPE appropriate to their job.</p>	<p>Construction and Well Test: Provide workers with PPE and train workers on use.</p>	Well pads	<p>Civil and Drilling Contractors: Supply all necessary PPE to workers.</p> <p>EHS Officers: Provide training to workers on use of PPE.</p> <p>PMU: Verify PPE is provided to workers and used properly.</p>

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Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
Safety and Health	<p>Safety and Health-7: Blowout Prevention. Each well shall be fitted with blow out prevention equipment (BOPE) of industry standard. The drilling contractor shall prepare and implement a blowout prevention and containment plan as part of the EHS Plan that will define specific measures for preventing and controlling a blowout (e.g., using a blowout preventer stack and stocking of material for quelling the blowout). The drilling services contractor shall have a qualified individual(s) certified in well control on site at all times during operation of the drill rig.</p> <p>Refer to Safety and Health-3 and General-1 regarding safety measures for personnel and worker training requirements.</p>	<p>Performance Standards: Blowouts are prevented.</p> <p>Conditional Requirements: If a well blowout occurs, emergency response protocol must be implemented consistent with the EHS Plan. Workers and local community members shall be informed of any danger, and trained workers will contain the well, when safe to do so.</p>	<p>Pre-construction: Address blowout prevention and containment in the EHS Plan.</p> <p>Construction: Fit wells with BOPE.</p> <p>Post-construction: Monitor wells for risk of blowout.</p>	Wells	<p>Drilling Contractor: Prepare blowout prevention and containment plan and install BOPE. Contain blowout should it occur.</p> <p>EHS Officer: Monitor that BOPE is installed.</p> <p>PMU: Verify that blowout prevention and containment plan is prepared and implemented.</p>
Safety and Health	<p>Safety and Health-8: Evacuation Plan. The contractor shall prepare an evacuation plan as part of the EHS Plan that defines the routes and means for evacuation in the case of volcanic eruption or emergency. The contractor shall provide all workers with a map and description of the emergency evacuation routes.</p>	<p>Performance Standards: Plan for safe evacuation in the event of a volcanic eruption or emergency is included in the EHS Plan. All workers have a map showing the evacuation routes.</p>	<p>Pre-construction: Include an evacuation plan in the EHS Plan and educate workers on evacuation routes.</p> <p>Construction: Educate workers on evacuation routes.</p>	Project site	<p>Civil and Drilling Contractors: Prepare evacuation plan.</p> <p>EHS Officers: Train workers on evacuation routes.</p> <p>PMU: Verify that the contractor has prepared an evacuation plan.</p>

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Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
Safety and Health	Safety and Health-9: Safety Equipment. The contractor shall ensure that adequate safety equipment is located at drilling sites and maintained in good working order, such as firefighting equipment, protective suits, respirators, and other breathing apparatuses.	Performance Standards: Safety equipment is available at drilling sites.	Well Drilling: Safety equipment is on site and in functional condition.	Wells	<p>Drilling Contractor: Supply safety equipment.</p> <p>EHS Officer: Inspect safety equipment. Conduct weekly safety audits.</p> <p>PMU: Verify that safety equipment is available at drilling sites.</p>
Safety and Health	Safety and Health-10: First Aid. The contractor shall provide first aid training to all workers on the project site. The contractor shall also furnish emergency medical equipment and supplies on the site and train workers in the use of emergency medical supplies and accident and injury response procedures as described in the EHS Plan. The contractor shall provide evidence that workers have received training. An Emergency Medical Technician (EMT) shall be available on the project site to provide medical assistance to workers and respond to injuries.	<p>Performance Standards:All employees are trained in first-aid and accident and emergency response.</p> <p>Emergency medical equipment available on site.</p> <p>EMT is hired by the contractor and is available on the site.</p>	Construction: Provide first-aid training and supply emergency medical supplies.	Project site	<p>Civil and Drilling Contractors: Provide training and supply emergency medical supplies.</p> <p>EHS Officers: Monitor that all employees have received training and emergency medical supplies are available.</p> <p>PMU: Verify that measure has been implemented.</p>

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Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
Safety and Health	Safety and Health-11: Drug and Alcohol Free Workplace. The worker camp and all work sites shall be maintained as a drug and alcohol free work environment. The contractor shall prepare a Drug and Alcohol Free Workplace Program that specifies the approach to drug testing and management of the work site as a drug and alcohol free environment. There will be a zero tolerance policy for drug and alcohol use. Failure of a drug test would be means for permanent dismissal from the project.	Performance Standard: No drugs or alcohol are on the work site. All workers have been tested for drugs and alcohol and any workers who fail a drug test are not allowed to work on the project.	Pre-construction: Prepare a Drug and Alcohol Free Workplace Program Construction: Regularly test workers for drugs and alcohol. Maintain a drug and alcohol free workplace.	Project site	Civil and Drilling Contractors: Prepare Drug and Alcohol Free Workplace Program. Test workers for drugs and alcohol and maintain a drug and alcohol free work place. EHS Officer: Report any use of drugs or alcohol on the project and remedial actions implemented. PMU: Verify that the contractor is implementing the Drug and Alcohol Free Workplace Program.
Socio-economic	Socio-Economic-1: Display and Informational Panels: The contractor shall erect an informational kiosk at the northeast corner of the project and adjacent to the access road. The kiosk shall provide information about the geothermal drilling and testing, including the project schedule and any road closures or other public safety precautions that are in place on the site.	Performance Standards: Information about the project is provided in a publicly accessible location near the project.	Pre-construction: Design kiosk and define information to provide to the public including a point of contact for grievances. Construction: Install informational kiosk.	Near project site	Civil Contractor: Install informational kiosk. PMU: Design informational kiosk.
Socio-economic	Socio-Economic-2: Sensitivity Training. Prior to the start of drilling, the PMU shall coordinate a project sensitivity training with the local community elders and leaders. The sensitivity training shall include information on local customs, traditions, and uses of the project area. All DSC workers shall attend the sensitivity training. The PMU shall provide the community with information on restricted access areas on the site that are defined to protect the safety of the community.	Performance Standard: Workers receive sensitivity training from local community leaders. The PMU communicates safety risks to the community.	Pre-Construction: Workers receive sensitivity training from the local community leaders.	Project site	Drilling Contractor: All workers attend the sensitivity training prior to start of construction. PMU: Coordinate the sensitivity training with the local community leaders.

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Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
Socio-economic	<p>Socio-Economic-3: Support for Women.</p> <p>a. Fund up to three five-day training sessions on income-generating activities, which shall be organized for women in the project region. The trainings shall be organized through local non-governmental organizations in Tadjourasuch as National Union of Djibouti Women (UNFD) if it has a local Tadjoura office. The training shall be funded by the project. The PMU shall consult with the Préfet of Tadjoura and UNFD regarding appropriate local NGOs and training needs</p> <p>b. The project worker training program shall include training on respect for women and local workers.</p> <p>c. The GCC and PMU shall define a grievance redress team to address any concern or conflict with workers or the community. One or two women shall be included on the grievance redress team specified in Section 7.5: Grievance and Redress Mechanism. The women should be leaders in their community. The PMU shall consult with the Préfet of Tadjoura regarding any unresolved conflicts with the community.</p>	<p>Performance Standards: Training sessions on income-generating activities are held with women in the project region.</p> <p>Conditional Requirements: If a grievance is filed with the PMU, the PMU must implement the grievance redress procedures defined in this ESMP.</p>	<p>Pre-construction and/or Construction: Fund a training program. Train workers on respect for women. Respond to all grievances.</p>	Communities near the project	<p>PMU: Coordinate with Préfet of Tadjoura regarding the appropriate local NGO and training needs. Verify funding and implementation of the training program for women. Develop and implement grievance redress mechanism.</p> <p>Drilling Contractor: Fund local NGO to provide training to women.</p> <p>Civil and Drilling Contractors: Provide worker training on respect for women.</p>

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Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
Socio-economic	Socio-Economic-4: Sexually Transmitted Diseases. Workers shall receive awareness training on sexually-transmitted disease prevention and treatment. The training shall be provided at the beginning of the project construction and follow-up trainings shall be provided monthly to any new workers on the project. Two training sessions on sexually transmitted disease prevention and treatment shall be extended to the local populations.	Performance Standards: Workers are provided training on sexually-transmitted disease prevention and treatment. Two training sessions on sexually-transmitted diseases are offered for the surrounding communities.	Pre-construction: Coordinate trainings. Construction: Train workers and offer two trainings to the community.	On the project site and in the surrounding community	Civil and Drilling Contractors: Ensure that sexually transmitted disease information is included in the EHS Plan. EHS Officers: Provide training to workers. PMU: Coordinate training with surrounding community.
Socio-economic	Socio-Economic-5: Preferential Hiring for Locals and Women. Preference shall be given to local residents and women in the hiring process.	Performance Standard: Women and local residents are given preference in hiring.	Pre-construction: Include preference for women and local workers in hiring decisions.	N/A	Civil and Drilling Contractors: Include preference for hiring locals and women in project staffing decisions. PMU: Include preference for hiring locals and women in all project staffing decisions.
Socio-economic	Socio-Economic-6: Supply Water for Local Population. The drilling contractor shall provide fresh water to the local population that is equal in volume to the fresh water supplied for the project worker camp. Alternatively, the project may purchase a machine that converts humidity in the air to fresh water. Should the project purchase a machine to supply fresh water for the project, the machine would be supplied to the local population at the completion of the exploration phase of the project.	Performance Standard: The contractor trucks and equal amount of water to the local community as the fresh water supplied to the worker camp.	Construction: Truck water to the local community	Local community	Drilling Contractor: Truck water to the local communities. PMU: Verify that water is supplied to the local community.

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Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
Socio-economic	<p>Socio-Economic-7: Health Clinic for Local Community and Workers. The on-site medical staff shall support a two-day free medical clinic in the local community. Free medical services shall be offered to the local community and worker families during the clinic. The clinic shall include free vaccinations for diphtheria-pertussis-tetanus for individuals who are not currently vaccinated.</p>	<p>Performance Standard: The contractor holds a one day health clinic in the local community</p>	<p>Construction: Hold a one-day health clinic</p>	Local community	<p>Drilling Contractor: Hold a one day health clinic in the local community</p> <p>PMU: Coordinate with the local community on the timing and location of the clinic and expected number of vaccinations required.</p>
Well Abandonment	<p>Abandonment-1: Temporary Abandonment. The following measures shall be implemented for any temporary abandonment of the wells at the project site:</p> <ol style="list-style-type: none"> a. Installation of blowout prevention to reduce the risk of blowout b. Monthly surveillance of the temporarily abandoned wells and well pads until permanently closed <p>Temporary abandonment is only possible when the casings are properly installed and cemented. The duration of temporary abandonment shall be consistent with all permits. If at any time during the temporary abandonment phase the well shows signs of weakness and potential failure (e.g., due to seismic activity or damage), the well shall be subject to permanent closure.</p>	<p>Performance Standards:BOPE is installed on all temporarily abandoned wells.</p> <p>Wells are inspected monthly during temporary abandonment.</p> <p>Conditional Requirements:If a well blowout occurs, emergency response protocol must be implemented. Workers and local community members shall be informed of any danger, and trained workers will contain the well, when safe to do so.</p>	<p>Post-construction: Determine whether wells can be temporarily abandoned or need to be closed. Regularly inspect wells that are temporarily abandoned.</p>	Wells	<p>Drilling Contractor: Install BOPE on wells that are identified for abandonment.</p> <p>PMU: Determine whether wells should be temporarily abandoned or closed. Provide for regular inspection of wells that are temporarily abandoned.</p>

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Potential Impact	Mitigation Measure	Performance Standards/Conditions	Timing/Phase	Locations	Roles and Responsibilities
Well Abandonment	<p>Abandonment-2: Well Closure. If any wells are determined to not have commercial potential for either production or injection, the wells may be used for data collection or may be closed. Any well that has a high risk of blowout must be closed. Well closure involves plugging the well bore with cement and removing all aggregate or concrete from the well pad. The well pad shall be resurfaced to achieve a more natural appearance.</p> <p>After complete closure of the well, a closure file shall be prepared by the contractor and filed with the PMU and MHUEAT. The closure file shall provide a description of the well status and the details of the closure procedure.</p>	<p>Performance Standards: Closed wells are plugged with cement and all materials from the well pad are removed from the site.</p> <p>A closure file is prepared and filed with MHUEAT.</p>	<p>Post-construction: Wells that do not have commercial potential are closed.</p>	Wells	<p>PMU: Determine whether wells have commercial potential.</p> <p>Drilling Contractor: Close wells that do not have commercial potential and reclaim well pad.</p>

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Table 7.2-4 Mitigation and Monitoring Implementation Costs

Implementation Requirements	Requirements with Direct Costs	Assumptions ¹	PMU	GCC	Civil Contractor	Drilling Contractor	Req. Total
Mitigation Measures							
Geology-1: Avoid Lava Lake	Define and delineate disturbance areas at all work areas (roads, well pads, and worker camp)	3 workers for 8 hours			\$3,000		\$3,000
Water Quality-1: Erosion Control	Delay surface disturbance work during rain events	Estimated 1 day delay			\$5,000		\$5,000
Geology-2: Geologic Hazard Risk Assessment and Design Standards	Assess rock slide hazards for roads and well pads	<i>N/A – Standard procedure</i>			--		\$0
	Install slope protection/rock slide protection barriers, as needed	<i>N/A – Part of construction contract</i>			--		\$0
Biology-1: Weed Management	Clean work vehicles and equipment prior to entering the site	<i>N/A – Standard housekeeping procedure</i>			--	--	\$0
General-1: Worker Training	Develop a worker training program (covers training described in General-1, Hazardous Materials-1, Waste-1, Safety and Health-1, Safety and Health-2, Safety and Health-3, Safety and Health-5, Safety and Health-6, and Safety and Health-9)	Development based on the EHS Plan and hazard risk levels.			\$4,000	\$4,000	\$8,000
	Provide worker training program to all workers prior to working	<i>N/A – Training would be a part of the regular work day/period and workers would be paid a regular wage for training</i>			--	--	\$0
	Conduct weekly EHS meetings	<i>N/A workers would already be on site</i>			--	--	\$0
Water Quality-2: Drilling Fluid Storage	Prepare and implement Hazardous Materials Storage, Disposal, and Spill Containment Plan	Estimate for removal of materials. Depends on volume of material spilled			\$2,000	\$6,000	\$8,000
Water Quality-3: Drilling Mud							
Water Quality-4: Discharge	Purchase and use spill kits for any cleanup	<i>N/A – Standard procedure</i>			--	--	\$0

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Implementation Requirements	Requirements with Direct Costs	Assumptions ¹	PMU	GCC	Civil Contractor	Drilling Contractor	Req. Total
Standards and Water Quality Testing Hazardous Materials-1: Hazardous Materials Storage, Disposal, and Spill Containment Plan	Use non-toxic and biodegradable drilling mud where feasible	Estimate				--	\$0
	Embankreserve pits if drilling mud contains foams	<i>N/A – Standard procedure</i>				--	\$0
	Install containment berms and redirect stormwater flows around hazardous material storage sites	<i>N/A – Part of construction contract</i>			--	--	\$0
	Test cuttings for heavy metals and volatile compounds (following construction)	Estimated cost for testing	\$15,000				\$15,000
	Cap drilling mud determined to be toxic with clean fill materials	Cost to import fill materials. Assumes 500 cubic meters of fill obtained from local quarry				\$5,000	\$5,000
	Test extracted geothermal fluids (regular basis during construction)	Estimated cost for testing and equipment purchases	\$80,000				\$80,000
	Discharge geothermal fluids into soak pits or allow to evaporate in evaporation ponds	<i>N/A – Part of well pad design</i>				--	\$0
Reclamation-1: Site Reclamation	Remove and dispose of drilling mud treatment facilities and fluid pipelines	<i>N/A – Part of construction contract</i>				--	\$0
	Dismantle and restore worker camp	<i>N/A – Part of construction contract</i>			--	--	\$0
Biology-2: Water Supply Intake at Bay of Ghoubet	Design and construct the low-impact water intake system in Bay	Installation of the intake system				\$5,000	\$5,000
	Inspect and maintain water intake system daily when active	Assume intake system would be active for 90 days of civil work and 180 days of drilling work, and inspections by 1 worker for 1 hours a day by boat				\$30,000	\$30,000
Water Supply-1: Water supply for civil work	No direct cost associated with requirement	N/A					\$0

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Implementation Requirements	Requirements with Direct Costs	Assumptions ¹	PMU	GCC	Civil Contractor	Drilling Contractor	Req. Total
Waste-1: Solid Waste Management	Prepare a Waste Management Plan for solid waste	Hazardous waste disposal would be addressed in a separate plan			\$2,000	\$2,000	\$4,000
	Store and dispose of solid waste at an appropriate facility	Disposed of weekly for 52 weeks at a dump located in Tadjoura (75 km away)			\$10,000	\$20,000	\$30,000
Waste-2: Wastewater	Install sufficient latrines at all work sites	<i>N/A – Standard procedure</i>			--	--	\$0
	Maintain facilities	<i>N/A – Standard procedure</i>			--	--	\$0
Safety and Health-1: H ₂ S Monitoring and Abatement	Purchase H ₂ S monitoring devices and respirators	<i>N/A – Standard procedure</i>				--	\$0
	Install and maintain H ₂ S monitoring devices during drilling and testing	<i>N/A – Standard procedure</i>				--	\$0
Safety and Health-2: Limit Heat Exposure Safety and Health-3: EHS Plan Safety and Health-6: Personal Protective Equipment	Prepare and implement an EHS Plan with all required elements	Drilling contractor plan would include greater hazards, risk management strategies, and emergency response procedures			\$6,000	\$12,000	\$18,000
Safety and Health-7: Blowout Prevention	Provide bottled drinking water to workers at all work sites	<i>N/A – Standard procedure</i>			--	--	\$0
Safety and Health-8: Evacuation Plan Safety and Health-9: Safety Equipment Safety and Health-10: First Aid	Purchase and provide PPE, First Aid, and safety equipment	<i>N/A – Standard procedure</i>			--	--	\$0
Safety and Health-4: Dust Control	Prevent fugitive dust through water application during ground disturbance and stabilizing disturbed areas	Assume 1 water truck and locally sourced sea water would be used by the civil contractor for 90 days			\$54,000		\$54,000

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Implementation Requirements	Requirements with Direct Costs	Assumptions ¹	PMU	GCC	Civil Contractor	Drilling Contractor	Req. Total
Safety and Health-5: Fence Open Pits	Fencing will be installed around all open pits	Assumes up to 600 meter length of construction limit fencing or equivalent material is installed			\$1,000		\$1,000
Safety and Health-11: Drug and Alcohol Free Workplace	Drug testing for workers	Assumes monthly testing of up to 100 workers. Each test is estimated to cost \$40.			\$12,000	\$24,000	\$36,000
Socio-Economic-1: Display and Informational Panels	Design and install an informational kiosk at the entrance to the project site	One kiosk would be used for duration of construction	\$2,000		\$1,000		\$3,000
Socio-Economic-2: Sensitivity training	One two-hour training for drilling workers	Provided to 75 drilling workers for 2 hours				\$3,000	\$3,000
Socio-Economic-3: Support for Women	Provide up to three five-day trainings sessions for women on income generating activities	2 instructors for 4 hours per day	\$15,000				\$15,000
Socio-Economic-4: Sexually Transmitted Diseases	Provide monthly sexually transmitted disease training to new workers	Provided to 50 civil workers and 75 drilling workers for 15 minutes each by 1 instructor monthly			\$2,000	\$3,000	\$5,000
	Provide two sexually transmitted disease training sessions to local community members	1 instructor for 2 hours each	\$1,000				\$1,000
Socio-Economic-5: Preferential Hiring	No cost associated with the measure	No cost measure					\$0
Socio-Economic-6: Supply Water for Local Population	Trucking approximately 450,000 liters of water during civil works (3 months) and 1,350,000 liters of water during drilling and testing (9 months)	Each tanker truck holds 25,000 liters of water and \$500/tanker truck delivery				\$27,000	\$27,000
Socio-Economic-7: Health Clinic for Local Community and Workers	Vaccinations and salary for EMT	Assumes up to 300 individuals require vaccination and 1 day salary of the EMT				\$2,000	\$2,000
Abandonment-1: Temporary Abandonment	Install blowout prevention at temporarily abandoned wells	<i>N/A – Standard procedure</i>				--	\$0

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Implementation Requirements	Requirements with Direct Costs	Assumptions ¹	PMU	GCC	Civil Contractor	Drilling Contractor	Req. Total
	Travel to the site to inspect temporarily abandoned wells monthly until permanently closed	Mileage costs to travel to the site are approximately \$120/trip Assumes wells are temporarily abandoned for three years	\$4,320				\$4,320
Abandonment-2: Well Closure	Removing well structure materials, permanently sealing the well closed with cement, and completing well closure documentation	<i>N/A – Standard procedure</i>				--	\$0
Subtotal			\$117,320	\$0	\$102,000	\$143,000	\$362,320
Monitoring							
On-site Compliance Inspection and Monitoring	Contractor HSE Officers – Inspect all facilities and work sites daily and prepare Daily Compliance Checklists PMU Monitor – Inspect construction sites (approx. monthly)	HSE Officers: 5 hours per week (1 hour/day) for 52 weeks \$120 mileage costs/trip for PMU inspections Training	\$16,440		\$13,000	\$39,000	\$53,440
Reporting and Documentation	Prepare/review Pre- and Post-construction Audit Reports, Monthly Compliance Reports, and Quarterly Monitoring Reports	Estimate reflects weekly review of on-site compliance reports and preparation of quarterly reports by the GCC	\$5,000	\$15,000			\$20,000
Subtotal			\$21,440	\$15,000	\$13,000	\$39,000	\$88,440
Unanticipated Emergency and Readiness Costs							
Grievance and Redress Mechanisms	Redress grievances from community members, if needed	<i>N/A – It is assumed that this will be within the duties of the Social Expert at PMU and addressing grievances will not have a direct cost.</i>				--	\$0

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Implementation Requirements	Requirements with Direct Costs	Assumptions ¹	PMU	GCC	Civil Contractor	Drilling Contractor	Req. Total
Emergency Response/Cleanup Environmental Rehabilitation/Restoration	Respond to emergencies and clean up hazardous material spills, if needed Address environmental rehabilitation/restoration, if needed	This cost is estimated as a contingency. Actual costs would be dependent on the emergency and the response required.			--\$20,000	\$40,000--	\$60,000
Subtotal			\$0	\$0	\$20,000	\$40,000	\$60,000
Project Total			\$138,760	\$15,000	\$135,000	\$222,000	\$510,760

Notes:

¹ Standard procedures and tasks that would be included with contractor construction contracts are identified in project mitigation measures and this table. Costs associated with these tasks are considered to be a standard construction cost and would not require additional funds associated with mitigation implementation.

7.3 ROLES AND RESPONSIBILITIES

This section outlines the roles and responsibilities of parties involved with direct implementation of mitigation measures or implementation oversight.

7.3.1 Electricité de Djibouti

Electricité de Djibouti (EdD) is ultimately responsible for overseeing all aspects of the project and implementation of mitigation measures in this MMMP. The direct responsibility of mitigation implementation has been assigned to the project contractors (addressed in Section 7.3.3). EdD has selected a project management unit (PMU) to manage the project. The PMU will include:

- Project Director
- Project Manager (GCC)
- Project Coordinator
- Expert on Environmental, Health, and Safety (EHS)
- Expert on Social Issues
- Accountant
- Secretary

7.3.1.1 Expert on Environmental Health and Safety

The PMU will oversee the project during all construction phases and ensure that mitigation measures are implemented correctly. The PMU expert on environmental, health and safety shall be responsible for verifying that the mitigation measures are implemented adequately. The EHS expert shall have relevant experience monitoring construction on projects that have World Bank and/or AfDB funding and mitigation compliance components. The qualified candidate should also have experience with environmental compliance on projects involving drilling. The EHS expert shall become familiar with mitigation measure requirements and MMMP procedures for the project. The EHS expert shall serve as the monitor for the PMU and shall be the key contact person regarding compliance with mitigation measures. The EHS expert shall be responsible for:

- Acting as the key point of contact for contractors and oversight agencies regarding compliance with mitigation measures
- Verifying project compliance with mitigation measure requirements through auditing and field inspection
- Providing direction to contractors regarding mitigation measure interpretation and ESMP procedures
- Issuing notices of non-compliance (addressed in Section 7.4.6) to contractors if they do not comply with mitigation measures or environmental laws
- Overseeing any rehabilitation of environmental damage that may occur

7.3.1.2 Expert on Social Issues

The PMU expert on social issues will be responsible for coordinating with the local community and verifying the socio-economic measures in the MMMP are properly implemented. The social issue expert shall have knowledge of the local community and shall have relevant experience addressing social issues and responding to complaints. The social issue expert shall serve as the point of contact for the local community and for workers should a social issue arise during project implementation. The social issue expert shall be responsible for:

- Activating a project phone number and email address for local residents and community members to contact if they have grievances with the project (address in Section 7.5), and acting as the key point of contact to resolve project grievances
- Acting as the point of contact for filing of any worker grievances and responding to worker grievances
- Verifying project implementation of socio-economic mitigation measures

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7.3.2 Donors

The PMU EHS expert shall submit quarterly ESMP monitoring reports to designated members of the World Bank and African Development Bank. The quarterly reports will document implementation of the ESMP and compliance with mitigation measures and environmental laws. The contents of the quarterly reports are specified in Section 7.4.4.3: Quarterly Compliance Reports.

7.3.3 Steering Committee and Agencies

The project is subject to oversight from agencies with stake in the project or who are responsible for enforcing environmental laws. These agencies will form a Steering Committee that will guide the PMU. The Steering Committee will include the following agencies:

- Ministry of Energy and Water, in charge of Natural Resources (MEERN)
- Ministry of Economy and Finance, in charge of Industry and Planning (MEFIP)
- Djibouti Studies and Research Center (CERD)
- MHUEAT
- Ministry of Transport and Equipment (MTE)
- Ministry of the Interior (MI)
- Electricité de Djibouti (EdD)

The MEFIP will provide administrative and financial oversight and MEERN shall act as the chair of the Steering Committee.

7.3.3.1 Djibouti Ministry of Habitat, Urbanism, Environment, and Town Planning

MHUEAT may have representatives periodically visit project areas to verify compliance with environmental laws, and may also request copies of monitoring reports from the PMU. The MHUEAT will also conduct an environmental audit of the project following construction (addressed in Section 7.4.2).

7.3.3.2 Djibouti Center for Environmental Research and Development

The Center for Environmental Research and Development (CERD) will perform sampling and laboratory analysis of water quality and soil samples collected from the site and will provide technical support for the geothermal exploration.

7.3.4 Contractors

Project contractors are responsible for complying with all mitigation measure requirements and MMMP procedures, and for ensuring that contracts and construction plans for the project meet all design requirements identified in the mitigation measures.

7.3.4.1 Geothermal Consulting Company

Geologica has been contracted as the Geothermal Consulting Company (GCC) for the project to prepare a geothermal energy feasibility study. Panorama Environmental, Inc. (Panorama) has been subcontracted by Geologica to prepare this ESMP and MMMP, and to remotely support the compliance and MMMP documentation effort. The GCC's compliance responsibilities include:

- Ensuring that construction contracts contain provisions for implementing mitigation measure requirements, including post-construction restoration or environmental rehabilitation, if applicable
- Ensuring that contractors understand all mitigation requirements, such as the effort and duration that would be expected, as well as the procedures addressed in this MMMP
- Verifying construction contractor compliance and managing documentation for the PMU by:
 - Reviewing pre-construction plans and programs for completeness
 - Reviewing reports prepared by the construction contractors

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- Communicating directly with construction contractors to answer questions and resolve any issues
- Reviewing construction and mitigation documentation provided by the construction contractors
- Preparing quarterly compliance reports for the PMU to be distributed to donors and agencies (addressed in Section 7.4.4)

Mitigation measures and specific GCC responsibilities are identified in Table 7.2-3. The GCC Project Manager shall be the key point of contact for compliance requirements.

7.3.4.2 Drilling Services Contractor

A drilling services contractor will be contracted to perform the physical drilling and sampling at well sites. The drilling services contractor shall be responsible for implementing applicable mitigation measures identified in Table 7.2-3. The drilling services contractor will be required to retain a qualified EHS Officer and comply with reporting requirements defined in this section.

7.3.4.3 Civil Contractor

A civil contractor will be contracted by EdD to prepare roads leading to the site and construct spur roads to the well pads, construct the well pads, construct worker housing, and construct the storage area. The civil contractor shall be responsible for implementing applicable mitigation measure requirements identified in Table 7.2-3. The civil contractor will need to retain a qualified EHS Officer and comply with reporting requirements defined in this section.

7.3.4.4 Construction Contractor EHS Officers

Each construction contractor is responsible for retaining an EHS Officer to oversee compliance with mitigation measures applicable to their scope of work. The construction contractors are responsible for selecting EHS Officers with the necessary skills, experience, and availability to perform their duties adequately. Necessary qualifications include previous experience monitoring the implementation of mitigation measures on a project of similar scope and scale. Experience complying with World Bank and/or African Development Bank environmental requirements is preferred. Construction contractors shall ensure their EHS Officers have completed all necessary EHS training prior to the project. EHS Officers will be responsible for the day-to-day implementation of mitigation measure requirements identified in Table 7.2-3. EHS Officers will be responsible for:

- Acting as the key point of contact for the PMU EHS expert, as well as oversight agencies if applicable, regarding compliance with mitigation measures
- Ensuring that all personnel including subcontractors have received environmental training prior to work on the project site and have been informed of mitigation measures and their associated responsibilities when working
- Ensuring that all personnel comply with mitigation measures
- Inspecting active work sites on a daily basis, and documenting compliance through completion of a daily compliance checklist and photographs (addressed in Section 7.4.2)
- Preparing required reports and managing compliance documentation during all phases of construction (addressed in Section 7.4.2)
- Ensuring that compliance documentation is complete and available for PMU or oversight agency auditing
- Managing any rehabilitation of environmental damage that may have occurred

7.4 IMPLEMENTATION AND VERIFICATION PROCEDURES

7.4.1 Implementation Phases

Mitigation measure requirements, as well as implementation and verification procedures, are applicable during one or more of three construction phases. Implementation phases include:

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- Prior to construction (“Pre-construction”)
- During construction, drilling, and well testing (“Construction”)
- Following construction (“Post-construction”)

Implementation phases for mitigation measure requirements are identified in Table 7.2-3. Implementation phases for ESMP procedure requirements are identified in this section.

7.4.2 Auditing

Decree No. 2001-029/PR/MHUEAT, Environmental Impact Assessment Procedures, Articles 35-38, require preparation of an environmental audit report at the completion of construction or upon any modifications to the project. Additional reports shall be prepared to document compliance with the ESMP.

7.4.2.1 Pre-Construction Audit Report

The PMU ES expert and civil works EHS Officer shall survey the project site prior to construction to document the condition of all work areas, identify sensitive areas to avoid, and select the location of the worker camp. The PMU EHS expert will prepare a pre-construction audit report that documents the detailed status of each project work area prior to project activities. The pre-construction audit report shall include:

- Description of each project work area that identifies and describes the locations of previously disturbed or undisturbed features
- Areas that should be avoided to the extent feasible (e.g., Lava Lake)
- Photographs of each work area and important feature from multiple angles if necessary

The pre-construction audit report and photographs will be compared to site conditions following construction and determine the adequacy of restoration.

7.4.2.2 Construction Auditing

The PMU EHS expert shall visit the site on as needed or approximately weekly to monthly to verify compliance at the site. Oversight agencies may also visit the site on an as needed basis at any time.

7.4.2.3 Post-Construction Audit Report

The PMU EHS expert and EHS Officers for each contractor shall visit the project site following construction to document the condition of all work areas and sensitive areas adjacent to work areas. The status of each location and any issues shall be documented in a post-construction audit report prepared by the PMU EHS expert. Any issues identified with the condition of the work sites shall be addressed by the responsible contractor to the satisfaction of the PMU. According to Article 38(3) of Decree No. 2001-029/PR/MHUEAT, the post-construction audit report must include:

- A non-technical summary in French
- An introduction including the background and the activity of the investigated facility
- A description of the project site (e.g., location, environmental and historical context, land situation)
- Environmental management plans required for the project
- A review of compliance with laws, regulations and policies
- Conclusions and recommendations
- Recommendations for any additional studies

7.4.3 Monitoring Frequency

Contractor EHS Officers would be on site on a daily basis to inspect active work sites and complete the daily compliance checklist.

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7.4.4 Compliance Reporting

7.4.4.1 Daily Compliance Checklists

Contractor EHS Officers shall complete a daily compliance checklist each day that work occurs in the field. GCC shall prepare a daily checklist form for EHS Officers to use that summarizes regular and ongoing requirements. Photographs will be attached to the checklist to document daily work activities.

The daily checklist form may be developed for use on mobile devices (i.e., smart phones and tablets). If so, access to digital copies of the daily checklists would be made available to agencies upon request.

7.4.4.2 Monthly Compliance Reports

EHS Officers shall prepare and submit a monthly compliance report to GCC and the PMU EHS expert to document construction and compliance activities completed during the month, and to track the resolution of any issues that may have occurred. The reports should include the following information for the period:

- Summary of completed construction activities
- Estimate of remaining construction and schedule
- Summary of compliance activities
- Updated list of all EHS incidents that occurred during the project
- Follow up information from any past issues that are still being resolved
- Photographs of project activities

7.4.4.3 Quarterly Compliance Reports

The GCC shall prepare and submit a quarterly compliance report to the PMU and donors (AfDB and World Bank) to document construction and compliance activities completed during the period, and to track the resolution of any issues that may have occurred. The GCC will use daily compliance checklists and monthly reports prepared by the construction contractors to develop the quarterly report.

The PMU EHS expert shall be responsible for reviewing and submitting the quarterly reports to applicable oversight agencies. The reports should include the following information for the period:

- Summary of completed construction activities
- Estimate of remaining construction and schedule
- Summary of compliance activities
- Contractor's implementation activities
- PMU's and agency oversight activities (i.e., site visits)
- Updated list of all EHS incidents that occurred during the project, including attached notices of non-compliance that were issued
- Follow up information from any past issues that are still being resolved
- Photographs of project activities

7.4.5 Contractor Training

7.4.5.1 Health and Safety

Contractors are required to ensure their workers are adequately trained prior to beginning work on the project. In addition to applicable worker safety laws, mitigation measures identify specific health and safety requirements that each contractor must comply with. Health and safety training requirements are identified in Table 7.2-3.

7.4.5.2 Environmental Responsibilities

Contractors are required to train workers on the environmental requirements for the project as a whole, as well as how to comply with applicable mitigation measure requirements when completing their work. In addition to general environmental awareness training, specific environmental training requirements are identified in Table 7.2-3.

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7.4.6 Health, Safety, and Environment Incidents and Non-Compliance

7.4.6.1 Incident Reports

Contractor EHS Officers are responsible for preparing and submitting incidents reports to the GCC and PMU EHS expert within 72 hours from discovery of the incident. EHS Officers shall maintain a complete project record of incidents associated with their contract scope of work. The record shall be regularly updated and included with monthly reports submitted to the PMU.

Examples of EHS incidents include:

- Fires
- Accidents or “near miss” events
- Hazardous material spills that contaminate soil or water resources
- Improvement orders or notices issued by oversight agencies
- Non-compliance with mitigation measures

At a minimum, EHS incident reports should include:

- Dates the incident occurred and was discovered, if different
- Description of the incident
- Mitigation measures or environmental laws that were violated
- Parties present during the event
- Corrective actions taken to remedy the issue and prevent it from recurring
- Any remaining actions that are required to correct the situation, such as rehabilitation

7.4.6.2 Notices of Non-compliance

If any issues with compliance are discovered by the GCC or PMU EHS expert, the observing party shall submit a written notice of non-compliance to the alternate party and contractors that documents the issue and presents preliminary corrective actions, if applicable. Notices of non-compliance shall include the following information:

- Dates the issue occurred and was discovered, if different
- Description of the issue
- Mitigation measures or environmental laws that were violated
- Parties present during the event
- Description of corrective actions taken
- Description of any necessary follow up actions or longer term rehabilitation requirements if environmental damage occurred

7.4.6.3 Corrective Actions

Contractors are responsible for responding to and addressing notices of non-compliance in a timely manner and to the satisfaction of the PMU EHS expert. Contractors will be responsible for the rehabilitation costs and work effort associated with any environmental damage that may occur due to non-compliance with mitigation measures and environmental laws.

7.5 GRIEVANCE AND REDRESS MECHANISM

The PMU social issue expert will be responsible for activating a project phone number and email address for workers, local residents and community members to contact if they have grievances with the project. The PMU social expert will act as the key point of contact to resolve project grievances. Contractor EHS Officers will also act as points of contact for local residents or workers that express grievances at the project site. If grievances are expressed in the field, the receiving EHS Officer is responsible for notifying the PMU social issue expert within 48 hours of receipt.

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The PMU social issue expert is responsible for addressing project grievances and directing contractors to make any appropriate changes to their work. The contractor shall take reasonable action to address grievances as required by local laws and this MMMP.

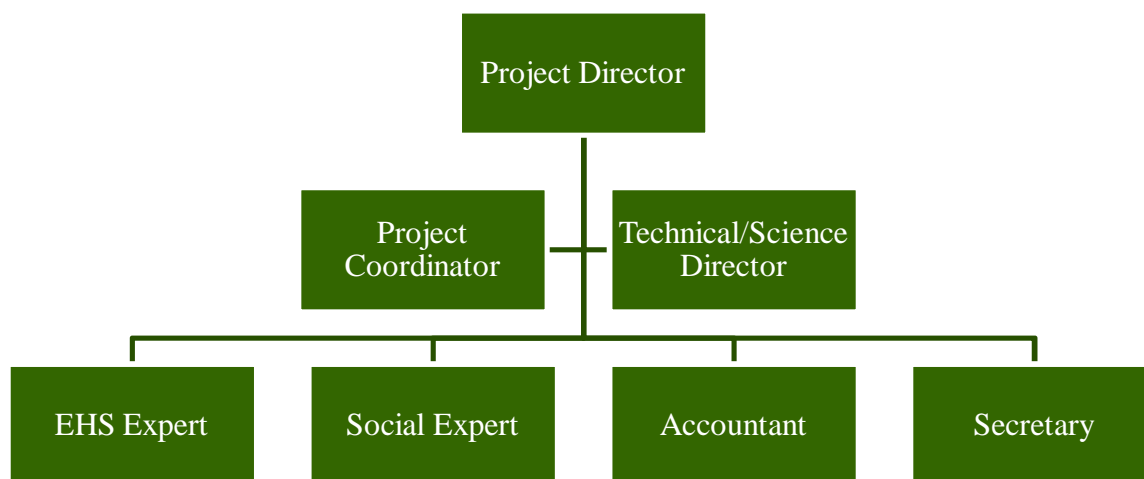
8 INSTITUTIONAL CAPACITY AND CAPACITY BUILDING

8.1 INSTITUTIONAL STRUCTURE

This Section outlines the institutional and management arrangements designed to effectively implement the mitigation measures for the project. The project PMU is funded by AfDB, World Bank, and AFD for the geothermal exploration project. The PMU roles and responsibilities are defined in Section 7.3.1.

The geothermal exploration project will be implemented by several contractor teams including the GCC, civil works contractor, and DSC. The management structure for this project and this ESMP is illustrated in Figure 8.1-1.

Figure 8.1-1 Project Management Structure



8.2 INSTITUTIONAL CONSTRAINTS AND CONCERNS

8.2.1 Labor Capacity

Institutional constraints were defined through coordination with the PMU, GCC, and stakeholders. The project currently lacks an EHS expert and social expert. This management expertise is critical to successful oversight of this ESMP.

8.2.2 Training

MHUEAT, the PMU, ODDEG, and CERD have expressed a need for training in geothermal development. In office training is needed prior to well drilling. In the field training is required during implementation of the project. Training requirements include technical training in geothermal exploration for geologists and hydrologists and training for environmental monitoring and mitigation

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implementation. Training at the geothermal field in Olkaria, Kenya is highly recommended to provide expert geothermal field that is currently under development.

8.2.3 Equipment

The PMU lack the following equipment required to conducting the water quality and soils sample analyses defined in this ESMP:

- Spools
- Lip tubes
- Separator
- Weir box
- Atmospheric gage, pressure gage, temperature gage, spinner gage, etc.
- Mounted wireline trailer
- Liquid and gas sampling equipment
- Associated accessories

A full list of equipment will be included in the Request for Proposals for drilling and testing the well. The selected contractor will be responsible for providing the necessary equipment to conduct water quality and soil sample analyses.

The following equipment will be needed to log the well and sample water quality:

- Geophysics laboratory equipment:
 - Winglink software
 - 1 MT station
- Geological laboratory equipment:
 - Software and equipment for topographical and geological maps
 - Computer with GIS capability
 - Thermometers
 - Stereoscopes
 - Laser Rangefinders
 - Geological hammer
 - Altimeters
 - Portables GPS
 - Microscope (Binocular and polarized)
 - XRF Scanner (allows rapid and non-destructive determination of the elemental chemical composition of sediments and rocks)
 - Diffractometer for X-ray diffraction (XRD or English XRD)
 - Mass Spectrometer (for dating rocks)
 - Thin Film
- Geochemical laboratory equipment:
 - Geochemical software
 - Chemical equipment for sampling (water and gas)
 - Field laboratory (PH meter, conductivity, CO₂, H₂S)
- Reservoir engineering laboratory equipment:
 - TOUGHFLAG modeling software
 - All materials test for wells (in English "Logging Equipment")
- Drilling
 - RIM Base software for PM 125 T
 - Logging truck (Double Drums, e-line, and slick-line)
 - Wireline skid equipment

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- K10 geothermal PTS surface readout
- Natural gamma ray logs
- Neutron logs (n-n)
- Resistivity logs: 16-inch, 64-inch, and self potential
- Caliper logs
- Cement Bond logs
- Gyroscopic logging equipment
- Collar Casing Locator
- Directional survey
- DrillPro drilling software
- Casing design software
- Mud design software
- Button hole assembly design software
- Cementing design software

The Ministry of Agriculture has expressed the need for additional water capacity in the region and has suggested use of equipment that can extract drinking water from the humidity in the air. The contractor will investigate options for providing water to the project site; however, a long term solution for water supply is not expected with the exploration phase of the project and is better suited for the development phase of the geothermal resource.

8.3 KEY ACTIONS FOR CAPACITY BUILDING

8.3.1 Labor

EdD shall hire the necessary EHS and social experts to the PMU team. The qualified individuals shall meet the minimum qualifications defined in Section 7.3.1. EdD will also need to hire qualified technical experts to staff the project in addition to the staff that will be supplied by the GCC and DSC. It is necessary that the PMU build a technical knowledge base for geothermal exploration and testing within Djibouti. This knowledge base is important for future exploration and development efforts in the country.

8.3.2 Trainings

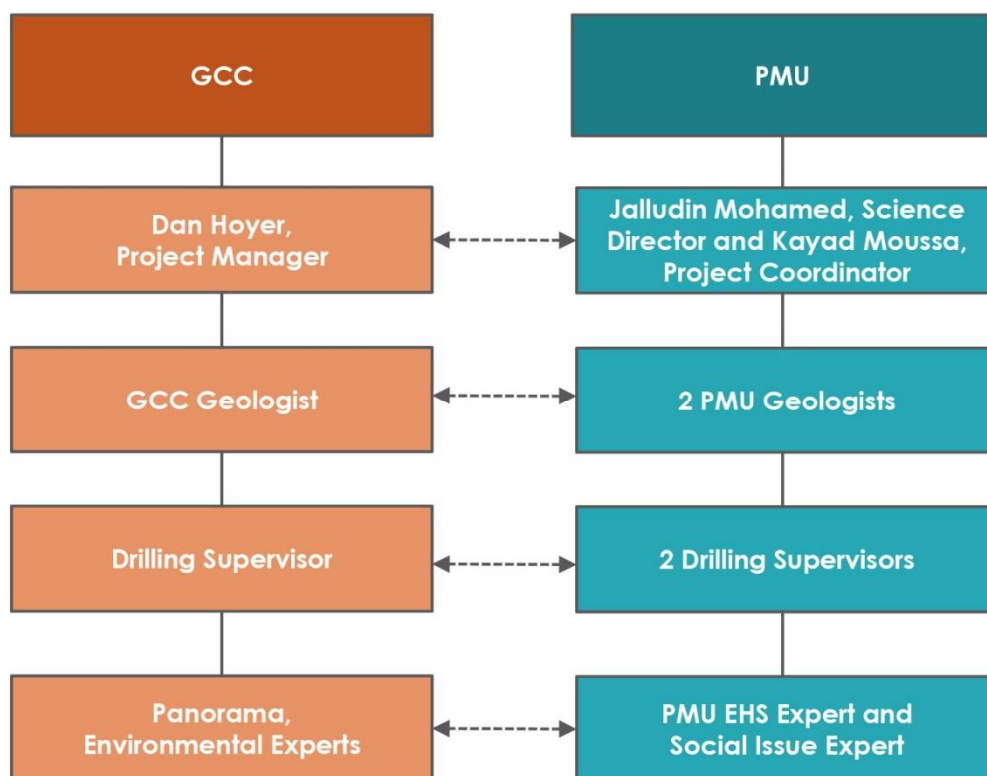
The GCC will prepare and implement the training program. The training program will be specific to the project, incorporating information specific to geothermal exploration and mitigation measures in this ESMP. Working under the direction of the GCC, the PMU shall coordinate with appropriate training organizations to receive in-class training for staff prior to drilling. A training session at the nearby geothermal field in Olkaria, Kenya is highly recommended. Training may also be provided to MHUEAT regarding the environmental impacts and mitigation. The mitigation measures in this ESMP require that all staff working on the project site receive health and safety training.

Technical experts at the PMU will receive in the field training by working side-by-side with experts at GCC during drilling. Figure 8.3-1 shows how technical experts at the PMU will be partnered with technical experts at the GCC to receive training during project implementation. In the field training may be organized by topics, which include:

- Geothermal well design
- Geothermal well monitoring (using gages, software for logging the well, taking samples)
- Well testing (surface and belowground well testing instruments, short- and long-term testing, injectivity, interpretation methods)
- Geothermal reservoir modeling and software
- Power plant design

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Figure 8.3-1 Capacity Building through Teaming



8.3.3 Equipment Procurement

Several pieces of equipment would need to be acquired prior to project initiation. In addition to the equipment needed to analyze water and soil samples and log the wells (listed above in Section 8.2.3), the following pieces of equipment would be necessary for the project:

- Carbon dioxide and hydrogen sulfide measurement instruments
- Chemical analysis field kit
- Liquid and gas sampling devices
- Flame ionization detector for gas chromatography equipment
- Modeling software