Government of Saint Lucia

Renewable Energy Sector Development Project
Environmental and Social Impact Assessment
Belle Plaine Site

July 2025

RENEWABLE ENERGY SECTOR DEVELOPMENT PROJECT
RESDP
"PURSUING ENERGY INDEPENDENCE"

PANORAMA
ENVIRONMENTAL, INC.

Government of Saint Lucia

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Prepared for:

Government of Saint Lucia

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Prepared by:

Panorama Environmental, Inc.

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Acronyms and Abbreviations

RAP	Resettlement Action Plan
BMP	Best Management Practice
cm	centimeter
C	Celsius
CLO	community liaison officer
CO_2	carbon dioxide
dB	decibel
DCA	Development Control Authority
DIPT	Department of Infrastructure, Ports and Transport
EHSG	Environmental Health and Safety Guidelines
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
gpm	gallons per minute
GDP	gross domestic product
GoSL	Government of Saint Lucia
GRM	grievance redress mechanism
H_2S	hydrogen sulfide
IFC	International Finance Corporation
IUCN	International Union for Conservation of Nature
km	kilometer
l/s	liter/second
LAC	Limits of Acceptable Change
LUCELEC	Saint Lucia Electricity Services Limited
OP	Operational Policies

O_3	ozone
PAP	project affected persons
PIU	Project Implementation Unit
$PM_{2.5}$	particulate matter with particle size smaller than 2.5 µm
PM_{10}	particulate matter with particle size between 2.5 µm and 10 µm
PMA	Pitons Management Area
ppm	parts per million
PPV	peak particle velocity
PS	Performance Standard
RAP	Resettlement Action Plan
RESDP	Renewable Energy Sector Development Project
SO_2	sulfur dioxide
WASCO	Water and Sewerage Company
WHO	World Health Organization
WRMA	Water Resource Management Agency
UNESCO	United Nations Educational, Scientific and Cultural Organization
VdB	vibration decibels

Executive Summary

ES.1 Overview

Geothermal exploration drilling is proposed within the southwestern region of the country at Fond St. Jacques, Belle Plaine, and Saltibus. Associated works will include water supply infrastructure, access road widening (where necessary for equipment passage) and a temporary storage area to support the drilling activities, and within the Belle Plaine site for material storage area for the drilling at Belle Plaine and Fond St. Jacques. Three slim-hole wells will be drilled to obtain information on the geology and geothermal reservoir characteristics in these areas. Although three sites will be subject to geothermal investigation, this ESIA assesses the impacts at the Belle Plaine site. The environmental and social impacts associated with the geothermal investigation at Fond St. Jacques and Saltibus are assessed in a separate ESIA.

This Environmental and Social Impact Assessment (ESIA) was prepared for geothermal exploration drilling and testing at the Belle Plaine Site (project) in accordance with Government of Saint Lucia laws, World Bank Environmental and Social Safeguard Policies and World Bank Environmental, Health, and Safety Guidelines (EHSGs), to provide an assessment of the environmental and social risks and impacts of the project. The organization of the ESIA follows the World Bank guidance. In addition, this ESIA adheres to the guidelines stated in the Guidance and Toolkit for Impact Assessments in a World Heritage Context (UNESCO, ICCROM, ICOMOS, IUCN, 2022).

This ESIA focuses on the exploration phase of geothermal development and does not address development of a power plant in the event that an economically viable geothermal resource is identified. A separate ESIA would be prepared to address potential impacts from power plant development.

ES.2 Purpose and Need

Saint Lucia has a population of about 180,000 and a Gross Domestic Product (GDP) of US $1.76 billion in 2021. The country's economic growth and development are primarily driven by the success of its tourism industry and associated activities. Presently, Saint Lucia depends on the importation of petroleum products to satisfy its energy requirements. Up to seventy-five percent of the diesel oil consumed in the economic sectors is utilized to produce electricity by Saint Lucia Electricity Services Limited (LUCELEC). Consequently, energy security including the dependence on diesel oil in the power sector remains a matter of concern.

Additionally, the extremely high and volatile cost of electricity is a major impediment that erodes the country's competitiveness as it seeks to attract a larger share of regional tourism revenues. This not only undermines growth in business and services but also creates hardship and burdens for private consumers, especially the poor.

Given these challenges, the Government of Saint Lucia (GOSL) has secured funding through the World Bank to implement the Renewable Energy Sector Development Project (RESDP). The development objective of the RESDP is to inform the Government of Saint Lucia of the viability of its geothermal resource for electricity generation and strengthen the enabling environment to scale up clean energy investments with the private sector. The Project is being implemented by a Project Implementation Unit (PIU) in the Department of Infrastructure, Ports and Transport (DIPT) of the Ministry of Infrastructure, Ports, Transport, Physical Development and Urban Renewal.

ES.3 Project Description

The proposed project includes drilling a slim-hole geothermal well and testing the geothermal resources at the proposed Belle Plaine drilling target. Slim-hole wells (3.78-inch bottom hole diameter) typically require less capital investment and cause less environmental and social impact than deep full-sized wells because they are drilled with smaller drill rigs on smaller well pads, drilling takes less time, and less fluid is produced. An exploratory drilling program using slim-hole wells is a cost-effective method for geothermal exploration.

The project would include the following activities and components:

- Access road improvements
- Equipment and material storage
- Well pad construction and water supply
- Well drilling
- Geothermal resource data collection and testing
- Site restoration following testing activities

ES.4 Key Project Impacts and Mitigation Measures

The findings presented in this ESIA identify environmental and social impacts that would result from the project. Most impacts would be temporary and focused within the drilling area during

well drilling and testing. The project would not result in significant residual negative impacts that could not be mitigated.

ES.4.1 Potential Adverse Risks Impacts

Potentially adverse environmental and social impacts that could occur as a result of the project include:

- **Soil Erosion and Water Quality.** The project would require grading roads and well pads, which could mobilize sediment and impact water quality. The drill cuttings could contain high levels of heavy metals. And discharged brine could contain heavy metals and elements that should not be released to the environment. Implementation of sediment and erosion control best management practices, testing drill cuttings, use of blow-out prevention equipment, and containment of any produced geothermal fluids and drilling effluent will protect water quality during drilling. Site restoration activities will restore the well pad and avoid long-term soil loss.
- **Water Supply.** Constructing the well pad and access roads would require water for dust control and for drilling water supply. Water will be obtained from a nearby spring during civil works and drilling. Improving the water storage infrastructure at the spring will provide for improved water supply conditions following the project. The extraction of water from the spring would have a negligible impact on water supply in the area as there is no current use of the water from the spring and no water diversions are located downstream of the spring runoff.
- **Air.** Geothermal testing could result in a temporary increase in carbon dioxide (CO_2) and hydrogen sulfide (H_2S) levels in proximity to the well. Air quality will need to be monitored and emergency evacuation procedures would be implemented if CO_2 or H_2S levels exceeded standards at receptors. The risk of exceeding air quality standards is low and would most likely be attributed to an upset condition, such as a well blowout (which is rare). Any potential exceedance of air standards would be short in duration because the geothermal gases would disperse quickly after the geothermal gases are contained. The mitigation would adequately manage the risk of geothermal gas emissions.
- **Geology and Soils.** The well pad contains topsoil that is currently used for agricultural production. The well pad is not in an area that is prone to landslide or mudflow. Mitigation to protect topsoil includes stockpiling topsoil materials and reapplying topsoil to the site during the site restoration phase.
- **Noise.** Operating construction and drilling equipment would result in a temporary increase in noise in proximity to the well pads. Well drilling and testing would occur 24 hours a day and could result in elevated noise levels at residences near the drilling sites. The mitigation includes installing noise control devices on the generator at the drill rig, and a mechanism to receive and respond to noise complaints as well as providing advance notice of any resource testing that would

involve venting of the resource and noise reduction measures. The mitigation would adequately manage temporary noise impacts.

- **Vibration.** Construction and drilling equipment would temporarily produce vibration in proximity to the equipment use. The vibration is not anticipated to impact any structures; however, mitigation includes pre- and post-project surveys to evaluate structures in proximity to access roads and equipment activities to ensure no impacts occur.
- **Natural Habitats and Biodiversity.** The project areas would be positioned in open agricultural and previously disturbed areas absent of natural and sensitive habitats. Project noise could impact bird nesting behavior in forested habitat adjacent to the drilling area; the forested area adjacent the well pad provides habitat for five endemic and nine priority bird species. The forested habitat adjacent the project area does not contain vegetation communities that are rare or scarce in Saint Lucia. Mitigation includes pre-construction surveys for sensitive bird species and worker training. The mitigation would adequately manage the risk to biodiversity.
- **Archaeology and Cultural Resources.** The well pad is located near a sensitive area for archaeological resources, but no archaeological resources have been recorded in the area. Grading and excavation activities could impact resources if encountered during construction. The access road is located over an existing unpaved access road and within an area that contains cultural resources. Mitigation includes halting construction in the vicinity of the find while an archaeologist investigates the resource and training workers on the sensitivity of resources. The mitigation would adequately manage the risk to archaeological resources.
- **Landscape and Visual Quality.** The project area is outside of the Pitons Management Area (PMA) but is within the PMA buffer zone. The project would not be in view from established tourist viewpoints. The drill rigs and equipment would have a minor and temporary impact on landscapes and views and could temporarily be visible from some portions of the PMA. Grading and vegetation removal could impact the landscape. Mitigation includes restoration of the well pad and revegetation after the project is completed. Implementation of site restoration would adequately manage this risk.
- **Traffic and Road Safety.** The project will include transporting large equipment to the drilling areas. Temporary lane closures may be required during equipment transport. Mitigation includes use of traffic controls and flaggers. The mitigation would adequately manage the risk on traffic and safety.
- **Utilities.** Transporting the drill rig could damage low-hanging utility lines along the roads. The mitigation requires minimum clearance for overhead utilities or temporary relocation of the line. The mitigation would adequately manage the risk on utilities.
- **Fires.** Construction equipment, welding, or worker smoking could ignite a fire in brush near the work sites. Mitigation includes worker training and maintaining

fire suppression equipment at the work sites. The mitigation would adequately manage the risk of wildfire.

- **Hazards and Hazardous Materials.** Hazardous materials such as fuel, oil, lubricants, and caustic soda would be stored on the well pad. The drill cuttings and geothermal brine could contain elements in concentrations that are considered hazardous to human health and environment. The mitigation includes proper storage and containment of all hazardous materials and classification of the drill cuttings to ensure proper disposal of any materials that are classified as hazardous. The mitigation would adequately manage the risk.
- **Waste.** The project would generate non-hazardous waste from packaging, containers, and drill cuttings. Mitigation includes preparation and implementation of a waste management plan to adequately manage solid waste.
- **Livelihoods and Resettlement.** The project will not require resettlement of any structures or people. The well pad is located in areas where active agriculture production occurs, and the project would temporarily impact the livelihoods of individual farm owners and farmworkers. Mitigation includes compensation for loss of agricultural production in accordance with the Resettlement Action Plan (Appendix E). The mitigation would adequately manage the impact on livelihoods.
- **Health and Safety.** The project would expose workers to occupational hazards associated with heavy equipment, the drill rig, and potentially production of geothermal steam and hot water. Workers would also be at risk of exposure to geothermal gases including H_2S and CO_2. The community living in proximity to the well pad would also be exposed to risks associated with a well blowout. The mitigation includes blowout prevention, emergency evacuation planning, a worker safety program and worker safety training. The mitigation would adequately manage the risk to health and safety.

ES.4.2 Potential Beneficial Impacts

The project could result in potentially beneficial social impacts through creation of temporary local jobs during construction and drilling operations. The project would provide opportunities for training and increased knowledge of geothermal drilling and testing. The project would upgrade the access road in Belle Plaine, which would improve access road conditions for farmers in the area. The project would also create good working conditions with fair employment practices in accordance with all laws and policies governing labor rights and working conditions. The project would create increased economic activity including the need for temporary worker housing, entertainment, food, and beverage services. If the project is successful, it could lead to development of a geothermal power plant to reduce Saint Lucia's reliance on fossil fuels and reduced emissions of pollutants.

ES.5 Conclusions

All impacts associated with the project could be avoided or mitigated by implementing the mitigation measures identified in this ESIA. The project would comply with the World Bank's Environmental and Social Safeguard Policies through implementation of the mitigation measures listed in Table ES.5-0-1.

Table ES.5-0-1 Summary of Mitigation Measures

Issues/Potential Impacts	Mitigation Measures
Environmental Mitigation Measures	
Water Resources (including Water Quality, Water Supply, Flooding, Hazardous Materials)	Water-1: Stormwater, Erosion, and Sediment Control Water-2: Drilling Effluent Management Water-3: Geothermal Brine Management Water-4: Blowout Prevention Water-5: Worker Latrine Management Water-6: Water Extraction Strategy Hazards-1: Hazardous Materials Management Plan Waste-1: Waste Management Plan
Air Quality (including Geothermal Emissions)	Air-1: Fugitive Dust Management Air-2: Construction Emissions Controls Air-3: Air Quality Monitoring and Noxious Gas Management Water-4: Blowout Prevention
Geology and Soils (including Erosion and Topsoil Loss, Landslides and Mudflows)	Soils-1: Topsoil Preservation and Restoration Water-1: Stormwater, Erosion, and Sediment Control
Noise	Noise-1: Noise Abatement and Community Coordination Noise-2: Noise Control During Well Testing Social-3: Community Engagement and Sensitivity
Vibration	Vibration-1: Vibration Monitoring
Natural Habitats and Biodiversity	Biodiversity-1: Invasive Weed Control Biodiversity-2: Nesting Bird Avoidance and Impact Minimization Biodiversity-3: Worker Training
Archaeological and Cultural Resources	Cultural-1: Inadvertent Discovery of Cultural Resources Cultural-2: Worker Cultural Resources Sensitivity Training
Landscape and Visual Character	Landscape-1: Site Restoration Landscape-2: Dark Sky Lighting
Traffic Circulation and Safety	Traffic-1: Traffic Control
Utilities and Communication Systems	Utilities-1: Protect Overhead Utility Lines

Issues/Potential Impacts	Mitigation Measures
Hazards and Hazardous Materials	Hazards-1: Hazardous Materials Management Plan Hazards-2: Drill Cutting Characterization Water-2: Drilling Effluent Management Water-3: Geothermal Brine Management Water-4: Blowout Prevention Waste-1: Waste Management Plan Safety-5: Emergency Response Plan
Fires	Fires-1: Fire Prevention and Response Safety-1: Health and Safety Plan
Solid Waste	Waste-1: Waste Management Plan
Social Mitigation Measures	
Livelihoods	Social-1: Agricultural Production
Working Conditions and Equality	Social-2: Working Conditions and Equality Social-3: Community Engagement and Sensitivity
Health and Safety Mitigation Measures	
Worker Health and Safety	Safety-1: Health and Safety Plan Safety-2: Personal Protective Equipment Safety-3: First Aid and Emergency Response Equipment Air-3: Air Quality Monitoring and Noxious Gas Management Hazards-1: Hazardous Materials Management Plan
Community Health and Safety	Safety-4: Community Safety Safety-5: Emergency Response Plan Safety-1: Health and Safety Plan Social-3: Community Engagement and Sensitivity Air-3: Air Quality Monitoring and Noxious Gas Management Traffic-1: Traffic Control Hazards-1: Hazardous Materials Management Plan

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1 Introduction

1.1 Overview

The Government of Saint Lucia (GoSL) proposes to conduct a geothermal exploration drilling program (the project) in Saint Lucia. The project involves drilling geothermal exploration wells to evaluate the feasibility of commercial geothermal energy-fueled electric power generation. The GoSL seeks funding for the project from the World Bank. The World Bank requires borrowers to prepare an Environmental and Social Impact Assessment (ESIA) prior to approving funding in accordance World Bank Operational Protocols. Due to the project location within the Pitons Management Area buffer zone, the project has also been evaluated in this ESIA consistent with *Guidance and Toolkit for Impact Assessments in a World Heritage Context* (UNESCO, ICCROM, ICOMOS, IUCN, 2022).

The primary purpose of the ESIA is to present a detailed analysis of the risks and impacts the project would have on the existing environmental and social conditions in the project area. Feasible mitigation measures are defined in the ESIA to avoid, minimize, or compensate for the impacts. The ESIA specifies costs of proposed mitigation measures, and their suitability under local conditions; and the institutional, training, and monitoring requirements for the proposed mitigation measures.

This ESIA is organized as follows:

- **Section 1: Introduction.** Summarizes the purpose and contents of the ESIA.
- **Section 2: Legal and Institutional Framework.** Summarizes environmental and social laws that are applicable to the ESIA process.
- **Section 3: Project Description.** Describes the proposed geothermal exploration program in detail, including the specific locations, procedures, and scheduled of the project.
- **Section 4: Baseline Data/Existing Environment.** Summarizes the findings of the literature review and baseline data collected for the Project.
- **Section 5: Environmental and Social Risks and Impacts.** Describes the specific risks and impacts that would result from the project.
- **Section 6: Mitigation Measures.** Provides the full text of mitigation measures that would be implemented to avoid or minimize impacts, including the specific tasks, roles, and responsibilities (e.g., RESDP, civil contractor, and drilling contractor).
- **Section 7: Analysis of Alternatives.** Summarizes alternatives that were considered and screened out when developing the project description.
- **Section 8: Key Measures and Actions for the Environmental and Social Commitment Plan.** Lists the important plans and actions that would ensure

implementation of the required mitigation measures and compliance with the World Bank's polices and standards.
- **Appendices A through E.** Provides additional information and documents that are an integral part of the ESIA.

1.2 Project Location

The project is located in the Soufrière district of Saint Lucia in Belle Plaine (Figure 1.3-1). The Belle Plaine site is located at the northeast end of the agricultural area and adjacent to undeveloped areas north and east of the drilling site. The project site is within the PMA green buffer zone. The project site is accessed via an existing unpaved access road and paved road network. Materials would be delivered to the project site from Vieux Fort via existing paved roads.

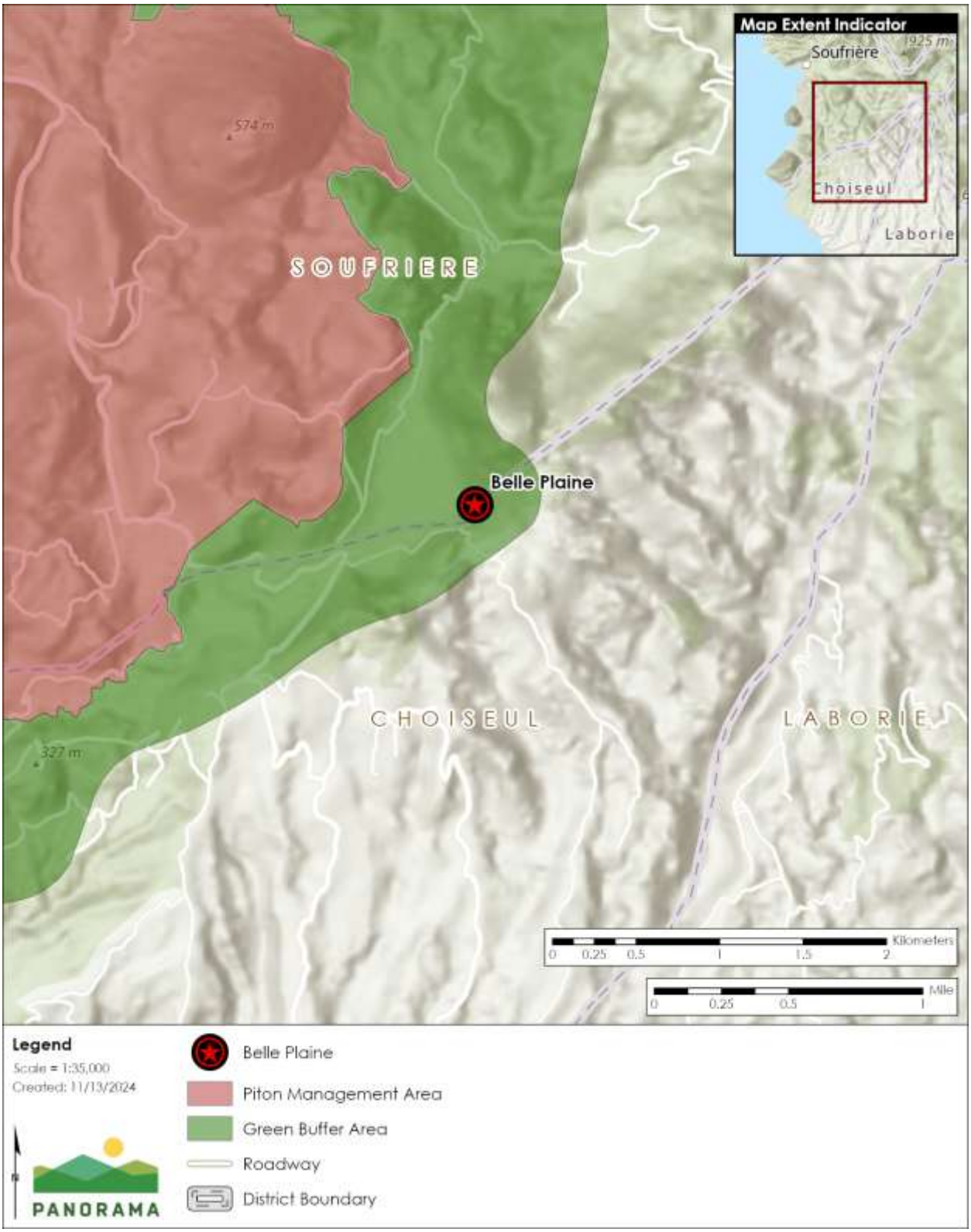
1.3 Project Need

The project is needed to e determine the viability of commercial geothermal power generation in Saint Lucia. The outcome of the exploration program would provide the GoSL and Saint Lucia Electricity Services Limited (LUCELEC) with valuable information that will support future capital investment decisions regarding further exploration of the geothermal resource and potential development for electric power generation.

Geothermal resource development in Saint Lucia would include the following benefits:

- Reduce consumption of non-renewable fossil fuels by providing a reliable source of clean renewable energy
- Help Saint Lucia meet its Paris Accord targets for renewable energy production
- Increase Saint Lucia's energy independence by reducing reliance on imported fossil fuels

Figure 1.3-1 Belle Plaine Project Site Location



. Source: *(ESRI, 2024; UNESCO Group, 2017; ELC Electroconsult-SPA and Theobalds Consulting, 2024)*

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2 Legal and Institutional Framework

2.1 Overview

This section provides a legal context for the ESIA, identifies Saint Lucia's legal requirements, and the World Bank's policies and guidance on environmental and social impact assessment. This ESIA has been prepared to fully comply with environmental and social legislation and procedures in Saint Lucia and with the World Bank's environmental and social safeguard policies.

2.2 World Bank and International Standards

2.2.1 Environmental and Social Safeguard Policies

Applicants seeking financing from the World Bank are required to comply with the applicable bank environmental and social safeguards policies, which consist of 11 operational policies (OPs). A summary of the key objectives of relevant OPs are provided below.

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. OP 4.01 requires stakeholder outreach prior to preparation of the Environmental Assessment and dissemination of information in the Environmental Assessment. All Category A and Category B[1] projects must take into account views of any

[1] 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.

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 a project-specific environmental management plan.

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.

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.

OP 4.12: Involuntary Resettlement. OP 4.12 recognizes that involuntary resettlement may cause severe long-term hardship, impoverishment, and environmental damage unless appropriate measures are carefully planned and carried out. OP 4.12 outlines the requirements for a Resettlement Action Plan (RAP) or Resettlement Policy Framework (RPF).

OP 4.36: Forests. OP 4.36 recognizes that the management, conservation, and sustainable development of forest ecosystems and their associated resources are essential for lasting poverty reduction and sustainable development. In accordance with OP 4.01, the Environmental Assessment addresses the potential impact of the project on forests.

2.2.2 Environmental and Social Performance Standards

The International Finance Corporation's (IFC) Environmental and Social Performance Standards define IFC clients' responsibilities for managing their environmental and social risks. The 2012 edition of IFC's Sustainability Framework includes Performance Standards (PSs). The ESIA was prepared in consideration of best practices including IFC PSs and equator principles.

The PSs that apply to the project include:

- IFC PS1 – Social and Environmental Assessment and Management System.
- IFC PS2 – Labor and Working Conditions.

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.

- IFC PS3 – Pollution Prevention and Abatement.
- IFC PS4 – Community Health, Safety and Security.
- IFC PS5 – Land Acquisition and Involuntary Resettlement.
- IFC PS6 – Biodiversity Conservation and Sustainable Natural Resources Management.
- IFC PS8 – Cultural Heritage.

2.2.3 Environmental, Health, and Safety Guidelines

General Guidelines

The World Bank's General Environmental, Health, and Safety Guidelines (EHSGs) are technical reference documents with general and industry-specific examples of Good International Industry Practice. The applicability of the EHSGs should be tailored to the hazards and risks established for each project on the basis of the results of the environmental assessment. The General EHSGs cover the following topics: Environmental, Occupational Health and Safety, Community Health and Safety, and Construction and Decommissioning.

Geothermal Power Generation Guidelines

The World Bank's *Environmental, Health, and Safety Guidelines for Geothermal Power Generation* provides specific recommendations for management of 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. Although this project does not include power generation, the guidelines provide recommendations for management of drillings fluids and cuttings, air emissions (i.e., H_2S), 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.

Mining

The World Bank EHS Guidelines for Mining are applicable to underground and open-pit mining, alluvial mining, solution mining, and marine dredging (IFC and World Bank Group, 2007c). The EHS Guidelines for mining are not directly applicable to the proposed geothermal exploration activities but were considered for storage and disposal of the waste rock produced during the drilling activities, which is similar to underground mining. The guidelines were also considered for requirements for geochemical characterization and effluent limitations that could be applicable to the project.

World Health Organization Air Quality Guidelines

The World Health Organization (WHO) Air Quality Guidelines were considered to define quantitative health-based air quality levels for key air pollutants. Exceedance of the air quality guideline levels is associated with risks to public health (World Health Organization, 2021).

2.3 Equator Principles

The Equator Principles is a risk management framework that has been adopted by 91 financial institutions in 37 countries for determining, assessing and managing environmental and social risk in projects that are financed by the Equator Principle Financial Institutions. There are ten principles that are primarily intended to provide a minimum standard for due diligence to support responsible risk decision-making. Currently, there are no financial institutions involved with the project that have adopted the Equator Principles. The Equator Principles are considered in the ESIA in an effort to attract private investors that have adopted the principles.

2.4 Government of Saint Lucia

2.4.1 Environmental and Social Laws

Forest, Soil and Water Conservation Act (1945 and 1983). This legislation establishes a legal framework for the management of forests and forest resources. Removal of and dealing in timber are regulated by a permit system. It establishes the guidelines for maintaining protected forests.

Saint Lucia National Trust Act (1975). The Saint Lucia Nation Trust Act of 1975 established the Saint Lucia National Trust, which is a membership organization set up to help conserve the natural and cultural heritage of sites of Saint Lucia. The objectives of the Saint Lucia National Trust include the listing of buildings, objects and monuments of prehistoric, historic and architectural interest, and places of natural beauty.

Wildlife Protection Act (1980). This act creates a legal framework for wildlife protection, conservation, and management. A Chief Wildlife Protection Officer is responsible for administration and enforcement of the Act, research and data collection.

Fisheries Act (1984). This act defines fisheries management and development, marine reserves and conservation measures, enforcement measures and other regulations applying to fisheries in the fishery waters.

Land Conservation and Improvement Act (1992). This act provides for the conservation of land in Saint Lucia and establishes the Land Conservation Board. The main functions of the Board shall be to advise the Minister responsible for Agriculture and Lands on the general supervision of land.

National Conservation Authority Act (1999). The National Conservation Authority was established in 1999 "to identify, manage, conserve, and generally provide stewardship over natural assets including beaches, coastal, protected and other declared or designated areas, in a sustainable manner and to provide ancillary amenities thereby contributing to the social and economic development of Saint Lucia."

National Physical Planning and Development Act (2001 and 2005). The objectives of this Act include ensuring that appropriate and sustainable use is made of all publicly and privately-owned land in Saint Lucia in the public interest. The act also promotes the protection and conservation of the natural and cultural heritage of Saint Lucia.

Employees Occupational Health and Safety Act (revised 2005). Defines requirements for employers to provide a safe work environment. The regulation also defines requirements for disposal of waste, ventilation, drinking water, latrines, lighting, first aid, resuscitation, medical examination, notification of accidents, disease, or dangerous occurrence, and investigations.

Land Acquisition Act (2008). The Land Acquisition Act defines laws related to acquisition of land in Saint Lucia including procedures for assessment of compensation. The law also defines payments owed for certain leases.

Physical Planning and Development Act, Article 22 (2022), Environmental Impact Assessment. Defines requirements for preparation of an Environmental Impact Assessment for any development in St. Lucia that could significantly impact the environment.

Saint Lucia Labour Code (revised 2022). The Labour Code includes conditions of employment including minimum wage, sick leave and benefits, vacation. Employment of children, termination of employment, and termination benefits as well as provisions for occupational safety and health including hazardous chemicals and notification of accidents. The Labour Code also provides for equal opportunity and treatment in employment.

Domestic Violence Act (2022). The act prohibits acts of domestic violence and defines protections for victims.

2.4.2 Environmental Policies

Statutory Instrument No. 7 (2024). The Government of Saint Lucia declared the Piton Management Area (PMA) an Environmental Protection Area. The policy ensures the Outstanding Universal Value of the PMA is maintained by incorporating the Limits of Acceptable Change (LAC) into law for the PMA. The LAC included a Design Guide which outlines locations, specifications, and methods of development that could occur within the PMA.

National Environment Policy and National Environmental Strategy (2005). In 2005, the Government of Saint Lucia approved a five-year National Environmental Management Strategy and a National Environmental Policy. The 2005 Policy, with a pending update initiated in 2014, is intended to guide implementation of national environmental goals and targets and track progress towards these goals and targets. The focus is on a clearly defined results-based operational strategy and action plan detailing specific modalities for interventions by national agencies as well as by regional and international development partners.

National Land Policy (2007). This policy is intended to guide the use, management, development and administration of land resources in Saint Lucia in order to optimize the contribution of land to sustainable development.

National Energy Policy (2024). The National Energy Policy covers the period 2023 to 2030. The objective of the National Energy Policy is to strengthen energy security and reduce energy supply costs while meeting national commitments for greenhouse gas emission reductions under the Paris Agreement on climate change. The National Energy Policy calls for implementation of a detailed National Energy Policy Action Plan in the energy sector.

National Climate Change Adaptation Policy (2013). The National Climate Change Adaptation Policy provides a framework for addressing the impacts of climate change, in an integrated manner, across all key sectors. While the Policy specifically addresses climate change adaptation, it is recognized that some activities provide meaningful adaptation, as well as mitigation, co-benefits, thereby increasing resilience in the face of existing and emerging climate change impacts.

National Water Policy (2004). The goal of the policy is to sustain economic growth, human development and environmental sustainability by promoting and facilitating the use and management of freshwater resources in an efficient, sustainable, and equitable manner that is consistent with the social, economic, and environmental needs of current and future generations as well as with the country's international obligations.

2.4.3 International Labour Convention Commitments

Saint Lucia is a member of the International Labour Organization. The International Labour Organization produces Conventions, which are legally binding international treaties that may be ratified by member states. Saint Lucia has ratified a total of 29 Conventions (International Labour Organization, n.d.).

2.5 World Heritage Designation for the Pitons Management Area

2.5.1 Pitons Management Area and Buffer

The PMA is designated as a World Heritage Site by United Nations Educational, Scientific and Cultural Organization (UNESCO) for its Outstanding Universal Value. The management of the PMA must adhere to the Operational Guidelines for the Implementation of the World Heritage Convention (UNESCO, 2017). An Integrated Development Plan was prepared for the PMA and surrounding Soufriere Region that identifies policy areas and development goals to preserve the PMA and World Heritage Site designation (Hyder Consulting Limited, 2008). In 2013, a study on the Limits of Acceptable Change (LAC) was prepared to identify acceptable development within the PMA policy areas, including a "green buffer" zone, as well as development that could conflict with the World Heritage Site designation (The Landmark

Practice, 2013). As shown in Figure 1.3-1, the Belle Plaine drilling area would be outside of the PMA, but within the green buffer zone.

2.5.2 IUCN Guidelines

The IUCN *Guidance and Toolkit for Impact Assessments in a World Heritage Contexts* (UNESCO, ICCROM, ICOMOS, IUCN, 2022) requires evaluation of project impacts on the values and attributes of the OUV of a world heritage site. The IUCN includes the following steps in the process of assessing impacts on world heritage as part of a wider environmental and social impact assessment:

- Participation from local communities along with environmental and heritage authorities in the impact assessment process.
- Screening
- Scoping
- Baseline assessment to define the current state of the World Heritage property, its OUV and attributes
- Understanding the legal and management system
- Understanding the proposed action and identifying alternatives
- Identifying and predicting impacts
- Evaluating impacts
- Mitigation of negative impacts and providing/enhancing positive impacts
- Ensuring the mitigation and enhancement take place
- Reporting the results in an impact assessment report
- Making the impact assessment report available for comment to rights holders, the local community, and other stakeholders with interest in the World Heritage property
- Decision making about the action throughout the impact assessment process
- Follow-up to monitor implementation of the mitigation measures to ensure the OUV is protected and sustainable development objectives are attained.

This ESIA addresses the requirements for an impact assessment report as defined in the guidance. The project has involved participation with local communities and the PMA office consistent with the guidance.

2.6 Relevant Threshold Standards

2.6.1 Effluent Discharge

The IFC and World Bank Group Environmental, Health, and Safety General Guidelines (IFC and World Bank Group, 2007a) have developed guidelines for effluent discharge to waters such as lakes, streams, rivers, or the ocean. The IFC and World Bank effluent threshold standards for mining, which has similar processes to geothermal drilling, are presented in Table 2.6-1 for informational purposes. The temperature threshold standard is a differential of less than 3 degrees Celsius (C).

Table 2.6-1 Threshold Standards for Effluent Discharge

Effluent Parameter	Threshold Standards (mg/L)
Total suspended solids	50.0
pH	6 to 9
Chemical oxygen demand	150.0
Five-day biological oxygen demand	50.0
Oil and grease	10.0
Arsenic	0.1
Cadmium	0.05
Chromium (hexavalent)	0.1
Copper	0.3
Cyanide (total)	1.0
Cyanide (free)	0.1
Cyanide (weak acid dissociable)	0.5
Iron	2.0
Lead	0.2
Mercury	0.002
Nickel	0.5
Phenols	0.5
Zinc	0.5

Source: (IFC and World Bank Group, 2007b)

2.6.2 Soil Toxicity

The GoSL and World Bank have not developed toxicity standards for soils. The toxicity standards codified in the United States (U.S.) Code of Federal Regulation Title 40 Section 261.24 are used to govern toxicity characteristic pollution limits, which govern levels at which material may be disposed in a standards landfill. These standards are used here because these standards underwent substantial study of impacts on human health during their adoption. Table 2.6-2 provides threshold standards for soil toxicity.

Table 2.6-2 Threshold Standards for Soil Toxicity

Pollutant	Threshold Standards (mg/L)
Arsenic	5.0
Barium	100.0

Pollutant	Threshold Standards (mg/L)
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
Pentrachlorophenol	100.0
Pyridine	35.0
Selenium	1.0
Silver	5.0

Pollutant	Threshold Standards (mg/L)
Tetrachloroethylene	0.7
Toxaphene	0.5
Trichloroethyleene	0.5
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)

2.6.3 Air Emissions

The World Health Organization (WHO) maintains air quality guidelines designed to "offer guidance in reducing the health impacts of air pollution" (WHO, 2021). Table 2.6-3 summarizes the WHO's threshold standards for air emissions.

Table 2.6-3 Threshold Standards for Air Emissions

Pollutant	Averaging Period	Threshold Standards (µg/m^3) [1]
Sulfur dioxide (SO_2)	Annual mean	125 (interim target 1) 50 (interim target 2) 40 (guideline)
Nitrogen dioxide (NO_2)	Annual mean	40 (interim target 1) 30 (interim target 2) 20 (interim target 3) 10 (guideline)
	24-hour mean	120 (interim target 1) 50 (interim target 2) 40 (guideline)
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) 15 (guideline)
	24-hour mean	150 (interim target 1) 100 (interim target 2) 75 (interim target 3) 45 (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) 5 (guideline)

Pollutant	Averaging Period	Threshold Standards (µg/m^3) [1]
	24-hour mean	75 (interim target 1) 50 (interim target 2) 37.5 (interim target 3) 15 (guideline)
Ozone (O_3)	Peak season	100 (interim target 1) 70 (interim target 2) 60 (guideline)
	8-hour mean	160 (interim target 1) 120 (interim target 2) 100 (guideline)
Carbon monoxide (CO)	24-hour mean	7 (interim target) 4 (guideline)
Hydrogen sulfide (H_2S)	24-hour mean	150
	30-minute mean	7

Note:

[1] The standards for SO_2, NO_2, PM_{10}, $PM_{2.5}$, and O_3 are listed in the "WHO Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide and Sulfur Dioxide" (2021). 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, 2021)

2.6.4 Noise Exposure

The World Bank's General EHS Guidelines provides maximum noise level guidelines for project-related noise. These guidelines are generally suited for permanent noise increases, such as noise associated with land use changes and permanent point sources from a facility. The project would produce temporary noise only.

Table 2.6-4 lists the World Bank's noise level guidelines by land use type. In addition to the land use guidelines, the General EHS Guidelines state that noise levels should not exceed the existing ambient noise levels by more than 3 dBA when measured at the closest noise-sensitive receptor.

Table 2.6-4 Noise Level Guidelines

Land Use	Maximum Noise Level (1-Hour L_{eq}) [a]	
	Daytime (7:00 to 22:00)	Nighttime (22:00 to 7:00)
Residential, institutional, and educational	55 dBA	45 dBA
Industrial and commercial	70 dBA	70 dBA

Note:

[a] Equivalent sound level (L_{eq}): the average A-weighted sound (dBA) level during a defined period of time.

Source: (IFC and World Bank Group, 2007a)

Table 2.6-5 lists occupational noise exposure limits and required hearing protection worker exposure.

Table 2.6-5 Occupational Noise Exposure Limits and Required Hearing Protection

Sound Level (dBA)	Maximum Permitted Exposure (Hour/Day)	Required Hearing Protection
80	16	--
85	8	Class C
90	2	Class C/B
100	1	Class B
105	0.5	Class B
110	0.25	Class A
115	0.125	Class A
>115	0	Class A

Source: (Kiama, 2016)

2.6.5 Vibration

Neither the World Bank nor the Government of Saint Lucia have established threshold for vibration. The vibration thresholds established by the U.S. Federal Transit Administration are used below as the primary vibration sources would be from mobile equipment and the primary risk of impact from vibration is to structural damage.

Table 2.6-6 Groundborne Vibration Impact Criteria for Structural Damage

Building Category	PPV (cm/sec)	PPV (in/sec)	VdB
I. Reinforced concrete, steel, or timber (no plaster	1.27	0.5	102
II. Engineered concrete and masonry (no plaster)	0.76	0.3	98
III. Non-engineered timber and masonry	0.5	0.2	94
IV. Buildings extremely susceptible to vibration damage	0.3	0.12	90

Notes:

[a] PPV = peak particle velocity;

[b] VdB = vibration decibels (referenced to 1-microinch per second).

Source: (Federal Transit Administration, 2018)

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3 Project Description

3.1 Overview

This section describes the proposed project location, civil works activities (site access improvements and well pad construction), water supply, drilling activities, resource testing activities, and site restoration or reclamation that will be undertaken during implementation of the project at the Belle Plaine geothermal exploration site.

The project involves drilling a slim diameter well to obtain information on the geology and temperature gradient in the area as well as testing of the geothermal resource, if encountered. Slim diameter wells lead to a better definition of well targets and will improve the probability of success of any future deep geothermal production wells. Due to the size of the proposed wells, the wells will only be used for data collection and are not capable of power production. The specific locations of the exploration well pad, access road, water supply, and staging/storage area have been selected based on site access, land accessibility/acquisition, avoidance of environmental and culturally sensitive areas, and avoidance of conflicts with water supply or other infrastructure to the extent feasible. Resettlement has also been avoided and minimized to the extent feasible as part of the project design process.

3.2 Project Location

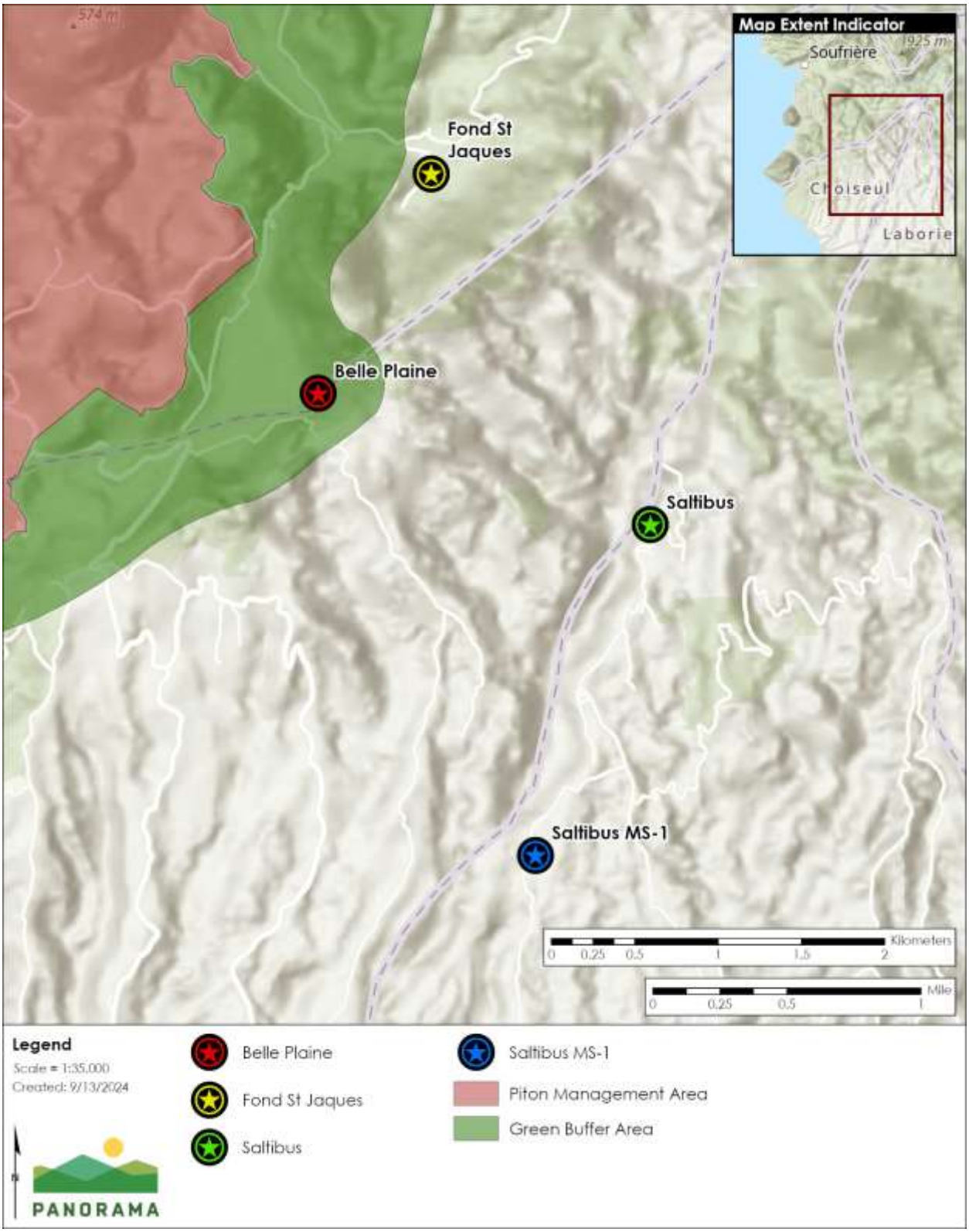
The proposed geothermal well pad in Belle Plaine is shown in Figure 3.2-1. The limits of the Pitons Management Area (PMA) and green buffer zone in relation to the Belle Plaine geothermal exploration site are shown on Figure 3.2-2.

The well pad at Belle Plaine is approximately 0.53 hectare (1.3 acres). The well pad is located entirely on private land. 1 acre of the well pad site will be permanently acquired, and the remained of the well pad and area for the water supply will have a temporary construction easement. The well pad site is located within an open field that is currently used for agricultural activity and is near a spring and remnant water storage tank. The areas surrounding the well pad are used for agricultural production or are undeveloped open space/forest. The area south of the well pad includes a stream and an undeveloped hill slope.

Figure 3.2-1 Belle Plaine Well Pad

Source: (ELC, 2024)

Figure 3.2-2 PMA and Green Buffer Zone



Source: (ELC, 2024)

3.3 Site Development, Civil Works, and Supplies

3.3.1 Equipment and Material Sources

Equipment and materials will be sourced locally, if available. In particular, civil works components will be procured through an international bidding procedure but most likely will be contracted locally. It is expected that some equipment and materials such as the drill rig will be shipped to Saint Lucia from nearby countries (most notably Central, South and North American countries). Shipped equipment and materials will be transported out of Port Vieux Fort to the south because of major improvements to the road network. Existing infrastructure at Port Vieux Fort could accommodate project needs for shipping and offloading of equipment such as the drill rig and casing.

Soufrière Bay does not have a commercial seaport that could accommodate project needs; therefore, the project will not use Soufrière Bay for import of materials for the project.

3.3.2 Access Roads

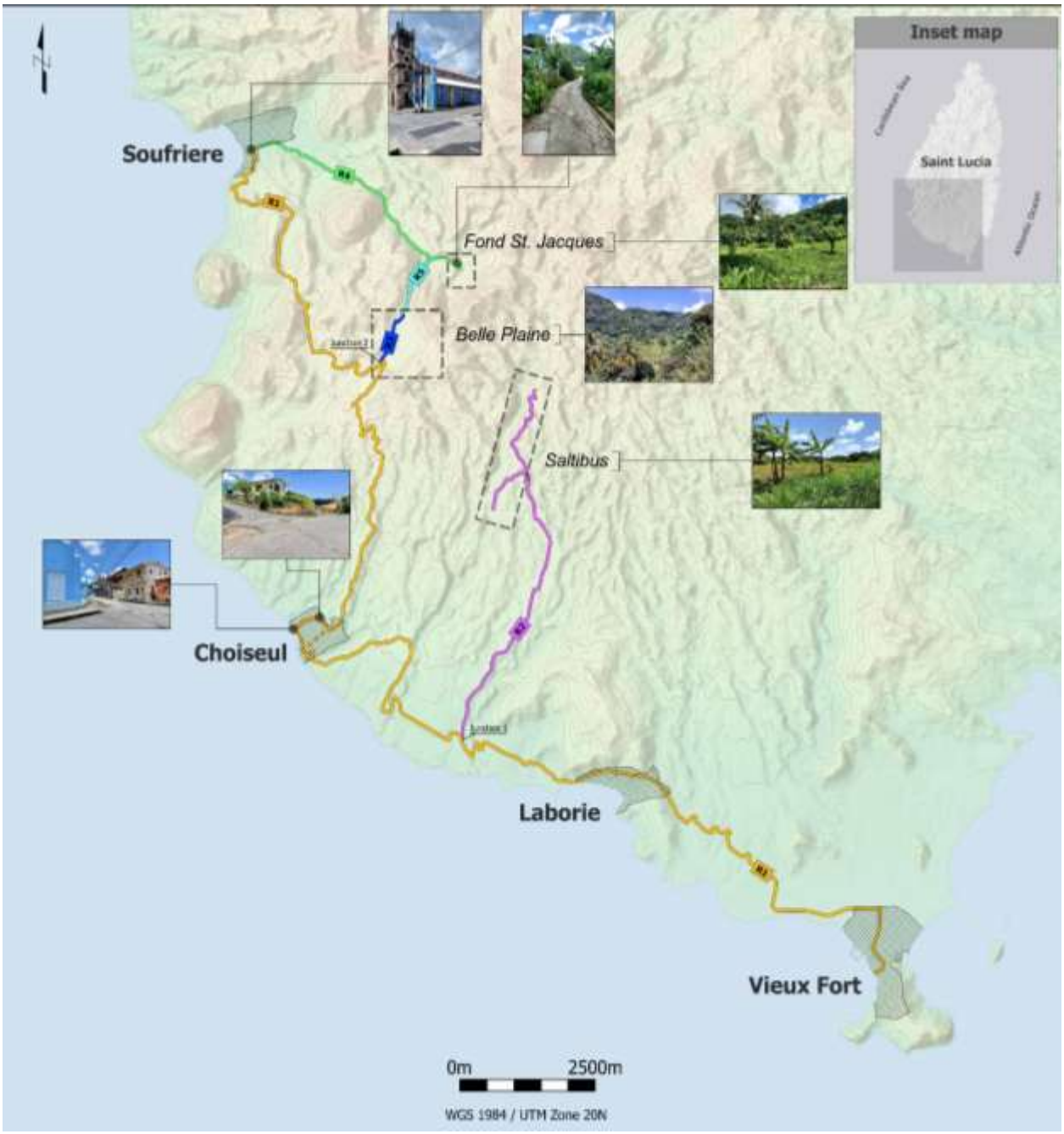
The equipment and materials will be transported from the port to the well pad using a network of existing paved and unpaved roads. The primary access road network is shown on Figure 3.3-1. The existing paved road network has been evaluated for accessibility and is suitable for transport of equipment and supplies to the project areas. No bridge or roadway improvements are proposed on the paved road network. From the paved road network, local access road improvements will be required to access the well pad.

The existing unpaved access road to the well pad will require improvements to the road surface and drainage. Approximately 700 meters (2,300 feet) of the existing unpaved road will be improved by installing subbase and crushed rock, compacting the road surface, and improving the roadside drainage. The improved road will have the same alignment as the existing road, but the road width will be enlarged to 16 feet (4.88 m) and the road surface and drainage will be stabilized. The road will remain accessible to individuals using the road for access to agricultural fields along the access road throughout the duration of construction and drilling. Measures to maintain road access are further described in Section 5.2.8.

3.3.3 Equipment and Material Storage

Equipment and material storage will generally occur within the Belle Plaine well pad site. A small area north of the well pad and within the well pad parcel will be used for temporary stockpile of topsoil removed from the well pad site.

Figure 3.3-1 Access Roads from Vieux Fort to Belle Plaine



Source: (ELC, 2024)

3.3.4 Well Pads

A well pads will be developed at the drilling location where the drilling equipment and materials will be positioned. The well pad will generally house the following equipment:

- Drill rig with auxiliary structures and laydown area
- Mud system including: mud tanks, suction tank, mud mixing tank, mud pumps
- Mud logging unit
- Air drilling package
- Cementing unit with cement silos
- Fuel tank
- Mud disposal pond
- Water pond
- Storage area
- Offices

Well pad development will include removing vegetation from the well pad site including the area of grading. The grading plan and well pad layout for Belle Plaine is shown on Figure 3.3-2.

A geotextile fabric will be installed on the well pad surface and engineered fill will be imported and compacted to the finished grade of the well pad surface. To the extent feasible, the existing soil will be reused at the site as fill material. Topsoil material will be stockpiled to be used in revegetation efforts after the exploration works have been completed. A layer of gravel will be installed on the surface of the pad to stabilize the pad.

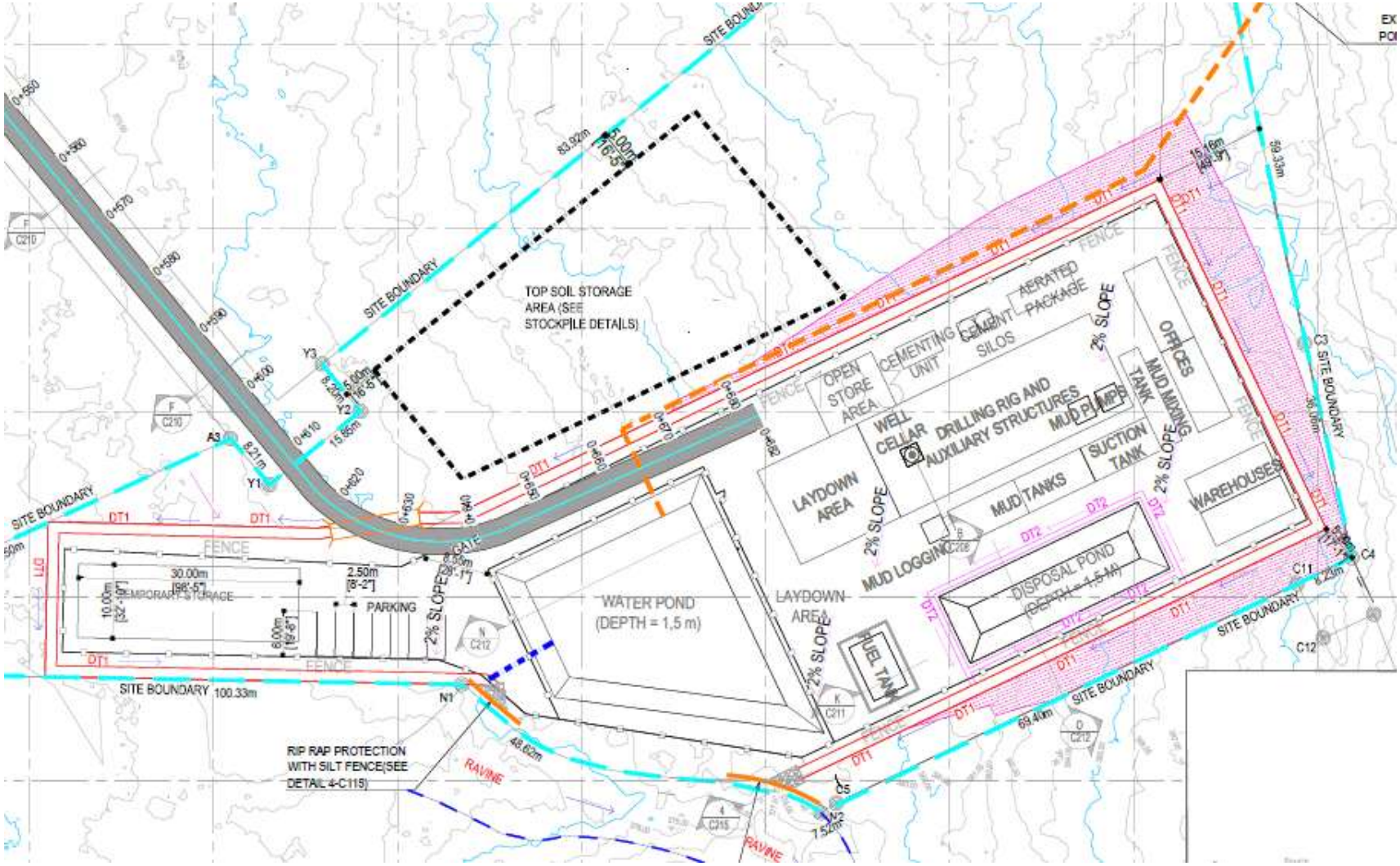
Drainage

A drainage ditch will be constructed to direct stormwater around the Belle Plaine well pad site as indicated by DT1 in Figure 3.3-2. Separate drainage controls (DT2) will be installed around the mud disposal pond to prevent stormwater from entering the mud disposal pond. Riprap and silt fence will be installed between the well pad and the adjacent ravine south of the well pad to protect water quality in the ravine and prevent erosion.

Concrete Cellar and Laydown

A reinforced concrete cellar will be constructed around the well within the well pad. The concrete cellar will house the lower section of wellhead assembly, including the casing head flange. The internal dimensions of the cellar are approximately 3 x 3 meters (10 x 10 feet). A laydown area (14 x 12 meters [45 x 40 feet]) will be located adjacent the drilling rig for temporary laydown of casing and other components required for the drilling operations.

Figure 3.3-2 Belle Plaine Well Pad and Site Layout



Source: (ELC, 2024)

Mud System

The mud system is required for drilling operations and would be installed near and at the same elevation as the drilling rig. The mud system includes 2 steel tanks (10 x 5 meters [33 x 16 feet]), 1 suction steel tank (10 x 5 meters [33 x 16 feet]), 1 steel mixing tank (3 x 14 meters [10 x 45 feet]), and 2 mud pumps (3 x 3meters [10 x 10 feet]). A mudlogging unit container (9 x 3 meters [30 x 10 feet]) would be used to monitor the drilling parameters with sensors installed on the rig systems and collect and analyze the drilling cuttings to define the geological formations and parameters.

Air Drilling Package

The air system will be located near and at the same elevation as the drilling rig. A typical aerated drilling package consists of compressors, air dryer unit, boosters, soap tank, soap pump and an air-water /or mud separator.

Cementing Unit and Silos

The cementing unit and silos for storage of cement are required to supply cement to the well during drilling operations. The cement unit (6 x 3 meters [20 x 10 feet]) will be installed near the location of well. Cement materials will be delivered to the pad as needed for temporary storage in the silos (3.5 meters in diameter).

Fuel Tank

A fuel tank will be located on the well pad to supply fuel to a generator at the drilling rig. The fuel tank will have a masonry wall surrounding the tank for secondary containment. A sump located adjacent to the tank will collect any runoff from the area. All runoff from the fuel tank area will be contained and will not flow to any surface water.

Mud Disposal Pond

The mud disposal pond collects the wastes/drill cuttings from the drilling operations. The mud disposal pond will be lined with a temperature resistant and water proof membrane in order to prevent any leakage of the drilling waste/drill cuttings into the groundwater. The pond is approximately 30 x 10 meters at Belle Plaine. The mud disposal pond has a depth of approximately 1.5 meters and will be covered to prevent any run-on to the mud disposal pond or run-off from the mud disposal pond during rain events. Drill cuttings shall be removed from the pond as needed to prevent the mud disposal pond from overtopping.

Water Pond

The water pond will store the water required for drilling operations. The water pond will be lined with a temperature resistant and waterproof membrane to prevent any contact with the groundwater. An existing water storage tank will be repaired to improve water storage of water obtained from the existing spring located northeast of the well pad. The dimensions of water pond at the well pad site are equivalent to an area of 30 x 30 meters (100 x 100 feet) at the Belle Plaine well pad. The water pond will be approximately 1.5 meters (5 feet) in depth.

Temporary Drilling Storage Area

The well pad has to include a small area for a short period storage of the casing and drilling parts.

Offices and Workshops

Offices will be made of standard containers of 12 x 2.5 x 2.6 meters (40 x 8 x 8.5 feet) length x width x height.

Fence

The well pad site shall be secured with a vinyl coated chain link fence approximately 8 feet tall with barbed wire at the top of the fence. The fence will provide security for the site and workers.

Lighting

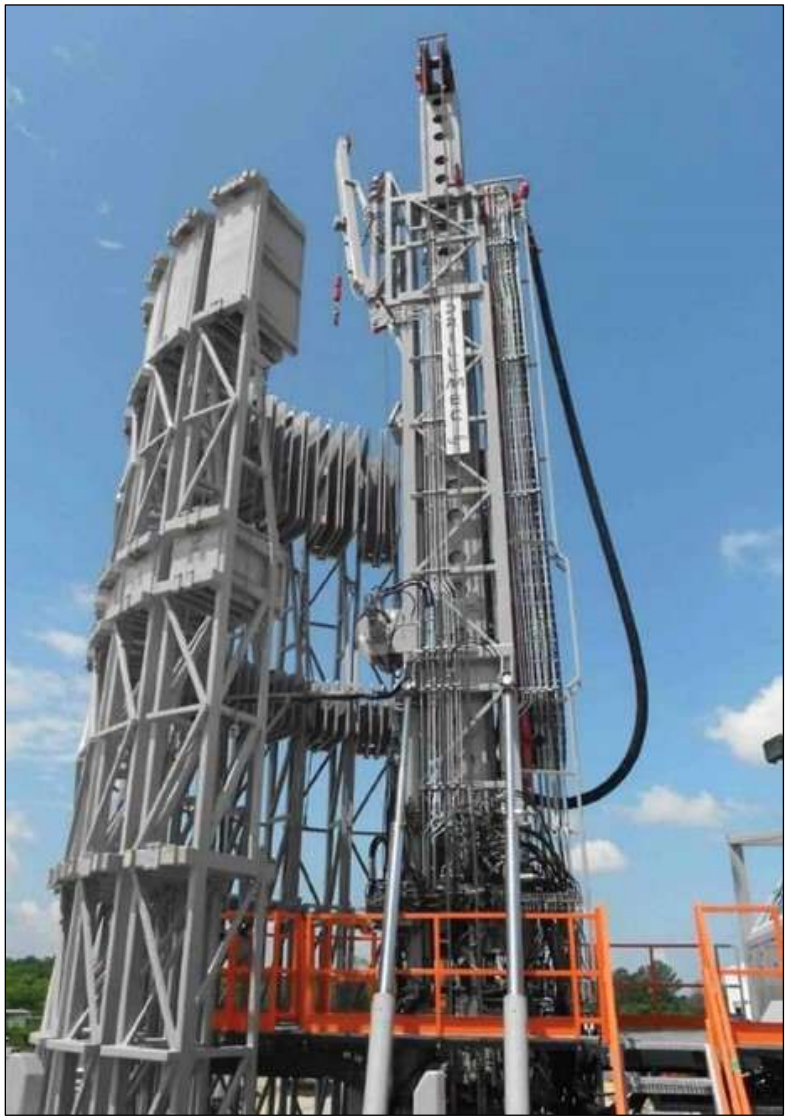
The well pad area will be illuminated during drilling activities. The drilling contractor will provide the lighting fixtures, which will be powered by a diesel generator on the drill rig. The lighting will be directed into the drilling site to minimize light pollution on adjacent properties.

3.4 Well Drilling

The project includes drilling one exploratory slim-hole well at the well pad. A drilling rig with a capacity of 160 metric tons with 700 horsepower draw works capacity will be used for the drilling of the slim hole wells. A trailer mounted telescopic double drilling rig or a super-single mobile drilling rig will be used. An example drilling rig is shown on Figure 3.4-1. Both super-single and telescopic double drilling rigs are fast moving, trailer or truck mounted mobile drilling units. The rig is approximately 4.5 meters to 5.5 meters (15 to 18 feet) high during transport and can be extended to a maximum height during drilling of 32 meters (105 feet) for super-single type drilling rigs and 45 meters (150 feet) for telescopic double drilling rigs.

The slim hole well is planned to reach a total depth of 1,500 to 1,800 meters (approximately 5,000 to 6,000 feet). The deepest cemented casing string will be set to approximately 750 meters depth (approximately 2,500 feet). A blowout-preventer (BOP) would be installed within the cellar above the 7-inch casing. The 7-inch casing will be set to a depth of approximately 250 meters (approximately 820 feet). Two to five generators will be housed on the drill rig and well pad to supply power for both the drilling activities, water supply operations lighting fixtures and office/warehouse electrical equipment.

Figure 3.4-1 Example Drill Rig for a Slim-hole Well



3.4.1 Drilling Water and Drilling Mud

Drilling will require water to cool the drill and wash drill cuttings from the drill bit.[2] Water will be obtained from an existing spring due northeast of the Belle Plaine well pad site. Water

[2] Drilling operations for the deeper sections of each well require relatively small amounts of water flow, whereas the larger hole diameters near surface require significantly more water flow for hole cleaning. If a reservoir is crossed in the final well section, partial or even total circulation losses increasing the water demand to up to 11 l/s. If water supply capacity is overcome, then aerated drilling will be used to drill under almost balance conditions to reduce the water loss during drilling.

demand for drilling is estimated to range from 4 to 11 liters/second (l/s; 63 to 175 gallons per minute [gpm]) and water supply will need to be continuous to ensure continuous drilling.

The existing storage tank and pipeline east of the well pad will be improved/repaired to supply water for the project. Water from the spring will provide supply to the extent feasible. If the available flow from the water supply is not sufficient for the drilling needs at Belle Plaine, the additional water will be delivered to the site by water tank trucks of about 20,000 liter (5,280 gallon) capacity. Considering that the drilling activities may require a peak demand of water of 11 l/s (175 gpm), it is estimated that approximately 2 trucks would have to deliver water to the well pad every hour.

Wells will be drilled using water and non-toxic drilling mud. Variable concentrations of non-toxic additives (drilling fluid) would be introduced to the drilling mud as needed to prevent corrosion, increase mud weight, and prevent mud loss. In addition, caustic soda and lignosulphonate would also be used in small quantities. Additional drilling mud would be mixed and added to the mud system as needed to maintain the required mud quantities.

3.4.2 Drill Cutting and Fluid Disposal

The drilling fluid carrying the rock cuttings is discharged at the shale shaker, where the cuttings are separated from the mud and discharged into the mud disposal pond. The recovered drilling fluid is reused in the drilling process. Drill cuttings will be tested to determine whether the cuttings contain any toxic or hazardous materials (e.g., arsenic, mercury, or other naturally occurring heavy metals in high concentrations). Any drill cuttings containing hazardous materials will be segregated and sent to a landfill that can accept the materials. Clean drill cuttings/rock will be available for commercial use such as in road bedding or other applications. The volume of cuttings produced from the exploration slim-hole well is estimated to be approximately 65 cubic meters (approximately 2,300 cubic feet). Drill cuttings will be tested for naturally occurring heavy metals and hazardous materials prior to disposition.

Each completed well will be equipped with a well head including a master valve and side valves. Any fluid remaining from the drilling process will either be reinjected to the geothermal well or will be evaporated from the mud pond prior to disposal of soils/solids from the mud pond.

3.5 Geothermal Resource Data Collection and Testing

Testing for the presence or absence of an exploitable geothermal reservoir will be conducted at all wells. Tests will include downhole temperature measurements, water loss and injection testing (completion tests) and production testing in wells intercepting a geothermal reservoir. Temperature logs will be recorded periodically for weeks after well completion and rig release.

3.5.1 Well Logging

Well logging under both shut-in and flowing conditions will be performed in all exploratory slim-holes. Logging can be performed during drilling and after drilling. During drilling, the logging activity takes place during a drilling stop and shall be accurately organized to avoid any delay in drilling operations. Well logging shall include pressure, temperature, and spinner logs, static formation temperature tests, water loss tests, gross permeability test, and pressure fall-off recording. The equipment will include:

i) a platform to work at the top flange master valve height for well logging operations;
ii) a trailer mounted slick line winch unit;
iii) a lubricator assembly with related accessories needed to run in pressurized wells;
iv) a set of downhole tools for pressure, temperature and flow rate measurement with downhole electronic memory, such as Kuster K10 or equivalent, and related accessories.

3.5.2 Flow Tests

Wells that encounter elevated temperature and permeability at depth allow for short-term production to assess sub-surface conditions. This testing will occur after a sufficient wellbore warm-up and does not require the presence of the drill rig on site. The proposed method for flow testing at the exploration well is the James lip method, which involves an atmospheric separator to control and monitor the discharge.

Air may be injected to pressurize the wellbore and displace the water level at depth if the warm-up monitoring will suggest that the well will not be able to start discharging upon the opening of the master valve. This will require one compressor and one booster of the air drilling package. The geothermal fluids will be discharged through a horizontal pipeline into the atmospheric separator, where steam will be released to the atmosphere, while separated brine will be temporarily stored in the mud disposal pond and the water pond. Discharge monitoring will include well head pressure, lip pipe pressure, weir box temperature and water level. Discharged fluids will be sampled for field monitoring and subsequent laboratory analysis. The silencer will consist of an inlet pipe discharging into a vertical pipe with a suitable large diameter to reduce the steam phase exit speed at below 4 meters/second, which will assure a strong reduction of noise of high frequencies. Flow testing would be conducted as allowed by the temporary storage volume of the water storage pond and mud pond including required freeboard available at each site. Prior to any discharge of brine to the water storage pond the outlet pipes for the water storage pond will be plugged and a cover will be installed over the water storage pond to prevent rainwater from encountering the pond and causing any overflow. A temporary sandbag berm will also be installed around the perimeter of the water pond to prevent any rainfall from running into the pond and causing overflow. Brine produced during the flow test will either be reinjected to the geothermal well at the completion of the test if there is sufficient permeability to allow for reinjection, or the fluid will be allowed to evaporate and the soils that come into contact with the brine will be discharged at a landfill that is authorized to accept hazardous materials.

3.6 Site Restoration

The commercial potential of the exploration well will be assessed after testing. The well will not be abandoned if it is determined to have long-term use as a monitoring well, or injection well. Equipment will be removed and the site cleared of excess material. The wellhead and well cellar (3 x 3 meters [10 x 10 feet]) will remain in place for future testing or monitoring. The wellhead and cellar will be protected by a fence with provisions to avoid water accumulation due to run off inside the cellar. Valves wheels shall be taken away to prevent valve operation by unauthorized people. A well head pressure monitor will be kept in place to control for excessive pressure due to accumulation of non-condensable gases. At Belle Plaine, the well pad site shall be graded to match the pre-existing site conditions to the extent feasible. Stockpiled topsoil materials will be applied to the well pad sites and vegetation will be planted to provide slope stability. All areas of temporary easement will be returned to agricultural use/production.

3.7 Erosion and Sediment Management

Best management practices (BMPs) for erosion and sediment control will be used to stabilize loose soil and control sediment as well as to prevent site run-on and manage site run-off. Typical BMP materials installed on construction sites include stabilized drainage channels, fiber matting, hydroseed, mulch, straw wattles, silt fencing, rock bags, and hay bales. Typical BMP procedures implemented to prevent fugitive dust on construction sites include wetting loose, dry soil during ground disturbance; preventing soil track-out onto paved roadways; and covering truck loads when transporting soil. All areas of disturbed soils will be revegetated at the completion of well drilling and testing activities and during site reclamation.

3.8 Hazardous Material Management

Hazardous materials, such as fuels, oils, and lubricants for construction equipment, would be stored in a designated roofed storage area with secondary containment. 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 materials. A temporary warehouse made by shipping containers with a roof structure will be built to protect construction materials from the rain. The well will be drilled with water and non-toxic drilling mud. Most of materials used in drilling fluids are not harmful for the environment, with the exception of caustic soda which is used in small quantities and lignosulphonate which is used in the chrome free product variation for environmental protection. Hazardous materials, including caustic soda, lignosulphonate, and diesel fuel used to power the generator and equipment will be transported, handled, and stored in accordance with applicable laws of Saint Lucia, World Bank General EHS Guidelines Section 1.5 (2007a), and World Bank EHS Guidelines for Geothermal Power Generation Section 1.1 (2007b).

3.9 Waste and Effluent Disposal

Fluids and solids removed during drilling will 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 at a landfill at Deglos. Excess drilling fluids will either be injected back into the well at the completion of testing activities or will be evaporated. Drill cuttings that do not exceed the toxicity threshold will be reused in commercial applications such as in road construction. A sanitary toilet cabin with mobile septic tank sized for the planned workforce will be installed by the contractor on the project site and would be maintained in a clean condition. Testing will occur prior to disposition of the material.

Trash would be maintained in covered receptacles at the well pads and storage area. Non-hazardous waste will be disposed of at an authorized landfill in either Vieux Fort or Castries.

3.10 Schedule and Workforce

The anticipated project schedule and workforce are summarized in Table 3.10-1. The anticipated work hours for project activities are summarized in Table 3.10-2.

Table 3.10-1 Anticipated Workforce and Schedule

Activities	Schedule	Workforce
Access Establishment and Site Development		Up to 50
Well Drilling (per well)	2 to 3 months	Up to 45
Well Production Testing (per well)	1 week	Up to 15
Well Abandonment and Pad Reclamation	1 month	Up to 15
Grand Total	**2 to 10 months**	**Up to 50**

Table 3.10-2 Anticipated Workhours per Day

Activities	Hours
Access Establishment and Site Development	7:00 to 19:00
Well Drilling	24 hours
Well Testing	24 hours
Well Abandonment and Pad Reclamation	7:00 to 19:00

Note:
Proposed workhours would be the same on weekdays and weekends for all activities.

4 Baseline Data/Existing Environment

4.1 Overview

A comprehensive scoping studies report was prepared for the project in 2017 to obtain and evaluate information about the existing environmental and social conditions within the project area. Additional investigations were conducted in 2024 to update the prior investigations. This section summarizes the baseline/existing conditions that may be at risk or impacted by the project based on the results of the baseline studies. Baseline investigations and conditions are documented in Appendix C.

4.2 Environmental Conditions

4.2.1 Water Resources

Water Supply

Surface Water Resources

The Belle Plaine drilling site is located within the Choiseul/Trou-Barbet watershed. There is a spring located immediately north of the proposed Belle Plaine well pad that discharges water year-round. The discharge at the spring generally drains southeast and within a ravine adjacent and east of the proposed well pad and along the perimeter of the valley. The water at the spring located north of the well pad is not currently used as water for agricultural production. No irrigation drains are used to supply water within the project area in Belle Plaine. The primary sources of water for agriculture in the project area include rainwater and potentially shallow groundwater.

At the national level, Saint Lucia benefits from an extensive water supply network managed by the Water and Sewage Company (WASCO). Water supply in the rural areas such as the project area is generally stable, but during the dry season, challenges such as water rationing and shortages are common. Rural communities, particularly those in higher elevation areas experience water supply interruptions more frequently than urban areas. There have been ongoing efforts to upgrade water infrastructure, but gaps still exist in ensuring consistent service in remote communities. WASCO does not have any water supply infrastructure in Belle Plaine but maintains a diversion from a ravine in Delcer, some distance south of the project area (WRMA and WASCO, 2024).

In Soufrière, the majority of households have access to public piped water directly into their homes. According to the census, about 87.8 percent of households in Saint Lucia have piped

water into the dwelling. In Soufrière, 82 percent of households are connected to a public piped water supply, while a smaller percentage rely on private catchment systems, springs, and rivers. This access enhances the community's overall quality of life, reducing the burden of water scarcity.

A household survey conducted in 2017 indicated that the majority of households in Belle Plaine use mainly public pipe-borne water supplied by WASCO as their primary source of water for domestic purposes, which is generally considered good quality and reliable. Rainwater harvesting tanks/containers were also used by most households. Spring water was generally used for other non-drinkable domestic purposes and farming. A few households also reported using a combination of public standpipe, spring, and river water.

Groundwater

No groundwater investigations have been performed in the project area and there is no reported use of groundwater resources for water supply in the area. Rainwater runoff from topographically high areas, including the mountains surrounding Belle Plaine, recharge groundwater aquifers in the valleys. No data currently exists on groundwater volume or depth to groundwater in the area.

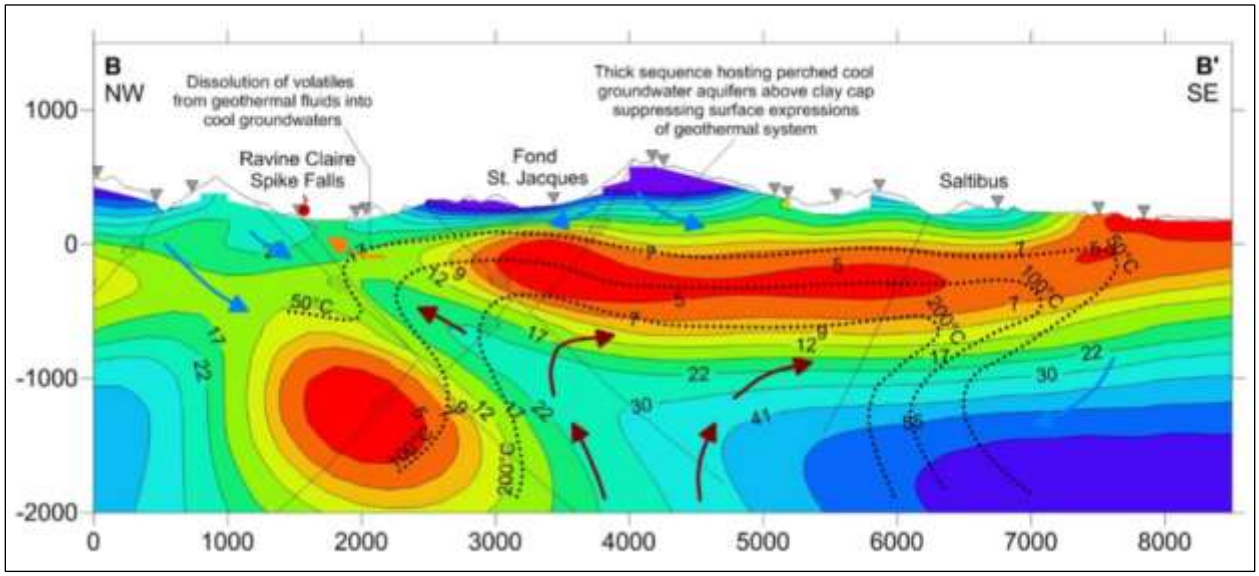
Geothermal Resource

The geothermal aquifer is naturally separated from the groundwater aquifer by aquitards, which limit infiltration and cross-contamination of geothermal resources with surface water or shallow groundwater resources. Jacobs (Jacobs New Zealand Limited, 2016) developed a conceptual hydrogeological model of the area of influence (shown in Figure 4.2-1). The conceptual model shows the presence of a clay layer, which suppresses surface expression of the geothermal system. The cool groundwater aquifer is perched above the clay layer. The hydrothermal alteration appears to occur at relatively shallow depths just at or below sea level. Surface manifestation of the geothermal resource occurs along fractures where there is upflow, such as in the vicinity of Ravine Claire Spike Falls.

Water Quality

The water quality of Saint Lucia's rivers has declined considerably in recent years due to an increase in agriculture, especially banana cultivation. Research carried out by the River Surveillance Monitoring Project (Lloyd et al., 1996) concluded that the variable that most affects Saint Lucia's ecosystems is the intensification of agriculture in combination with deforestation near water sources. Water quality data were collected at a ravine downstream of the Belle Plaine well pad on November 22, 2024 (provided in Appendix C). Water quality data collected in the area indicate high levels of bacteria that do not meet the water quality criteria for contact recreation. All other constituents were below water quality thresholds (refer to Appendix C).

Figure 4.2-1 Schematic Conceptual Hydrogeologic Model



Source: (Jacobs 2016)

4.2.2 Air Quality

Project Area Ambient Air Quality

Ambient air quality was measured for a 20-day period in the vicinity of the project in 2017. Low ambient concentrations of nitrogen dioxide (NO_2), Sulphur dioxide (SO_2), and hydrogen sulfide (H_2S) were measured near the project areas. The 20-day average concentrations were well below the World Health Organization (WHO) Guidelines. WHO guidelines specify 10-minute maximum concentrations of 500 µg/m³ for SO_2, a 1-hour average of 40 µg/m³ for NO_2 and a 30-minute average of 7 µg/m³ for H_2S. Fugitive dust monitoring was conducted at the Belle Plaine project site in September 2024. The 24-hour average concentration of particulate matter 10 microns or less (PM_{10}) was 5 µg/m³ and the average concentration of particulate matter 2.5 microns or less ($PM_{2.5}$) was 3 µg/m³. The WHO guidelines are 50 3 µg/m³ and 25 µg/m³ for PM_{10} and $PM_{2.5}$ respectively. The measured levels of PM_{10} and $PM_{2.5}$ were well below the guidelines for protection of public health.

Naturally Occurring Geothermal Emissions

Geothermal systems may contain gases that are potentially hazardous to human health. The most common gases in geothermal systems include: carbon dioxide (CO_2) and H_2S. People visiting Sulphur Springs and other areas of fumarolic activity with uncontrolled naturally occurring emissions in Saint Lucia are at the greatest risk for exposure to geothermal gas emissions (Jan Lindsay, 2002). There have been reports of people and animals dying from CO_2 inhalation associated with geothermal systems in the Caribbean, including Saint Lucia (Jan Lindsay, 2002).

Ambient concentrations of SO_2 and H_2S at Sulphur Springs were substantially higher than concentrations in the project vicinity. H_2S concentrations at Sulphur Springs were 29.24 µg/m³,

which exceeds WHO guidelines of 7 µg/m^3. It should be noted that the WHO guidelines are for annoyance, with potential eye irritation likely caused when concentrations reach 150 µg/m^3 or above. A 20-day SO_2 average concentration of 292 µg/m^3 was measured at the Sulphur Springs site. This average SO_2 concentration was below WHO guidelines and in line with concentrations measured during the University of West Indies Study, which showed monthly average concentrations ranging from 177 to 623 µg/m^3 between April and December 2014. The higher concentrations measured at this site are representative of emissions at the fumarole where there is venting of the geothermal gases. No fumaroles or sources of SO_2 occur in Belle Plaine. Therefore, ambient levels of SO_2 in the project area would be de minimis.

4.2.3 Geology and Soils

Belle Plaine is located in a wide, flat valley surrounded by steep mountains. Geologically, this area is characterized by pumiceous, pyroclastic flow deposits. The soil is used for agricultural production, including bananas, cocoa, and coconuts. The project area specifically includes a flat existing unpaved access road and a gently sloping area at the well pad. The well pad is at the margin of the valley and adjacent more steeply sloping hillslope and forested terrain. Soils within the Belle Plaine area are highly productive. The well pad itself contains numerous crops. The geotechnical investigation at Belle Plaine found a plasticity index ranging from 9 to 14 and the soils on the well pad are suitable for compaction and well pad construction (ELC, 2024b).

Soil erosion is the most severe environmental problem in Saint Lucia and affects the water supply and agricultural productivity. An agricultural study of soils showed that the loss of soil cover is very high as a result of high storm intensity (Cox, Sarangi, & Madramootoo, 2006). More than 90 percent of annual soil erosion is generated in short periods of hours or days (Norville & King, 2001). The greatest contributors to erosion issues in Saint Lucia include:

- Loss of vegetation cover in watersheds
- Lack of proper soil conservation practices
- Inappropriate land use, and degradation of soils
- Inadequate road construction and maintenance

Factors that contribute to the degradation of soil quality in Saint Lucia include:

- Loss of nutrients or imbalances in the soil
- Overfertilization
- Use of pesticides and herbicides
- Disposal of both human and natural waste
- Waterlogging in flat areas

4.2.4 Noise

Existing daytime and nighttime ambient noise levels were measured in the project area of influence. The documented noise levels were consistent with a rural environment where the noise sources are predominantly natural (e.g., wind, water, wildlife, and farm animals). Other noise sources included mobile (e.g., traffic) and stationary sources encountered along roadways.

Table 4.2-1 provides the average high and low noise levels measured at the Belle Plaine well pad during daytime and nighttime hours. Noise data was collected at the well pad on 22 and 23 September 2024. The increased nighttime noise level was attributed to rainfall. Due to the remote location of the well pad, there are no significant baseline noise sources in proximity to the area and natural noise such as wind and rain are the primary source of noise in the area as well as agricultural equipment.

The Belle Plaine access road and well pad are surrounded by agricultural fields and undeveloped forest areas. Planning contours at intervals of 100 (330 feet), 200 (660 feet), 300 (1,000 feet), and 400 meters (1,300 feet) from the Belle Plaine well pad are shown on Figure 4.2-2**Error! Reference source not found.**. Two residential structures are located along the access road to the well pad,

Table 4.2-1 Existing Daytime Ambient Noise Levels

Time	Average (dBA)	Range (dBA)	Extreme Noise Sources during Measurements
Daytime	43	36 to 60	Higher noise levels were generated by farm equipment.
Nighttime	51	37 to 54	Environmental noise (e.g., frogs, insects, wind) attributed to overnight noise levels in excess of 50 dB.

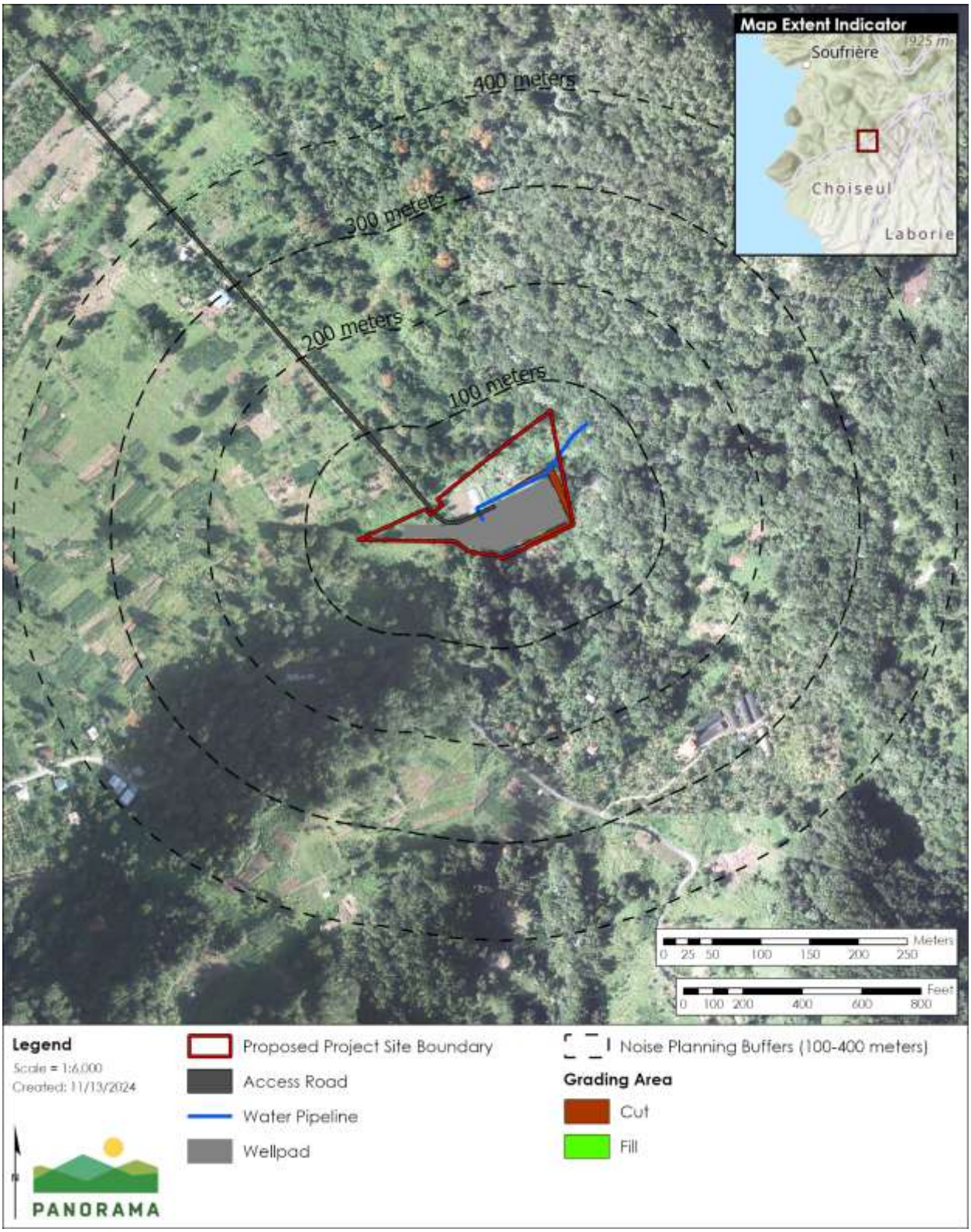
4.2.5 Natural Habitats and Biodiversity

Flora and fauna species observed within the project area of influence are provided in the Scoping Studies Report (Appendix C). No endangered or priority floristic, mammalian, herpetofauna, or insect species were encountered during surveys of the Belle Plaine area; however, several endangered and priority birds were encountered in the forest habitat adjacent to the well pad and in the area of the spring/water supply.

Vegetation Communities/Habitat Characteristics

Biological resource investigations were conducted within the broader Belle Plaine valley and adjacent forested areas in 2017. While the broader Belle Plaine Valley was evaluated for biological resource conditions, the primary area of focus for this ESIA and the impact analyses in Section 5.2.5 are the areas of the well pad and access road, which would be subject to disturbance during the project. The dominant land use/vegetation types within the well pad and access road consist of an existing unpaved access road and agricultural production. Forest habitat is adjacent the well pad and within the area of the proposed water supply pipeline. The Belle Plaine well pad and access road area has been cleared of natural forest habitat and replaced by agriculture. The access road is currently developed as an unpaved access road

Figure 4.2-2 Belle Plaine Noise Planning Contours



absent vegetation and the well pad area is currently covered with row crops including tomatoes and cabbage. The well pad area is bordered by forested lands. No natural habitat or critical habitat occurs within the Belle Plaine well pad or access road. The forested habitat adjacent to the well pad has not been designated for nature conservation value and no forestry or other reserves occur near the project site.

Fauna

Table 4.2-2 provides a summary of the common faunal species documented in the Belle Plaine area and surrounding area of influence (i.e., habitat areas within approximately 300 meters [1,000 feet] of the potential drilling sites). The well pad area and access road is characterized by a lack of native habitats. Bird, mammalian, herpetofauna, and insect species within the Belle Plaine area are generally limited due to existing agricultural production, which has limited suitable habitat; however, the surrounding forested edge provides natural habitat for bird species including two endangered species. The International Union for Conservation of Nature (IUCN) status of birds listed as endangered or vulnerable is included in Table 4.2-2.

Table 4.2-2 Faunal Species and Conditions in the Belle Plaine Study Area

Birds and Status	Mammals	Herpetofauna	Insects
A total of 36 species were detected in the Belle Plaine valley and surroundings. The majority of the detected species are resident species, with the exception of two, the Sand spotted sandpiper and the barn swallow. Five endemic birds occurred in the area; two of the Saint Lucian endemics were uncommon for the site. Nine priority species were found occurring in the forested area adjacent to the site, two of which are classified as endangered species and one is classified as vulnerable. The priority species observed include: • Saint Lucia Parrot (*Amazona versicolor*); Vulnerable • Saint Lucia Black finch (*Melanospiza richardsoni*); Endangered • Saint Lucia Oriole (*Icterus laudabilis*); Endangered	Mongoose (*Herpestes suropuntatus*) was recorded in the area. Mongoose was introduced to Saint Lucia and is classified as invasive wildlife. Two species of bats were observed in the study area including: • Fruit bats (*Monophyllus plethodon*) • Insectivorous bats (*Bracyphyllus cavernum*) These species are not considered endangered.	Five reptile species were recorded in the study area, including the endemic Saint Lucia anolis lizard (*Anolis luciae*). Other reptiles included: • Common house gecko (*Hemidactylus mabouia*) • Slipperyback skink, known as Zandoli tarre (*Gymnopthalmus pleei*)	Butterflies, dragonflies, and bees were common insects observed in the study area. Common butterfly species included: • Southern great white • White peacock • Common long tail skipper • Tropical chequered skipper • Ocola skipper • Fiery skipper • False barred sulphur • Spreadwing skipper • Caribbean buckeye • Southern broken dash • Hannos blues

Birds and Status	Mammals	Herpetofauna	Insects
• House Wren (*Troglodytes aedon mesoleucus*); • Saint Lucia Warbler (*Dendroica delicata*) • Saint Lucia Pewee (*Contopus oberi*) • Lesser Antillean Saltator (*Saltator albicollis albicollis*) • Lesser Antillean Flycatcher (*Myiarchus oberi sanctaeluciae*) • Grey trembler (*Cinclocerthia gutturalis macrorhyncha*)			

Sources: (Panorama Environmental, Inc., 2017)

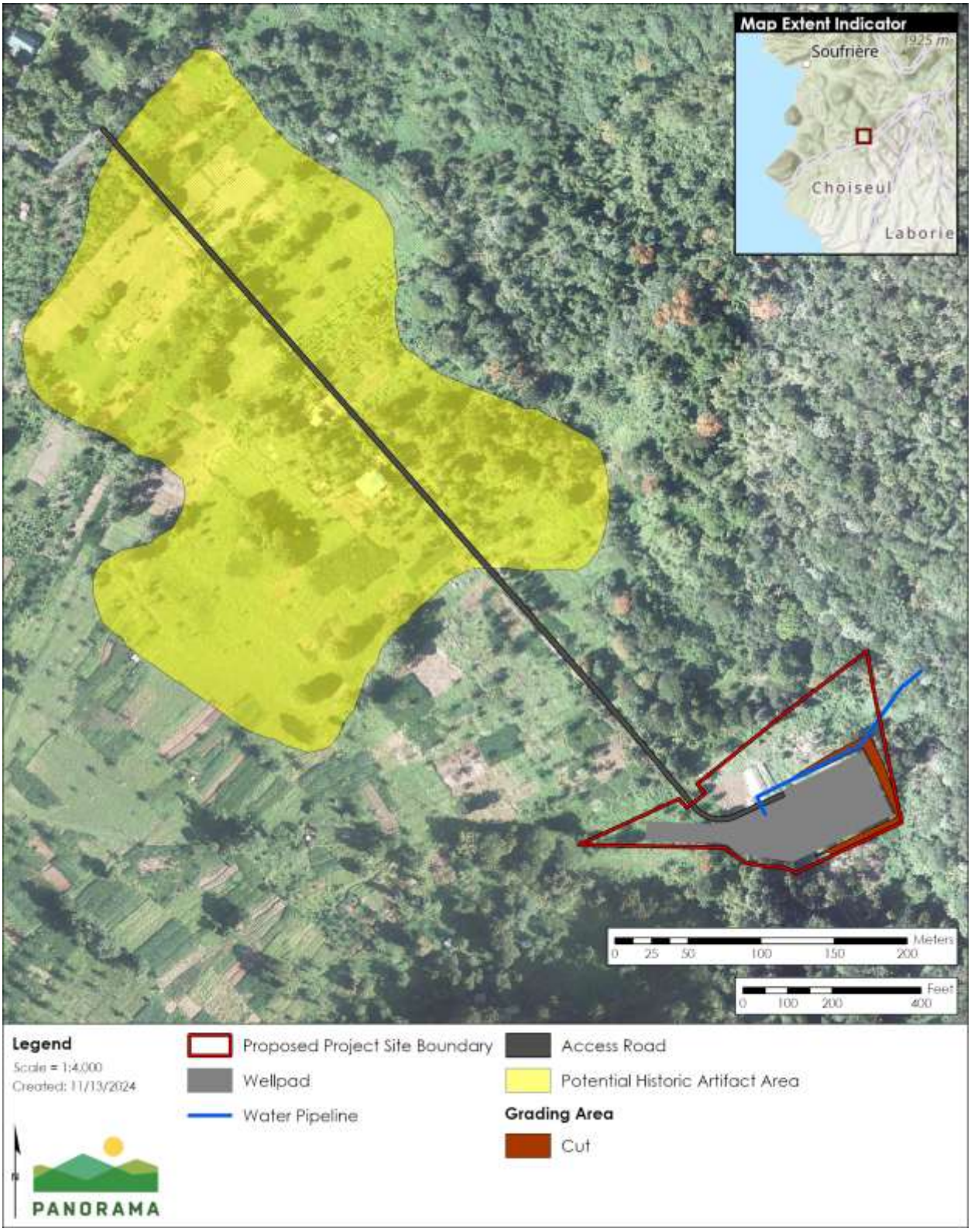
4.2.6 Archeological and Cultural Resources

The Belle Plaine valley contains significant amounts of both prehistoric and early colonial artifacts. Areas within the broader Belle Plaine valley that are highly sensitive for historical and prehistoric resources are shown on Figure 4.2-3 The Belle Plaine well pad is located east and north of early plantations, Rabot Estate and Belle Plaine Estate and outside of the area that is sensitive for archaeological resources. The existing unpaved access road that would be used for access to the well pad passes through an area that is sensitive for archaeological resources.

A fairly sizeable amount of prehistoric Amerindian materials were observed during pedestrian surveys at Belle Plaine. There is a potential for subsurface Amerindian resources due to the age of these resources. The discovery of Amerindian materials adds to the ever-growing database of Amerindian archaeological sites in Saint Lucia, as well as the broader Caribbean.

4.2.7 Landscape and Visual Character

The visual resources and landscape within the Belle Plaine valley is typical of agricultural areas in Saint Lucia and provide views of trees, row crops, and fallow agricultural fields as shown on Figure 4.2-3 Belle Plaine Historically Sensitive Areas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Proposed Project Site Boundary
Wellpad
Water Pipeline
Access Road
Potential Historic Artifact Area
Grading Area
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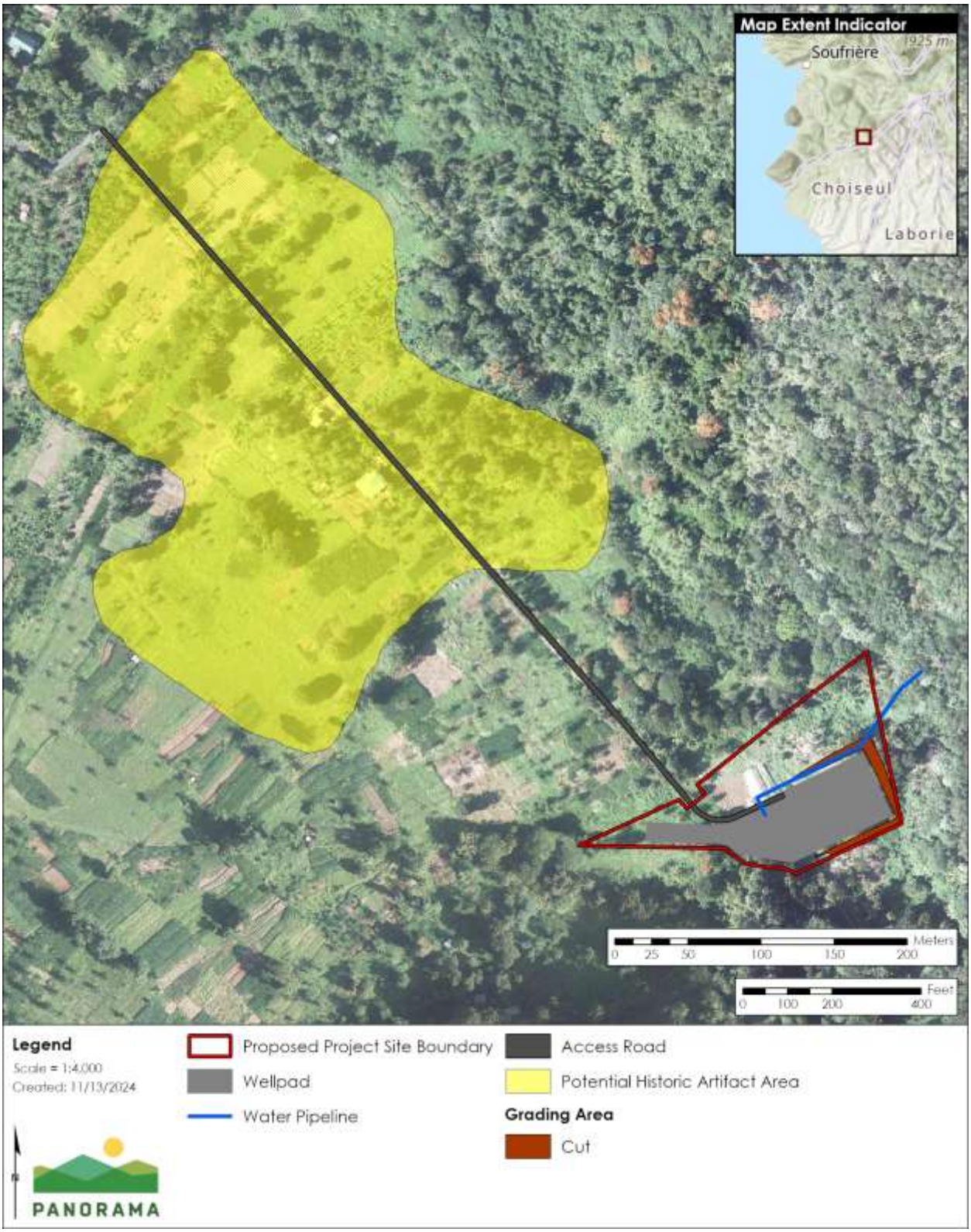
PANORAMA

Sources:

Figure 4.2-4 and Figure 4.2-5. A portion of Gros Piton is also visible from the well pad and a portion of the access road as shown on Figure 4.2-6. There are no scenic vistas or viewpoints in proximity to the project area in Belle Plaine. The drilling areas are only visible within the valley surrounding the potential drilling area due to the steep surrounding hillslopes and topography. The project area in Belle Plaine is not visible from any key viewpoints in the PMA referenced in the Limits of Acceptable Change Resort (The Landmark Practice, 2013).

Figure 4.2-3 Belle Plaine Historically Sensitive Areas



Sources: (ELC Electroconsult-SPA, 2024; Smith D. F., 2017; ELC Electroconsult-SPA and Theobalds Consulting, 2024)

Figure 4.2-4 View of Row Crops within Belle Plaine Well Pad Area

Figure 4.2-5 View of Agricultural Areas Adjacent the Belle Plaine Access Road

Figure 4.2-6 View of Gros Piton from Belle Plaine Area

4.2.8 Geohazard and Natural Disaster Vulnerability

Hurricanes and Tropical Storms

Saint Lucia faces a constant threat from hurricanes and other tropical storms; hurricanes have historically been the most common hazard to Saint Lucia (Government of Saint Lucia, 2006). Hurricanes are also the primary cause of widespread slope failure (Government of Saint Lucia, 2006). Recent climate change predictions indicate a future increase in hurricane activity and extreme rainfall events in the region, including an increase in associated landslide failure (Brian Lovelock, 2016). According to the World Bank, Saint Lucia has an average annual loss from hurricanes of US $9.5 million (0.7 percent of the GDP), and a probably maximum loss from hurricanes of US $382 million (27.2 percent of the GDP) over a 250-year return period (2016). Saint Lucia has a high vulnerability to impacts from hurricanes in all categories. Geothermal testing involves a very small volume of geothermal fluid production and does not affect overall subsurface pressure that could induce seismicity. Any reinjection of fluids during geothermal testing is not under pressure and would not induce seismicity.

Flooding Hazards

Flooding is a risk in Saint Lucia, particularly flooding associated with hurricanes and tropical depressions. The main areas at risk for flooding in Saint Lucia are narrow zones along river valleys and in the Soufrière Valley. The Global Facility for Disaster Reduction and Recovery produces a national flood hazard map for Saint Lucia, as part of the Caribbean Handbook on Risk Information Management project (2017). No flood hazard zones have been identified in the Belle Plaine project area.

Landslides

Numerous damaging landslides have been documented in Saint Lucia; the causes of the most significant landslides have been attributed to events including hurricanes, tropical storms, and poor farming practices (i.e., mass rainforest canopy removal). Research indicates that the majority of landslides in Saint Lucia are shallow failures of the soil mass at depths of 2 meters (7 feet) or less; the most common landslide types are debris flows; and earth flows, rockfalls, rock slides, and slumps also occur, but are less frequent (Brian Lovelock, 2016). Most slumps and rotational failures observed are associated with disturbed slopes such as road cuts or unplanned housing developments involving construction, earthworks, and vegetation changes (The University of the West Indies, 2017). Roads in Saint Lucia are often susceptible to new slumps and slope failures due to redirected or inadequate drainage, exposed soils, over steepened cut slopes, and/or the removal of support at the toe of slopes (Brian Lovelock, 2016).

The Saltibus well pad is located at the edge of the Belle Plaine valley. The well pad is in a flat to moderately sloped area with low land slide susceptibility. The hill slopes to the east and south of the well pad have a high landslide susceptibility as shown in Figure 4.2-7.

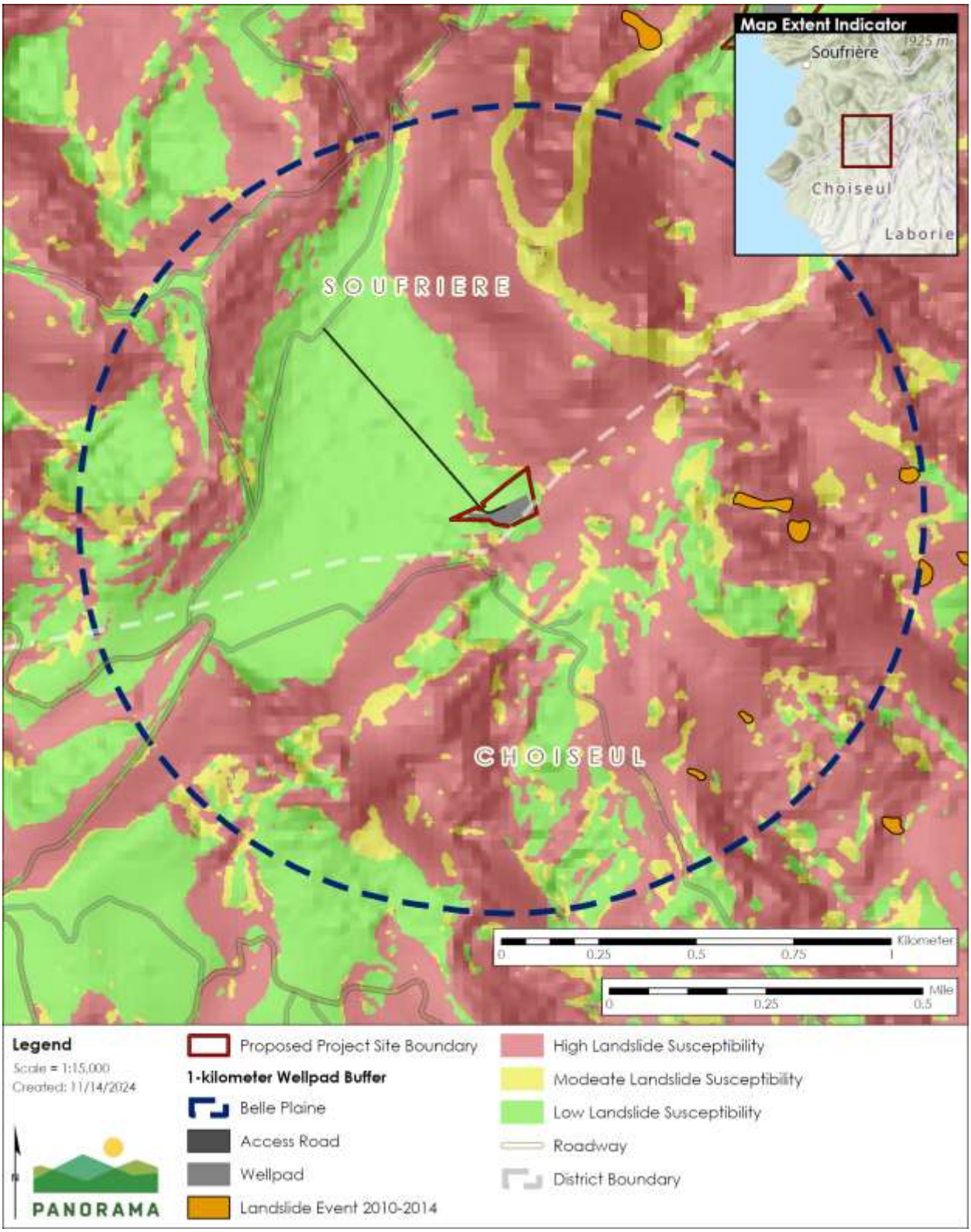
Seismicity and Earthquakes

There are no known active faults within the project drilling areas, and there is a relatively low potential for major earthquakes to cause substantial damage in Saint Lucia. According to the World Bank, Saint Lucia has an annual average loss from earthquakes of US $2.6 million (0.2 percent of the GDP), and a probably maximum loss from earthquakes of US $148 million (10.5 percent of the GDP) over a 250-year return period (2016). These values are less than half of those estimated for loss from hurricanes. Saint Lucia is considered to have a moderate vulnerability to impacts from seismicity and earthquakes in all categories.

Volcanic Eruptions

Approximately one third of Saint Lucia is within a moderate, high, or very high volcanic hazard zone identified on volcanic hazard maps used by the GoSL (Jan Lindsay, 2002). The well pad area at Belle Plaine is in a 'very high hazard zone.'

Figure 4.2-7 Belle Plaine Landslide Susceptibility



Source: (ESRI, 2024; ESRI, 2024; World Bank Group (WBG), European Space Agency (ESA), 2016; Westen, 2016)

4.3 Social Conditions

4.3.1 Population and Affected Communities

The population directly affected by the project consists of the individual land owners and tenants using the access road and area within the well pad at Belle Plaine. 10 individuals completed a census for this ESIA. The individuals who contributed to the census are in the agricultural industry and one individual is a pensioner. Of the 10 individuals surveyed, nine own their dwelling units and one rents.

According to the most recent data from the 2022 census, Saint Lucia experienced an overall household population increase of 3.9 percent between the 2020 and 2022 census periods (Government of Saint Lucia, 2022). This growth, however, was not evenly distributed across the island, as regional population trends varied significantly. The community potentially impacted by the project is concentrated within the district of Soufrière. In Soufrière, the population declined from 5.1 percent to 4.8 percent, signaling potential socio-economic challenges such as migration due to limited job opportunities or declining agricultural productivity.

At the community level, Belle Plaine saw population growth of 2 percent. The increase may be linked to emerging economic activities in the area. The 2022 population estimate for the Belle Plaine area includes 41 households with 49 female and 54 male individuals for a total population size of 103 individuals (Government of Saint Lucia, 2022).

4.3.2 Gender

Poverty

OECS countries are categorized as having a high human development, however, they experience a poverty rate fluctuating between 18 percent and 38 percent, are in financial debt and have low economic growth (Gandini, 2013). The incidence of poverty is slightly higher among men (29 percent) than among women (25 percent), while that among female-headed households (21.2 percent) is about the same as among male-headed households (22 percent). According to 2010 census data, 41% of households are headed by men and 27% by women. Households with single parents, both female and male, and with three generations are particularly at risk of being poor (Ranjitsingh, 2016).

Education

Women are less likely than men to have no formal education completed (17 percent versus 15 percent) and are more likely than men to have a diplomate/certificate or degree although levels of higher education generally remain low with the total percentage of the population achieving post-secondary or higher education at 13.6 percent of the population. At all education levels, female mean earnings are below male mean earnings, with the largest gap found among those with a school-leaving certificate, followed by those with a university degree (Budlender, 2012). This suggests that women are not getting the same monetary return to further education as men. Male enrolment slightly surpassed female enrolment in 2022/2023. Gender disparities in

educational performance are also evident, with females generally outperforming males across various subjects.

Health

Low maternal mortality, high percentages of prenatal care and of births attended by skilled staff is characterizing the whole sub-region, with St. Lucia reported to have maternal, childcare, and reproductive health services at all health centers (Gandini, 2013). Despite these advancements, teenage pregnancy is a major concern and has consequences both for mother and child's health. HIV/AIDS is one of the most urgent health concerns in the region, affecting both men and women's health. Although the Caribbean has had a steep decline in new infections since 2001, the region is still highly affected by the epidemic. Women aged 15 to 24 are three to six times more likely to contract HIV/AIDs than young men, as a result of poverty and gender roles and practices (Gandini, 2013).

Participation in the Labor Market

The employment rate for population aged 15-plus years unemployment rates between men and women are relatively equal. Table 4.3-1 includes employment rates by gender and age group based on the 2022 Census.

Table 4.3-1: Employment Rate by Gender and Age Group

Age	Unemployment Rate	
	Men	Women
15-19	49.5	52.2
20-24	25.0	22.5
25-29	16.0	15.0
30-34	11.5	11.2
35-39	8.8	9.3
40-44	8.0	7.2
45-49	5.9	6.9
50-54	5.8	6.8
55-59	5.7	6.5
60-64	5.6	4.2
65 and over	5.3	3.3
Total	11.9	11.8

Source: (Central Statistics Office of Saint Lucia, 2022)

Decision-Making Spaces

Participation in decision-making spaces is deeply entrenched in gender norms, with men holding the majority of public and private decision-making positions. In the last few decades,

Latin America and the Caribbean have progressed toward women in high governmental positions. St. Lucia has had considerable change in increase women's parliamentary participation, from 0 percent in 1990 to 2 women out of 18 ministers in the House of Assembly (11.1 percent) and 5 women out of 11 Senators (45.5 percent) (IPU Parline, 2024).

Gender-Based Violence

The legal framework that protects women and girls from gender-based violence includes the Constitution, Acts of Parliament, and rules from Common Law. Some acts of violence that cause physical harm constitute a criminal violation (for example, assault, wounding) and can be prosecuted under both the Criminal Code and Common Law. Saint Lucia adopted the Domestic Violence Act in March 2022, which prohibits acts of domestic violence and defines protections for victims. However, gender-based violence is deeply embedded in social norms, traditional roles, and cultural values in the Eastern Caribbean. Men that follow the traditional role of being a man are more likely to engage in partner abuse or sexual coercion, and women who subscribe to the traditional role of femininity are more likely to accept abuse (Gandini, 2013). Violence and abuses are increasing among the sub-region with 40 to 50% of women experiencing some form of domestic violence; which is more likely perpetrated by persons close to them (Gandini, 2013). Incidents of gender-based violence increased during the mandatory COVID-19 shutdown in Saint Lucia. "NGOs reported an increase in domestic violence complaints. Through October 2020, NGOs reported forty-seven (47) cases of gender-based violence, of which only three (3) were taken to trial and the remaining cases were awaiting processing, being stuck in a slow judicial system" (Organization of American States, 2024). Raise Your Voice Saint Lucia provides safe-house accommodation assistance and financial support to women who are victims of gender-based violence and provided support to 450 women and 126 children in 2024.

4.3.3 Employment, Livelihoods, and Income

Saint Lucia's economy and livelihoods are driven by three key sectors: tourism, construction, and agriculture. Tourism remains the largest contributor to the country's economic activity, with notable concentrations of tourism-related businesses in the northern (Gros Islet) and southern (Soufrière) regions. In 2023, the tourism sector accounted for approximately 13 percent of GDP, a significant rise from 8 percent in 2016. This growth can be attributed to continued investment in infrastructure, new hotel developments, and an increase in international arrivals.

Conversely, the agriculture sector has seen a continued decline, now contributing only 2.1 percent of GDP in 2023. The sector faced significant challenges in 2023, witnessing a sharp decline of 17 percent, largely due to damage by Tropical Storm Bret and financial constraints experienced by farmers. Banana production, once a staple export crop, experienced a dramatic decline, with output dropping by 45 percent. Despite efforts made to revitalise cocoa production, particularly in Soufrière, a reduction in external sales was experienced mainly due to higher input costs and reduced productivity.

The construction sector continues to be a significant driver of employment, particularly through public and private investments in infrastructure. Major hotel projects, road improvements, and airport expansions have provided vital job opportunities, especially in the central and southern

districts. This sector's growth has also contributed to a rise in household incomes, as these large-scale projects create employment across various skill levels.

In Soufrière, which includes Belle Plaine, the primary economic activities are agriculture, tourism, and small-scale retail. Agriculture remains significant, with crops such as bananas, vegetables, dasheen and other root crops being grown. However, the tourism industry, boosted by Soufrière's proximity to the Pitons and other natural attractions, plays an increasingly prominent role. Many residents are employed in tourism-related services such as hotels, tour operations, and restaurants.

Over the past five to six years, Saint Lucia's socio-economic landscape has evolved significantly, reflecting both growth and ongoing challenges. According to the Economic and Social Review 2023 (Government of Saint Lucia, 2023) the country's labor market experienced notable improvement, driven by the expansion of key economic sectors. The overall employment rate increased by 6.7 percent, with growth largely stemming from wholesale and retail trade (17.7 percent) and administrative support services (8.5 percent). Accommodation and food services, tied closely to the tourism industry, accounted for 13.9 percent of total employment, underscoring tourism's critical role in the economy.

Despite these gains, unemployment remains a concern, although the national unemployment rate has dropped significantly from 16.5 percent in 2022 to 14.0 percent in 2023. This marks a steady improvement from the over 20 percent unemployment rate recorded in 2016. However, youth unemployment remains a critical issue, standing at 25.0 percent in 2023. Although down from previous years, youth unemployment remains 11 percentage points higher than the national average.

Table 4.3-2 below**Error! Reference source not found.** lists the results of a household employment survey conducted in 2024 for the Belle Plaine community. The findings of the sample survey are consistent with a similar survey conducted in 2017 for the project.

Table 4.3-2 Household Employment Rates of Belle Plaine Community

Household Respondents	Percent of Respondents
Full-time employment	38 %
Part-time employment	None reported
Self-employed	62 %
Unemployed	None reported
Total	**100 %**

The income levels in Soufrière are generally low, reflecting the challenges posed by the high unemployment rates. According to the 2022 Census, national unemployment was 11.9 precent whereas unemployment in Soufrière was 13.9 percent. Household incomes in these areas are further affected by limited access to high-paying employment opportunities, and the

dominance of informal and seasonal jobs. Incomes generated from agriculture are often supplemented by remittances from family members working abroad or in more urbanized parts of Saint Lucia.

Water resources in Saint Lucia continue to be vital for sustaining the country's domestic, commercial, and agricultural needs. The country's freshwater is primarily sourced from rivers and tributaries. Water is extracted through raw water intakes, treated in nearby communities, and then distributed for potable use. Refer to Section 4.2 for further details on water resources.

Climate change poses a significant threat to the availability of water resources, especially during periods of drought, which has affected agricultural production in recent years. The agriculture sector, which has seen a decline in productivity, is heavily dependent on consistent water supplies. As agricultural lands in regions like Soufrière shrink, access to reliable water resources remains essential for revitalizing crop and livestock production (Government of Saint Lucia, 2023). Furthermore, climate change impacts on both water resources and agricultural lands pose serious risks to sustainable development.

4.3.4 Education

Belle Plaine falls within the Soufriere Education District 8, which has a total of 8 primary and 1 secondary schools. The Fond St. Jacques Primary School and the Soufrière Comprehensive Secondary Schools serves the community of Belle Plaine. These schools are located approximately 3 and 8 kilometers (2 and 5 miles) from Belle Plaine, respectively.

The 2022 Census Report reveals that education levels in Soufrière mirror the broader trends observed across Saint Lucia, with a notable emphasis on primary and secondary education. In Soufrière, 32.5 percent of the population across its communities, have attained at least primary education. Secondary education remains the most common level of attainment across Soufrière. Additionally, a smaller proportion of the population advances to post-secondary or tertiary education, with qualifications such as associate degrees and bachelor's degrees making up about 5.9 percent and 3.6 percent of educational achievements, respectively.

Over the past five years, educational institutions have faced multiple challenges, including fluctuating enrolment rates, evolving student performance metrics, and infrastructure needs, especially in rural and economically vulnerable communities such as Soufrière. Primary education for the academic year 2022/23 has seen a 4.5 percent decline in enrolment across public schools compared to the previous year. Rural communities face shrinking school populations due to outmigration and limited economic opportunities. Public secondary education has also experienced fluctuating trends with enrolment declining by 0.9 percent in the 2022/23 academic year.

The educational distribution indicates a significant proportion of residents in Belle Plaine without formal education. The community has a lower representation of secondary and tertiary education qualifications compared to the national averages. The 2024 sample household survey revealed that 57 percent of the population attained their highest level of education at the

primary school level, while 27 percent achieved secondary education, and 10 percent pursued tertiary or university studies. These results are consistent with the 2017 survey findings and align with both regional and national trends.

4.3.5 Access to Services (Water, Electricity, Healthcare)

At the national level, Saint Lucia benefits from an extensive water supply network managed by WASCO. Water supply in rural areas is generally stable, but during the dry season, challenges such as water rationing and shortages are common.

In Soufrière, the majority of households have access to public piped water directly into their homes. According to the 2022 Census, about 87.8 percent of households in Saint Lucia have piped water into the dwelling, with Soufrière following this trend. In Soufrière, 82 percent of households are connected to a public piped water supply, while a smaller percentage rely on private catchment systems, springs, and rivers, which are more common in Belle Plaine. This access enhances the community's overall quality of life, reducing the burden of water scarcity.

Saint Lucia's electricity generation is predominantly handled by Saint Lucia Electricity Services Limited (LUCELEC). Electricity access is widespread, with most households connected to the public electricity grid. The 2022 Census data shows that 95.5 percent of households use electricity as their primary lighting source, either from public or private sources. The 2022 Census report suggests Belle Plaine has high levels of electricity access, consistent with broader trends observed in the region.

Nationally, access to healthcare in Saint Lucia is centred around district hospitals and smaller health centres in rural communities. For residents of Soufrière, healthcare services are provided primarily through health centres and clinics, with major treatments available at the St. Jude Hospital in Vieux Fort and Soufrière Hospital. Health centres and clinics are typically located within reasonable distance from residential areas. However, rural communities like Belle Plaine face challenges such as longer travel times to access major healthcare services, especially for emergency or specialized care.

4.3.6 Health and Disease

Saint Lucia faces several health challenges, and like much of the country, the communities within Soufrière (including Belle Plaine) are not immune to the impacts of various diseases. At a national level, Saint Lucia continues to combat both communicable and non-communicable diseases. Chronic diseases, including diabetes and hypertension, are of significant concern. National health statistics indicate that non-communicable of lifestyle-related diseases contribute substantially to the morbidity and mortality rates, affecting both urban and rural areas alike.

Moreover, infectious diseases, particularly those influenced by environmental factors, such as leptospirosis and vector-borne diseases like dengue fever, remain common in flood-prone areas. These areas, characterized by heavy rainfall and less developed drainage systems, provide favourable conditions for mosquito breeding, leading to periodic outbreaks of dengue fever especially during the rainy season.

The COVID-19 pandemic severely affected Saint Lucia, straining the healthcare system. While the national response to the pandemic included a series of lockdowns, social distancing, and vaccination efforts, rural communities like those in Soufrière faced unique challenges due to limited access to healthcare resources and the economic impact on tourism-dependent communities.

The Ministry of Health reported that for 2014, the infant mortality rate (annual infant deaths under 1 year old per every 1,000 live births) was down to 17 and the average life expectancy had decreased to 74.4 years. Excluding maternal and reproductive conditions, injuries, road accidents, and non-communicable diseases (e.g., hypertension, heart disease, and cancer) were the most common causes of illnesses and death in Saint Lucia. In 2013 and 2014, mortality due to non-communicable diseases accounted for 58 percent of premature deaths and 73 percent of total preventable deaths. In recent years, there has been a significant increase in the number of suicides in Saint Lucia. The majority of the cases are due to mental health illnesses or substance abuse problems such as alcohol and the use of illicit drugs (Saint Lucia, 2015).

The gradual rise in the numbers of persons testing positive for HIV or dying of AIDS is of great concern, although the disease is not yet a significant cause of illness and death in Saint Lucia. The annual HIV/AIDS surveillance report by the Ministry of Health for 2014 reveals that the number of cases per 100,000 persons of HIV infection is 35. The number of new cases of HIV infection stabilized between 2005 and 2010, increased again between 2011 and 2013, and fell slightly in 2014 compared to 2013. At the end of 2014, there were 674 persons living with HIV out of the total 1029 cases recorded on the national register; males accounted for 50 percent. The majority of diagnosed cases live in the north (e.g., Castries, Babonneau, and Gros Islet) where roughly 55 percent of the population resides. About 34 percent of persons living with HIV in Saint Lucia are enrolled under the Ministry of Health's treatment program. Rural communities are also at risk due to environmental factors. Given the susceptibility of these regions to landslides and flooding, diseases often linked to poor sanitation following natural disasters, pose additional health risks.

Mental health is an emerging issue within the rural community. Increased awareness and the provision of mental health services are critical as the community grapples with stress and anxiety, exacerbated by socio-economic challenges. The prevalence of obesity is rising, influenced by dietary habits and sedentary lifestyles.

Belle Plaine is located within the Soufrière health region 6 where Soufrière Hospital is the main primary care health facility serving the community of Belle Plaine. There are two other health centers in Soufrière that provide general services including visiting specialist and pharmacist services. The Etangs Health Centre is approximately 5 kilometers (3 miles) from Belle Plaine. The Soufrière Hospital currently functions as a polyclinic or non-hospital referral facility and is not equipped to provide a high level of acute care.

Secondary level medical care for the Belle Plaine community is available at Victoria and St. Jude Hospital, both of which are about 45 kilometers (28 miles) away.

Nationally, the government has undertaken efforts to improve health infrastructure, with a specific focus on projects like the reconstruction of St. Jude Hospital and upgrades to community health centres. The recent focus on improving regional healthcare facilities is essential for the project affected areas, as the transportation infrastructure in the country's rural communities can be limited, impacting the timely delivery of healthcare services.

4.3.7 Land Ownership and Housing

At the national level, housing and ownership trends have been significantly shaped by economic and infrastructural factors. Data from the Economic and Social Review 2023 highlights that the country has seen a continuous increase in house purchases, with a growth in the stock of loans for residential land and house acquisitions. Nationally, this is attributed to an increasing demand for both house and land purchases, contributing to a steady rise in credit for housing purposes. House purchases grew by 8.6 percent, and land purchases increased by 5.0 percent in 2023.

This growth in national housing acquisition extends to rural communities such as those in Soufrière. These areas have traditionally been more agricultural, but recent developments in infrastructure and rural housing programs have aimed to bridge the gap in housing disparities compared to urban areas.

In Soufrière's communities like Belle Plaine, many properties are still held under family or communal ownership, a tradition that limits individual land sales but fosters community-based housing solutions. In these areas, ownership tends to follow generational patterns, and the rural population faces unique challenges in accessing financing for formal house purchases. Government policies under the National Housing Assistance Programme have been implemented to provide improved housing solutions for vulnerable communities across the region.

Belle Plaine's respondents reported 80 percent of family-land used for farming. In the Belle Plaine community cluster, members of a family comprising many siblings declared ownership of over 80 hectares (200 acres) of land, which is currently being used to grow a variety of crops for sale. These lands have already been sub-divided and titles are currently being prepared.

The predominant building materials for dwellings in Belle Plaine include concrete blocks, with many homes constructed post-2000. The community's housing primarily consists of concrete and wood, with a mix of traditional and modern styles.

4.4 PMA Values and Atrributes

Values and attributes of the PMA were defined consistent with *Guidance and Toolkit for Impact Assessments in a World Heritage Context* (UNESCO, ICCROM, ICOMOS, IUCN, 2022):

> *"The Statement of Outstanding Universal Value includes a description of the values and attributes of the World Heritage property for which it was inscribed on the World Heritage List.*

The OUV, including its authenticity and integrity, must continue to remain protected for any property on the World Heritage List. These concepts are important for carrying out impact assessment in a World Heritage context.

Values are what makes a heritage place special, and a particular combination of heritage/conservation values will explain why one specific place is of particular importance. In the case of a World Heritage property, the value that is considered to be 'of importance for present and future generations of all humanity' is its OUV (see Box 3.3 for an example). A World Heritage property may also have other heritage/conservation values that need to be considered in impact assessment, for instance, those that underpin national and local heritage designations, and/or the values held by of Indigenous peoples and associated communities. These may be formally designated or informally recognized.

Attributes are the elements of a heritage place that convey its values and makes them understandable. They can be physical qualities, relating to the material fabric and other tangible features, but can also be intangible aspects such as processes, social arrangements or cultural practices, as well as associations and relationships which are reflected in physical elements of the property."

The values and attributes of the PMA include (World Heritage Committee, 2004):

- The high biodiversity value provided by the Pitons, where a combination of slope, climate and soil regimes support significant plant and wildlife populations including endemic and rare species such as the Amazona Versicolour which is usually sighted within areas of the PMA.
- The reefs found within the coastal portion of the Pitons are among the healthiest and most diverse in St. Lucia.
- Due to physical isolation, the Soufriere region has been little affected by mainstream economic and social change that has transformed many other parts of Saint Lucia.
- Due to the striking landscape provided by the geological features of the area, the Soufriere community benefits from the ability of the area to attract visitors from far and wide. The natural heritage, and more specifically the Pitons, Sulphur Springs, rain forest, coral reefs, botanic gardens and waterfalls, have been touted as the key attractions for the average tourist visitor to Soufriere, which provides economic benefits for the state and livelihood of its citizens.
- The area in and around the Pitons, including the Sulphur Springs, continues to be of significant cultural and symbolic value to Saint Lucia, featuring most prominently as a national symbol on advertising and promotional materials.
- Sulfur Springs is the world's only drive-in volcano"
- The Pitons are unique in terms of providing an outstanding coastal vista and as the world's only example of closely paired, coastal volcanic cumulo-domes.

4.5 Cumulative Development

Cumulative projects within 2 kilometers of the project were obtained from the Saint Lucia Development Control Authority (DCA) in November 2024. Cumulative projects are listed in Table 4.5-1

Table 4.5-1 Cumulative Projects within 2 Kilometers

Application Number	Block and Parcel	Development Type
662/09	0627B 43	Small Sub
7/16	0627B 53	Commercial Storage
1070/23	0627B 62	Small Sub
136/08	0427B 79	Resd. Renovations -
416/03	0427B 74	Residential
797/03	0427B 3	Liquor Licence
158/04	0427B 3	Residential
709/04	0427B 80	Residential
1122/04	0427B 97	Small subdivision
1328/04	0427B 92	Residential
56/05	0427B 164	small subdivision
963/05	0427B 28	Residential Re Approval-
695/06	0427B 77	Liquor Licence
880/06	0427B 74	Residential
1304/07	0427B 74	Small Subdivision
460/08	0427B 20	Residential
643/09	0427B 15	Residential
186/10	0427B 34	Residential
1246/10	0427B 165	Residential
63/11	0427B 123	Small Sub
597/11	0427B 35	Residential
931/11	0427B 123	Small Sub. Ext.
309/12	0427B 31	Residential
439/13	0427B 67	Residential
1079/13	0427B 19	Residential

Application Number	Block and Parcel	Development Type
1002/16	0427B 18	Residential
49/17	0427B 172	Small Sub
551/17	0427B 174	Residential
766/17	0427B 29	Residential
707/18	0427B 125	Sign
57/19	0427B 35	Residential
184/19	0427B 154	Residential
307/19	0427B 62	Residential
790/19	0427B 357	Small Sub
170/20	0427B 14	Residential
522/20	0427B 62	Residential
589/20	0427B 202	Residential
363/21	0427B 175	Small Sub
421/21	0427B 155	Small Sub
426/21	0427B 75	Residential
74/22	0427B 59	Residential Ext.
730/22	0427B 15	Residential
733/22	0427B 205	Residential
398/23	0427B 36	Residential
547/23	0427B 197	Small Sub
1015/23	0427B 213	Residential
220/24	0427B 29	Residential
780/24	0427B 68	Residential
636/03	0429B 62	Small Sub
651/03	0429B 315	Small Sub
873/03	0429B 67	Small Sub
473/02	0429B 57	Residential
386/03	0429B 66	Small Sub
636/03	0429B 62	Small Sub

Application Number	Block and Parcel	Development Type
651/03	0429B 315	Small Sub
843/03	0429B 67	Commercial
873 /03	0429B 67	Small Sub
1082/03	0429B 198	Small Sub
1096/03	0429B 218	Residential
269/04	0429B 248	Small Sub
601/04	0429B 155	Small Sub
1121/04	0429B 54	Small Sub
1289/04	0429B 2	Small Sub
62/05	0429B 253	Residential
105/05	0429B 237	Small Sub
203/05	0429B 239	Residential
245/05	0429B 254	Small Sub
246/05	0429D 245	Small Sub
1002/05	0429B ?	Small Sub
1138/05	0429B 209	Small Sub
1139/05	0429B 254	Commercial
1175/05	0429B 13	Small Sub
175/06	0429B 254	Small Sub
1430/06	0429B 126	Small Sub
515/07	0429B 252	Residential
600/07	0429B 168	Residential
680/07	0429B 43	Residential
1355/07	0429B 27	Small Sub
336/08	0429B 233	Residential
580/08	0429B 278	Small Sub
252/09	0429B 279	Residential
650/09	0429B 226	Residential
873/09	0429B 291	Residential

Application Number	Block and Parcel	Development Type
885/09	0429B 22	Residential
1037/09	0429B 282	Small Sub
1348/09	0429B 281	Residential
151/10	0429B 25	Residential
269/10	0429B 269	Residential
1190/10	0429B 223	Small Sub
344/11	0429B 223	Residential
388/11	0429B 290	Residential
394/11	0429B 276	Small Sub
463/11	0429B 127	Large Sub
523/11	0429B 294	Residential
640/11	0429B 127	Residential
641/11	0429B 127	Commercial
1205/11	0429B 227	Residential Extension
1223/11	0429B 29	Small Sub
148/13	0429B 226	Residential Reapproval
284/13	0429B 7	Residential
421/13	0429B 279	Residential
566/13	0429B 246	Residential
754/13	0429B 233	Commercial Extension
178/14	0429B 317	Residential
421/14	0429B 288	Small Sub
638/14	0429B 37	Small Sub
912/14	0429B 316	Residential
99/15	0429B 349	Small Sub
131/15	0429B 199	Small Sub
416/15	0429B 55	Small Sub
517/15	0429B 288	Residential
619/15	0429B 288	Small Sub

Application Number	Block and Parcel	Development Type
690/15	0429B 96	Small Sub
701/15	0429B 204	Residential
773/15	0429B 40	Small Sub
812/15	0429B 34	SMALL SUB
820/15	0429B 304	Residential
1152/15	0429B 356 & 113	Residential
773/15	0429B 40	Small Sub
265/16	0429B 362	Residential
365/17	1446B 266	Small Sub
441/17	0429B 360	Small Sub
685/17	0429B 188	Residential
849/17	0429B 344	Small Sub
179/18	0429B 295	Small Sub
234/18	0429B 373	Small Sub
463/18	0429B 217	Liquor Licence
601/18	0429B 343	Residential
618/18	0429B 196	Tent (Temporary)
994/18	0429D 262	Residential
1062/18	0429B 210	Liquor License
206/19	0429B 374	Large Sub
538/19	0429B 26	Residential
729/19	0429B 385	Residential
951/19	0429B 156	Small Sub
8/20	0429B 271	Liquor License
431/20	0429B 65	Small Sub
734/20	0429B 388	Small Sub
989/20	0429B 346	Small Sub
997/20	0429B 259	Residential
21/21	0429B 256	Large Sub

Application Number	Block and Parcel	Development Type
553/21	0429B 367	Residential
600/21	0429B 356, 393	Residential
1134/21	0429B 41	Small Sub
486/22	0429B 362	Small Sub
501/22	0429B 405	Small Sub
721/22	0429B 272	Residential
802/22	0429B 397	Small Sub
86/23	0429B 44	Small Sub
480/23	0429B 421	Small Sub
999/23	0429B 371	Small Sub
1036/23	04298B 417	Residential
1039/23	0429B 165	Small Sub
0143/24	0429B419	Small Sub
0294/24	0429B247	Residential
0441/24	0429B355	Small Sub
0671/24	0429B168	Residential
0676/24	0429B165	Small Sub

4.6 Data Gaps

Data on flow rates from the spring at Belle Plaine does not currently exist. The data will be collected during construction and measures are included in Section 6 to provide contingent water supply if needed.

5 Environmental and Social Risks and Impacts

5.1 Approach to Impact Analysis

World Bank OP 4.01 requires that an ESIA "identifies ways of…preventing, minimizing, mitigating, or compensating for adverse environmental impacts and enhancing positive impacts; and includes the process of mitigating and managing adverse environmental impacts throughout project implementation."

The primary purpose of an ESIA is to predict the impacts resulting from a project and identify measures to avoid, reduce, or compensate for adverse impacts. Impacts can be direct, indirect, or induced, as defined in Table 5.1-1.

Table 5.1-1 Types of Impacts

Type of Impact	Definition
Direct	Impacts that result from a direct interaction between the project and a resource/receptor (e.g., between disturbance of a plot of land and the habitats on that plot of land that are affected).
Indirect	Impacts that follow from the direct interactions between the project and its environment as a result of subsequent interactions within the environment (e.g., impacts on bird population levels as a result of construction noise impacts on bird breeding behavior).
Induced	Impacts that result from other activities (which are not part of the project) that happen as a consequence of the project (e.g., increased spending in the local economy due to increased worker employment).

5.1.1 Step 1: Predict Impacts

Potential project impacts are predicted and quantified to the extent possible. The magnitude of impacts on resources (e.g., water and air) or receptors (e.g., people, communities, wildlife species, habitats) is defined. Magnitude is a function of the following impact characteristics:

- Type of impact (i.e., direct, indirect, induced)
- Magnitude including the size, scale, or intensity of impact
- Nature of the change compared to baseline conditions (i.e., what is affected and how)
- Geographical extent and distribution (e.g., local, regional, international)
- Duration and/or frequency (e.g., temporary, short-term, long-term, permanent)
- Reversibility of the impact (e.g., ability to restore the resource that is affected and avoid long-term or permanent impacts)

Magnitude describes the actual change that is predicted to occur in the resource or receptor. The magnitude of an impact takes into account all the various impact characteristics in order to determine whether an impact is negligible or significant. Some impacts can result in changes to the environment that may be immeasurable, undetectable, or within the range of normal natural variation. Such changes can be regarded as essentially having no impact and are characterized as having a negligible magnitude. In determining the magnitude of impacts on resources and receptors, embedded controls (i.e., physical or procedural controls that are incorporated into the proposed project) are taken into consideration. For example, the magnitude of impacts on stream water quality from ground disturbance take into consideration the effectiveness of proposed sediment and erosion control measures that would be applied during construction.

In addition to characterizing the magnitude of impact, the sensitivity of the impacted resource or receptor is characterized by its sensitivity to change, vulnerability, importance, and quality, as applicable. Resource sensitivity includes local, national, and international scale considerations, such as abundance or scarcity of a physical resource, as well as sensitivity to the specific project activities that are proposed. Human receptor vulnerability is also considered. Resource and receptor sensitivity are designated as low, medium, or high.

5.1.2 Step 2: Evaluate Impacts

The significance of a potential project impact is evaluated by considering the magnitude of the impact in combination with the sensitivity/vulnerability/importance of the impacted resource or receptor. The assignment of a significance rating facilitates decision-makers and stakeholders to understand how much weight should be given to the issue in their process. In the case of beneficial impacts, the significance is assigned as positive or beneficial.

Significance was assigned for each impact using the matrix shown in Table 5.1-2. This matrix applies universally to all resources or receptors.

Table 5.1-2 Risk and Impact Significance Matrix

Risk and Impact Magnitude	Resource or Receptor Sensitivity [a]			
	Very Low	**Low**	**Moderate**	**High**
Very Low	Negligible Impact	Negligible Impact	Negligible Impact	Negligible Impact
Low	Negligible Impact	Negligible Impact	Less than Significant Impact	Potentially Significant Impact
Moderate	Negligible Impact	Less than Significant Impact	Potentially Significant Impact	Significant Impact
High	Less than Significant Impact	Potentially Significant Impact	Significant Impact	Significant Impact

Note:

[a] Resource or receptor sensitivity collectively refers to characteristics including sensitivity to change, vulnerability, importance, and quality, as applicable.

The levels of impacts are defined using the following terms:

- **Negligible Impact.** A negligible impact is one where a resource or receptor (including people) would not be affected by a particular activity, or the predicted effect is deemed to be imperceptible or is indistinguishable from natural background variations.
- **Less than Significant Impact.** A less than significant impact is a minor impact is where a resource or receptor would experience a noticeable effect, but the impact magnitude is sufficiently low (with or without mitigation) and/or the resource or receptor is of low sensitivity. In either case, a less than significant impact must be sufficiently below applicable standard threshold limits.
- **Potentially Significant Impact.** A potentially significant impact is a moderate impact that meets applicable standards but comes near the threshold limit. The emphasis for such moderate impacts is to demonstrate that the impact has been reduced to a level that is as minor as reasonably practicable so that the impact does not exceed standard threshold limits and become significant.
- **Significant Impact.** A significant impact is one where an applicable standard threshold limit would or could be exceeded, or if a highly valued or very scarce resource would be substantially affected.

In addition to the risks and adverse effects, the proposed project may include positive effects. Some of the positive effects from the proposed project are described in the impact evaluation, such as the potential for generating temporary jobs during exploration activities; however, the impact evaluation primarily focuses on the adverse impacts.

5.1.3 Step 3: Evaluate Mitigation

After predicting and evaluating the impacts, the ESIA process involves evaluating mitigation measures that could be implemented to avoid, reduce, or compensate for the impacts, as necessary and to the extent reasonably feasible. A mitigation hierarchy from the World Bank Environmental and Social Framework was used in which preference is always given to avoid or minimize the impact before considering other types of mitigation (i.e., observe, remedy, compensate, offset). The hierarchy of mitigation measures includes:

1. **Anticipate and Avoid Impacts.** Remove the source of the impact (i.e., avoid the specific action or resource area).
2. **Minimize Impacts.** If the impact cannot be avoided completely, the impact should be reduced to the extent feasible to ensure minimal damage to the environment (e.g., changes in project layout or design to reduce impacts)..
3. **Rectification of Impacts.** Rectification of an impact implies that an impact will happen and can only be managed by enhancement, restoration, or revegetation of degraded or former habitat, etc. In a way, rectification tries to correct the mistake

that led to the adverse environmental impact. This is a mitigation strategy that applies generally during the construction stage.

4. **Compensate or Offset Impacts.** Where significant residual impacts would remain after exhausting avoidance, minimization, and rectification options, provide compensation or offsets for the impact, where technically and financially feasible. Compensation and offset impacts would include compensation paid for loss of livelihood or resettlement.

5.1.4 Step 4: Evaluate Residual Impacts

Residual impacts are the impacts that are predicted to remain after mitigation has been implemented based on the effective outcomes, including compensation and offset impacts. The significance of residual impacts are rated in the same way as impacts before mitigation (e.g., less than significant, potentially significant, and significant), but includes assumptions on how mitigation would reduce the impact magnitude or otherwise address sensitivity characteristics, thereby reducing its overall significance.

5.2 Environmental Risks and Impacts

5.2.1 Water Resources

Sensitive Resources

The natural landscape and agricultural areas surrounding the well pad would be sensitive to degradation from water quality impacts. The spring that would be used for drilling water supply was previously used for agricultural water supply. The spring currently discharges partially to a water storage tank and partially flows overland in the direction of the well pad. The primary source of water for agricultural production in the Belle Plaine valley is shallow groundwater and rainwater. The spring that would be used for the drilling water supply is located near the well pad.

Potential Risks/Impacts and Magnitude

The area of influence for water resources includes the watershed that the project is located within including downstream waters/tributaries of the project site.

Water Quality

Civil Works

The project would involve construction of an improved and expanded access road, and construction of a well pad. Grading and vegetation clearing activities during the civil works phase of the project could destabilize soil and result in erosion or sedimentation during rain events. Erosion and sedimentation that reaches the drainage network has the potential to degrade surface water quality. Grading would also result in localized changes in runoff patterns. Drainage would be directed around the well pad as indicated on Figure 3.3-2 and roadside drainage would be improved to include a drainage ditch along either side of the

expanded roadway. The redirected drainage would prevent stormwater run on to the well pad but would concentrate flows in the newly constructed drainage channels.

Sanitary waste would be generated by workers during civil works and drilling and testing phases. A mobile latrine would be housed on the well pad. The mobile worker latrine would need to be serviced regularly to manage worker sanitary waste and associated water quality impacts.

Well Drilling and Testing Fluids

During the drilling process drilling mud would be discharged to the mud pond on the well pad. Fluids would be recycled to the extent feasible in the drilling process; however, some fluid would remain. The mud pond would be lined and would be covered to prevent stormwater overflow of the mud pond. The well will be drilled with water and non-toxic drilling mud. Most of materials used in drilling fluids are not harmful for the environment, with the exception of caustic soda which is used in small quantities and lignosulphonate which is used in the chrome free product variation for environmental protection. During geothermal testing, any produced geothermal brine would be temporarily discharged to the mud pond and water pond.

Both the drilling mud and geothermal fluids produced during testing could contain high levels of the following heavy metals and radiological elements, which commonly occur in geothermal resources:

- Arsenic
- Boron
- Cadmium
- Chromium
- Nickel
- Mercury
- Zinc
- Uranium
- Radium
- Gross alpha and beta

Any fluids remaining from the drilling and produced geothermal fluids would be reinjected into the well if feasible or fluids would be allowed to evaporate if the well does not have sufficient permeability to allow for reinjection.

If the mud pond or water storage pond were improperly constructed or maintained or sufficient free board was not maintained within the mud pond or water storage pond, fluids in the ponds could discharge to groundwater or flow into the drainage network, which could degrade water quality downstream from the well pad.

The geothermal well would be cased within concrete and the geothermal piping. The well would use slotted pipe at depth (approximately 1,500 meters) to allow for interaction with the geothermal resource. The remainder of the well above the slotted pipe would be cased to ensure proper function of the well and avoid any contact with groundwater. As a result, the geothermal resource in the well would be isolated from any groundwater resources in the area and would not cause groundwater contamination.

There is a risk that the geothermal drilling and testing operations could result in a release of geothermal fluids to surface waters. While unlikely, a well blowout could result in an uncontained discharge of geothermal fluids that could flow to surface water. Well blowouts are typically caused by improper well construction or lack of BOP equipment. Well BOP equipment will be installed on the well as described in the Project Description.

Civil Works and Well Drilling

Earth moving equipment (e.g., graders and dozers) and drill rigs require the use of oil, grease, hydraulic fluids, and other chemicals. An above ground storage tank would be housed on the well pad to supply fuel to the generators on the well pad. The above ground storage tank would be housed within secondary containment to reduce the risk of contamination. Leaking construction equipment, fuel storage tank, drill rigs, or improperly stored hazardous materials could result in a discharge of hazardous materials to nearby rivers during rain events. The transport of hazardous materials to waterways has the potential to degrade water quality downstream of the work area. Incidental leaks or spills of hazardous materials could also contaminate nearby waterways if the materials are not properly contained.

Restoration

Site restoration would involve earth moving activities to regrade the well pad to match pre-project conditions. The grading activities would have a potential to cause erosion prior to vegetation establishment. The equipment used during restoration would also require small quantities of hazardous materials (e.g., oil, grease, and hydraulic fluid).

Water Supply

Civil Works

The project would improve the existing spring water capture system in proximity to the well pad. The project would replace the existing pipeline from the spring to a water catchment/storage tank and would extend a water supply pipeline to the well pad. The civil works activities would not affect any water supply infrastructure outside of the area that the well pad and spring are located on. The spring currently supplies water to the area of the well pad and is not used for agricultural production or any other use. The improvements to the spring capture system would reduce the amount of spring runoff flowing to the ravine downslope of the well pad and could theoretically reduce flow at streams south of and at a distance from the well pad. No water intakes are located on the ravine downstream of the well pad. The nearest WASCO diversion is located on a creek in Delcer that does not receive runoff from the spring. As there is no current use of the spring runoff and the project would not affect flows to any WASCO water diversions or other water supply, the use of spring water would not have an impact on water supply in the area.

Water would be required for dust control during road and well pad construction. The volume of water required for dust control would be minimal and would be supplied from the spring on the project parcel. The use of water for dust control would not affect water supplies in the area.

Well Drilling

The project would require fresh water for drilling, worker needs (e.g., drinking, washing, and sanitation), and dust control. Drilling water would be extracted from the spring to the extent supplied by natural spring discharge and any additional water supply needs would be carried by truck to the well pad. The volume of water required during well drilling would vary depending on the subsurface conditions and rock/fracture permeability, which are currently unknown. Higher permeability rocks with numerous open fractures would require more water during drilling. The water requirements (4 to 11 l/s [63 to 175 gpm]) specified in Section 3.4.1 reflect the maximum potential water demand assuming highly permeable rock is encountered with high water losses. The volume of water required for well drilling could exceed the volume of water that is available from the local spring in which case water would be trucked to the site. Assuming the maximum water demand of 11 l/s (175 gpm), two water trucks per hour would be required to supply water for drilling. If water were transported by truck to the project site, water would be obtained from L'Ivrogne River where RESDP currently has a license to abstract water. The RESDP completed an analysis of the water abstraction that demonstrated there is sufficient water available to within the L'Ivrogne River to allow for temporary use of the water supply for the project without negative impacts on any other water users including any agricultural activities. The water demand for drilling would be temporary during the drilling process (2 to 3 months) and would not create a permanent demand for water supply. Water would be obtained from natural spring discharge, the use of water from the spring would not affect groundwater elevations within the area as the spring naturally discharges from the ground under existing conditions and the use of the discharge would not create any pressure on the aquifer.

Restoration

Water use would be limited during site restoration and would be used primarily for dust control.

Flooding

Civil Works and Well Drilling

The project area in Belle Plaine is not located within a 100-year flood plain. The minimal surface recontouring to construct the 0.5 hectare (1.3 acre) well pad would not measurably affect runoff volumes downstream. Drainage would be redirected around the well pad area, but due to the small size of the well pad would not concentrate flows in a manner that would cause flooding downstream.

Restoration

The project site would be returned to pre-existing contours and vegetation types during site restoration (with the exception of the concrete cellar). Soils would be de-compacted to allow for rainfall infiltration. Restoration of the site would have no impact on flood intensity off site.

Impact Significance and Mitigation

The significance of each impact on water resources and mitigation measures that would be applied are summarized Table 5.2-1.

Table 5.2-1 Summary of Potential Water Resource Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Water Quality	Sediment Discharge	High	Moderate	**Significant**	Water-1	Negligible to Less than Significant
	Drilling Effluent	High	Moderate	**Significant**	Water-2	Negligible
	Geothermal Fluid Discharge	High	High	**Significant**	Water-3 Water-4	Negligible to Less than Significant
	Hazardous Material Discharge	High	Moderate	**Significant**	Hazards-1	Negligible
	Groundwater Contamination	High	Moderate	**Significant**	Water-2 Water-3	Negligible
	Sanitary Waste	High	Moderate	**Significant**	Water-5	Negligible
Water Supply	Water Use (Dust Control and Spring Capture)	High	Very Low	Negligible	--	--
	Water Use (Well Drilling)	High	Moderate	**Significant**	Water-6	Less than Significant
Flooding	Well Pad Construction	Low	Low	Negligible	--	--

5.2.2 Air Quality

Sensitive Receptors

The Belle Plaine well pad is surrounded by agricultural and forested areas. Occupied residential dwellings are considered sensitive air quality receptors. Residences within 305 meters (1,000 feet) of the well pad are shown on Figure 4.2-2**Error! Reference source not found.**.

Potential Risks/Impacts and Magnitude

The area of influence for air quality includes areas within approximately 305 meters (1,000 feet) of the well pad due to the short-term nature of potential project emissions and dispersion of air emissions at distances greater than 305 meters (1,000 feet).

Equipment Emissions and Fugitive Dust

Civil Works and Well Drilling

Well pad construction would require leveling and compaction of the well pad to create a stable surface for the drill rig and all drilling materials. Construction of the improved access road would also require grading of the expanded access road and earthwork. Grading, earthwork,

and vegetation removal activities could generate fugitive dust. Travel over unpaved access roads during civil works and well drilling operations could also create fugitive dust, which could impact air quality and visibility. Fugitive dust could settle onto adjacent agricultural products or could cause visible dust plumes that would be noticeable to people living or working in the area.

Both the civil works and well drilling phases would require the use of heavy diesel-powered equipment. Two to five generators would be housed on the well pad during drilling activities. The equipment exhaust would result in emissions that would temporarily affect air quality in the immediate vicinity of the equipment. The duration of construction in a single area would be limited to approximately 3 months for civil works and 2 to 3 months for well drilling. Equipment emissions would dissipate rapidly in the atmosphere and would not result in a substantial increase in any air pollutant at sensitive receptors.

Restoration

The air quality effects of restoration would be similar to those of civil works but likely short in duration (less than two weeks) during site recontouring. Restoration activities would involve revegetation to stabilize the site to avoid long-term emissions of fugitive dust.

Geothermal Gas Emissions

Well drilling and flow testing could result in the release of geothermal steam if a geothermal resource is encountered. The geothermal emissions may include water vapor, carbon dioxide, and H_2S. Small amounts of boron, arsenic, mercury, and bicarbonate may be entrained in geothermal steam and emitted during drilling and testing. These gases occur naturally at the surface manifestations of the geothermal resource at Sulphur Springs.

Well flow testing would only occur if the geothermal resource was encountered. Flow testing would involve venting steam to the atmosphere and could emit H_2S, boron, arsenic, mercury, and bicarbonate. The geothermal resource is usually encountered at the latter phase of drilling—the last 10 to 15 days. H_2S is the constituent of primary concern in geothermal emissions because it can cause health effects at elevated levels. The H_2S concentration measured at Sulphur Springs is characteristic of the anticipated H_2S concentrations anticipated during venting of the geothermal resource. H_2S concentrations at Sulphur Springs were 29.24 $\mu g/m^3$ during air quality monitoring in September 2017 (refer to Appendix C). Local receptors within 100 meters (328 feet) may smell a "rotten egg" odor if H_2S is present in the steam.

It is not feasible at this stage of the project to conduct air dispersion modeling to predict H_2S levels at receptors because (1) the chemistry of the geothermal resource in the potential drilling areas is not known, and (2) there is no data on the wind speed and direction in the project area. The air quality at Sulphur Springs where the geothermal resource naturally vents to the atmosphere indicates that the project could produce H_2S concentrations in excess of WHO guidelines for annoyance. Any emissions from the geothermal drilling and testing, including a potential blowout, would disperse quickly in the atmosphere. The air quality risk from geothermal testing would be moderate due to quick dispersion rates, the short duration of

testing activities, and limited volume of fluid that could be produced due to the limited storage volume on the well pad. The temporary venting of geothermal steam during resource testing would not cause any adverse health effects and is not expected to exceed WHO H_2S thresholds for eye irritation.

Impact Significance and Mitigation

The significance of each impact on air quality resources and mitigation measures that would be applied are summarized in Table 5.2-2.

Table 5.2-2 Summary of Air Quality Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Residents and Workers	Fugitive Dust	Moderate	Low	**Less than Significant**	Air-1	Negligible
	Equipment Emissions	High	Low	**Less than Significant**	Air-2	Negligible
	Geothermal Gas Emissions	High	Moderate	**Significant**	Air-3 Water-4	Negligible to Less than Significant

5.2.3 Geology and Soils

Sensitive Resources

The well pad is located in an area that is subject to active agricultural use and contains row crops. Productive topsoil is important to agricultural production and topsoil is considered a highly sensitive resource to the community. The project is located in a valley with gradual slopes. No landslides or other hazard conditions are known to occur in the area.

Potential Risks/Impacts and Magnitude

The area of analysis for geology and soils includes the geologic and soil units underlying all areas of temporary and permanent ground disturbance.

Erosion and Topsoil Loss

Civil Works

Soil erosion is a severe environmental problem in Saint Lucia and affects the water supply and agricultural productivity. Well pad grading and vegetation clearing activities could cause soil erosion and loss of topsoil as well as reduction in soil productivity due to soil compaction. Gravel would be installed at the well pad and access roads, where necessary, to facilitate all weather access for vehicles and equipment. Substantial topsoil loss or soil compaction could affect agricultural land and crop production. Development of the well pad involves stripping and stockpiling of the topsoil adjacent to the well pad. The topsoil would then be reapplied to the site after well drilling and testing activities have been completed.

Well Drilling and Testing

Well drilling and testing activities would be conducted within the stabilized well pad. Well drilling and testing activities would not disturb nearby areas or cause loss of topsoil. Drainage would be directed around the well pad within a stabilized drainage channel during well drilling and testing. Due to the shallow slope of the well pad site the risk of topsoil loss during drilling and testing activities would be minimal.

Restoration

Restoration would involve recontouring of the site to pre-existing conditions and apply the stockpiled topsoil back to the recontoured site. All gravel and imported materials would be removed from the site and soils decompacted to allow for full site restoration. The area would be replanted or revegetated to provide long-term stabilization of the site and avoid loss of the reapplied topsoil.

Landslides, Mudflows, and Unstable Soil Conditions

Civil Works, Well Drilling, and Restoration

The well pad and access road within Belle Plaine are located within the valley on areas that are flat to gently sloped. The project area is not at risk of landslide, mudflows, or unstable soil conditions due to the gradual terrain in the area.

Seismicity

Well Drilling and Testing

There is no causal link between exploratory geothermal drilling and induced seismicity. The exploration drilling program would not exert pressure on a known fault system or induce seismicity.

Restoration

Restoration activities would have no effect on seismicity.

Impact Significance and Mitigation

The significance of each impact on geology and soil resources and mitigation measures that would be applied are summarized in Table 5.2-3.

Table 5.2-3 Summary of Geology and Soil Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Topsoil	Erosion (Civil Works)	High	Moderate	**Significant**	Water-1 Soils-1 Landscape-1	Negligible to Less than Significant
	Erosion (Well Drilling)	High	Very Low	Negligible	--	--

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Slope/Soil Stability	Destabilization Slopes/Soil (Civil Works)	Low	Low	Negligible	--	--
	Destabilization Slopes/Soil (Well Drilling)	Low	Low	Negligible	--	--
	Induced Seismicity (Well Drilling)	Moderate	--	Negligible	--	--

5.2.4 Noise

Sensitive Receptors

Noise sensitive land uses can include residential areas, schools, and places of worship. No schools or places of worship are located in proximity to the well pad. Two residences are located within 200 meters (660 feet) of the well pad and two residences are located along the access road to the well pad. Residents are typically most sensitive to noise at night, when noise can interfere with sleep. The noise sensitivity for receptors in proximity to the drilling sites is considered high because the project would involve drilling and testing activities 24 hours a day during the drilling and testing periods.

Potential Risks/Impacts and Magnitude

The area of influence for noise includes all sensitive receptors located within 400 meters of the well pad for consideration of nighttime noise during resource testing.

Civil Works

The project would temporarily generate noise during construction activities from the operation of motorized vehicles (e.g., trucks and bulldozers) and stationary equipment (e.g., generators, compressors, pumps, etc.). Civil works activities would occur during daytime hours. Typical noise levels from civil works activities are listed in

Table 5.2-4. Reference noise levels for typical noise sources are provided in Table 5.2-5 below to provide context for the noise that would be experienced.

Table 5.2-4 Typical Noise from the Proposed Activities

Activity	Predicted Noise Levels (dBA) at Distance [a]								
Meters	**5**	**10**	**20**	**50**	**100**	**200**	**400**	**800**	**1,700**
Civil Works[b]	86	80	74	68	62	56	50	44	--
Well Drilling (Mud Drilling)	80	74	68	62	56	50	44	--	--

Activity	Predicted Noise Levels (dBA) at Distance [a]								
Well Discharge Through Drum Silence	96	90	84	76	70	64	58	51.9	45.4

Note:

[a] Estimated noise levels are given for various distances from the noise-generating sources. These noise levels do not account for the topographical barriers, trees, vegetation, and manmade structures through the project area that would absorb or deflect sound waves, thereby reducing noise levels.

[b] Civil works noise reflects use of bull dozers, trucks, and other heavy equipment for grading of the well pad.

Sources: (Mannvit hf, 2013)

Table 5.2-5 Typical Noise Levels in the Environment

Common outdoor noise source	Noise level (dBA)	Common indoor noise source
	110 dBA	Rock band
Jet fly-over at 1,000 feet		
	100 dBA	
Gas lawn mower at 3 feet		
	90 dBA	
Diesel truck at 50 feet at 50 mph		Food blender at 3 feet
	80 dBA	Garbage disposal at 3 feet
Noisy urban area, daytime		
Gas lawn mower, 100 feet	**70 dBA**	Vacuum cleaner at 10 feet
Commercial area		Normal speech at 3 feet
Heavy traffic at 300 feet	**60 dBA**	
		Large business office
Quiet urban daytime	**50 dBA**	Dishwasher in next room
Quiet urban nighttime	**40 dBA**	Theater, large conference room
Quiet suburban nighttime		
	30 dBA	Library
Quiet rural nighttime		Bedroom at night, concert hall (background)
	20 dBA	
		Broadcast/recording studio
	10 dBA	
	0 dBA	

Source: Caltrans 2013

The noise level would change with distance from the source. Noise levels attenuate (decrease) at an average rate of approximately 6 dBA per doubling of distance from a source. Conversely, noise levels increase by approximately 6 dBA when distance is reduced by half. For example, if noise from a bulldozer is 80 dBA at a distance of 10 meters (33 feet), the adjusted noise level would be 74 dBA at 20 meters (66 feet) and 86 dBA at 5 meters (16 feet). The noise from access road improvements adjacent residents would be an increase from background levels. However,

the access road improvements would be limited in duration of the activity and would be conducted during daytime hours. Civil works from well pad construction would be at a distance of 200 meters or more from the nearest sensitive receptor. Because civil works activities would be temporary and limited to daytime hours, the temporary noise increase would be noticeable but less than significant.

Well Drilling

Well drilling would involve use of noise generating equipment including:

- Air compressors and boosters as part of the aerated drilling package (compressors and boosters creates continuous high noises when they are in use, especially bleeding of the compressed air causes higher level of noise for a short period of time)
- Mudpump engines (mechanical rigs)
- Drawworks engines and brakes (mechanical rigs)
- Topdrive hydraulic power units
- Cementing unit
- Daily work as rig up/rig down of equipment, pipes, etc. or run in hole or lay down of the drill string, casings, etc.
- Generators to supply power to the drill rig. Generators can be placed inside a sound enclosure but their exhaust will cause noise, also container doors shall be opened occasionally for good ventilation and airflow.

The well pad is located within an agricultural area, but there are some scattered residences to the south of the well pad. The World Bank's guidelines for noise in residential areas (refer to Section 0), when measured at the nearest sensitive receptor, are as follows:

- ≤ 55 dBA during daytime hours (7:00 and 22:00)
- ≤ 45 dBA during nighttime hours (22:00 and 7:00)
- ≤ 3 dBA increase above existing ambient levels (all periods)

The World Bank's guidelines are generally suited for permanent noise increases, such as noise from permanent facility or frequent operation activity. Infrequent and temporary construction noise typically exceeds these guidelines; however, the guidelines can indicate a potential noise impact for construction noise that is relatively long-term (more than a few weeks or months). All noise associated with the well drilling and testing phase would be temporary and limited to 2 to 3 months. The ambient noise levels at the well pad ranged from 36 to 60 dB during the daytime and 37 to 54 at nighttime. The average nighttime noise level was over 50 dB due to natural environmental noises (e.g., frogs, wind, rain).

The nearest residence to the Belle Plaine well pad is over 150 meters (500 feet) from the well pad. While the World Bank guidelines recommend a nighttime noise threshold of 45 dBA, the existing nighttime noise level at the well pad is 51 dB and an increase of 3 dB over baseline would be noticeable (> 54 dB). Nighttime drilling noise would be less than 54 dB at a distance of

150 meters (450 feet) and would not exceed 3 dB over baseline nighttime noise at the nearest receptor.

Well Testing

Well testing activities would produce noise if a geothermal resource were encountered. Production and venting of geothermal steam can produce noise levels up to 70 to 110 dB when a drum silencer is used (Mannvit hf, 2013). The timeframe for venting and production of the geothermal resource would be limited by the capacity of the on-site storage for brine at the water pond and mud pond including sufficient freeboard. The resource would be vented for less than a week and 24 hours a day. The noise from well testing/resource venting would exceed the 45 dB threshold for a distance of nearly 1,700 meters (5,600 feet) not accounting for topography, which would reduce or block noise. Because nighttime noise levels average 51 dB and were measured at up to 54 dB on the well pad, residents within 400 meters (1,300 feet) would experience nighttime noise levels during testing that are 3 dBA greater than ambient nighttime noise conditions. That distance would be reduced to 200 meters (660 feet) with installation of a sound barrier between the testing location and the receptors. The well testing activities could therefore disturb sleep for the residents located within 200 meters (660 feet) of the well pad after installation of a sound wall. The well testing activities could therefore disturb sleep for the residents located within 200 meters of the well pad. Testing activities would occur for a maximum of one week at the maximum noise level of 110 dB, if a high-pressure resource is encountered. Mitigation Measure Noise-2 requires coordination with the community members within 200 feet of testing activities and providing noise canceling devices to address noise during testing activities.

Restoration

Site recontouring and restoration activities would produce temporary noise from use of large equipment for re-grading the site, similar to the equipment that would be used for the civil works phase. Noise during restoration would be very short in duration. Restoration activities would take place during daytime hours. The noise impact would be similar to large truck noise or agricultural equipment noise, which is part of the ambient environment.

Impact Significance and Mitigation

The significance of each impact on noise sensitive receptors and mitigation measures that would be applied are summarized in Table 5.2-6.

Table 5.2-6 Summary of Noise Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Residences	Civil Works	Moderate	Low	**Less than Significant**	Noise-1	Less than Significant
	Well Drilling	Moderate day/ High night	Low	**Less than Significant**	Noise-1	Less than Significant

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
	Well Testing	Moderate day /High night	High	**Significant**	Noise-2	Less than Significant

5.2.5 Vibration

Sensitive Receptors

Vibrating objects in contact with the ground radiate energy through the ground. Vibratory motion is commonly described by identifying the peak particle velocity (PPV). At the highest levels of vibration, damage to structures is primarily architectural (e.g., loosening and cracking of plaster or stucco coatings) and rarely results in structural damage. For comparison, a freight train passing at 100 feet can cause vibrations of 0.1-in/sec PPV, while a strong earthquake can produce vibration in the range of 10-in/sec PPV. Structures in proximity to construction activities could experience plater or stucco damage from vibration in excess of PPV 0.5 cm/sec (0.2 in/sec).

Potential Risks/Impacts and Magnitude

The area of influence for vibration includes all structures within 10 meters of the well pad and access roads. A larger distance for pre-project surveys was applied due to an abundance of caution.

Civil Works

Use of heavy equipment (haul trucks) may cause periodic vibration that could be felt up to approximately 10 meters (30 feet) from the equipment depending on ground conditions. Vibration attenuates rapidly over distance, and any vibration would be temporary and short-term. Vibration from road construction could affect structures directly adjacent the construction area depending on the structural integrity.

Drilling

Drilling may also cause periodic vibration that could be felt up to approximately 10 meters (30 feet) from the drill rig depending on ground conditions. Vibration attenuates rapidly over distance, and any vibration would be temporary and short-term. Vibration is not expected to affect any structures due to the rapid attenuation of vibration with distance. Though no damage is expected as result of vibration caused by drilling, mitigation is included to monitor and ensure that any damage caused by the project would be repaired by the project.

Restoration

Use of heavy equipment (haul trucks) may cause periodic vibration that could be felt up to approximately 10 meters (30 feet) from the equipment depending on ground conditions. Reclamation would occur on the well pad site and no sensitive receptors occur within 10 meters of the well pad.

Table 5.2-7 Summary of Vibration Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Structures	Vibration (Civil Works/Well Drilling)	High	Low	**Significant**	Noise-4	Negligible

5.2.6 Natural Habitats and Biodiversity

Sensitive Resources

The project area consists of disturbed and agricultural production areas as well as forested areas. No natural habitat occurs within the project area. A portion of the well pad is within and directly adjacent forested areas There are no rare, endangered or protected species present on the well pad, but two endangered species and an IUCN vulnerable species Amazona verisolour, which is known from the PMA were observed in the forested areas surrounding the Belle Plain valley including the forested area along the margin of the well pad and within the area of the proposed pipeline. No endangered or vulnerable plant, mammal, lizard, reptile or insect species are known to occur in the well pad or access road areas. The sensitivity of biological resources within the well pad is low within areas containing existing row crops and farming on the majority of the land, and moderate on forested habitat along the margin and adjacent the well pad.

Potential Risks/Impacts and Magnitude

The area of influence for biological resources includes the areas of direct impact where vegetation and habitat would be removed temporarily or permanently and all areas within 100 meters that would be affected by noise during civil works activities.

Direct Impacts on Habitat and Species (Civil Works)

Access road grading and well pad construction would occur primarily in agricultural areas and disturbed areas. A small portion of the well pad contains forested areas that provide habitat for wildlife. Wildlife would tend to avoid areas of noise and human activity. No rare plants occur on the well pad.

Indirect Impacts on Habitat and Species (Civil Works and Well Drilling)

Invasive Weeds

Construction equipment, vehicles, and drill rigs can carry mud and invasive weed fragments or seeds on the vehicle and equipment tires or undercarriage. Invasive weeds could be introduced to the project area and surroundings through imported construction equipment and drill rigs. Invasive weeds can outcompete native vegetation and cause loss of habitat and potentially increased risk of wildfire. The potential drilling area in Belle Plaine is located in proximity to the PMA. Introduction of invasive weeds was identified as a threat to the biological diversity of the PMA (The Landmark Practice, 2013). The introduction of invasive weeds could adversely impact native habitats surrounding the potential drilling areas.

Vegetation Removal
Vegetation clearing and ground disturbing activities would occur within areas containing an existing access road and areas subject to agricultural production. The well pad does not contain natural habitats and construction of the well pad would not reduce the availability of habitat for natural flora or fauna.

Noise
Heavy equipment used during civil works and well drilling activities would produce noise levels that exceed the ambient noise conditions in the area (refer to Section 5.2.4 for predicted noise levels). Noise from heavy equipment and the drill rig could disturb wildlife and interrupt bird nesting behavior. Nine priority bird species including two IUCN endangered and one vulnerable bird species were documented in the forested areas surrounding the well pad. An intermittent increase in noise could potentially cause nest abandonment if birds are nesting in the vicinity of the drilling area. Disturbing nesting behavior or causing nest abandonment could adversely impact bird populations by reducing reproductive success. Drilling noise levels would be fairly constant over the drilling period. Drilling noise after the initial start of drilling activity is not expected to cause nest disturbance because any species nesting in the vicinity of the drilling area would be accustomed to the constant noise level; however, drilling noise could cause birds to avoid habitat in proximity to the drilling areas. Resource testing, particularly resource venting would result in noise levels that would substantially exceed the existing noise in the area. Bird species tolerance of noise is dependent on the species. Endangered bird species are frequently less accustomed to and less tolerant to noise from anthropogenic sources. The ambient noise levels in the project area range from 37 to 60 dB. Civil works noise would exceed 60 dB for a distance of approximately 100 meters (330 feet) from the well pad. Well drilling noise would exceed 60 dB for a distance of approximately 50 meters (165 feet) from the well pad. Well testing activities would exceed a 60 dB noise level for a distance of approximately 300 meters (1000 feet) from the well pad.

Worker Behavior
Workers could attract wildlife to the construction area if they were to feed wildlife or improperly store food waste. Attracting wildlife to the work area could put wildlife in danger of injury or mortality from heavy equipment or vehicles.

Restoration
Restoration activities would return the well pads to the preconstruction state with the exception of the well cellar (3 meters by 3 meters [10 feet by 10 feet]). The well pad would be revegetated to match pre-construction conditions. Trees would be planted in areas that are currently forested to replace any trees removed. Restoration activities would not adversely affect biodiversity or natural habitats.

Impact Significance and Mitigation
The significance of each impact on natural habitats and biodiversity and the mitigation measures that would be applied are summarized in Table 5.2-8.

Table 5.2-8 Summary of Natural Habitats and Biodiversity Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Rare Species	Vegetation Removal	Very Low	Low	Negligible	--	--
PMA	Introduction of Invasive Weeds	High	Moderate	**Potentially Significant**	Biodiversity-1	Negligible
Priority, Endangered, and Vulnerable Birds	Nesting Disturbance	High	Moderate	**Significant**	Biodiversity-2 Biodiversity-3	Negligible
Wildlife	Attracting Wildlife	Low	Moderate	**Potentially Significant**	Waste-1	Negligible

5.2.7 Archeological and Cultural Resources

Sensitive Resources

The Belle Plaine valley contains an abundance of historical and Amerindian resources. The area that is sensitive for archaeological and cultural resources in Belle Plaine is located west of the well pad. The access road passes through the archaeologically sensitive area.

Potential Risks/Impacts and Magnitude

The area of influence for archaeological and cultural resources includes all areas of grading and earthwork where cultural resources could be encountered or disturbed.

Civil Works

The project would involve grading and ground disturbance at the well pad, which is located outside of the archaeologically sensitive area in Belle Plaine. The existing access road in Belle Plaine would be widened and material would be added to the access road. Due to the disturbed nature of the existing access road and because no excavation would occur within the access road, the access road improvements have a low potential to impact archaeological resources. While the well pad is located in a portion of the Belle Plaine valley that has low sensitivity for archaeological resources, there is always a potential for grading, vegetation removal, and excavation activities to displace or destroy archaeological or cultural resources. There is also a potential for workers to take artifacts that may be uncovered, which could result in the loss of important historical resources.

Well Drilling

Well drilling activities would occur within the graded and disturbed well pad that would be constructed during the civil works phase. No archaeological or cultural resources would be disturbed by well drilling activities due to the depth of drilling (below human occupation).

Restoration

Restoration activities would occur in the areas disturbed by civil works activities. Restoration activities would not cause effects to cultural resources.

Impact Significance and Mitigation

The significance of each impact on archaeological and cultural resources and the mitigation measures that would be applied are summarized in Table 5.2-9.

Table 5.2-9 Summary of Archaeological and Cultural Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Historical and Amerindian Resources	Damage or Relocate Resources	Low	Moderate	**Potentially Significant**	Cultural-1 Cultural-2	Negligible to Less than Significant

5.2.8 Landscape and Visual Character

Sensitive Resources

There are no scenic vistas within the project area. The well pad within Belle Plaine is located within the buffer area for the PMA. Landscapes and viewsheds in the PMA buffer zone are considered to have a moderate or high sensitivity to visual effects.

Potential Risks/Impacts and Magnitude

The area of influence for landscape and visual character includes areas within the viewshed of the project site.

Civil Works

The removal of vegetation from the well pad and the grading of the well pad will have a temporary impact on the landscape and scenery in areas adjacent to the well pad. The well pad construction could have a minor but long-term impact on visual quality if the well pad and access roads with vegetation that contributes to scenic quality were not revegetated following project activities.

Well Drilling

The presence of a tall drill rig and construction equipment as well as lighting at the well pad would contrast with the natural landscape and temporarily degrade the visual quality near well pad. The drill rigs would only be in place for up to 6 months during civil works, drilling, and testing. Trees, dense vegetation, and topography in the area would partially screen the drilling activities from views, such as those from the primary access road. The well pad is not visible from any of the key viewpoints in the PMA that were considered in the Limits of Acceptable Change report (The Landmark Practice, 2013).

Restoration

Restoration activities would be short-term and would not have an adverse effect on the landscape or visual character of the area. Restoration activities including site recontouring, revegetation, and trash removal would restore the site to pre-construction conditions to avoid long-term impacts on the landscape. The only remaining project element would be the well cellar, which is 3 meters by 3 meters (10 feet by 10 feet) and would not be visible at a distance.

Impact Significance and Mitigation

The significance of each impact on landscape and visual quality and the mitigation measures that would be applied are summarized in Table 5.2-10.

Table 5.2-10 Summary of Landscape and Visual Quality Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
PMA Buffer Zone	Vegetation Removal and Grading	High	Moderate	**Potentially Significant**	Landscape-1	Negligible to Less than Significant
	Visible Construction Equipment	Moderate	Low	Less than Significant	--	--
	Night Lighting	High	Low	Less than Significant	Landscape-2	Negligible to Less than Significant
Views from Adjacent Roads and Residences	Vegetation Removal and Grading	Low to Moderate	Low	Less than Significant	--	--
	Visible Construction Equipment	Low to Moderate	Low	Less than Significant	--	--

5.2.9 Traffic Circulation and Safety

Sensitive Resources

The roads that would be used to access the well pad are used by community members and potentially tourists; traffic volume on the roads leading to the project area is generally low. The existing road network to Belle Plaine is paved. An unpaved access road from the primary access road through Belle Plaine would be improved to provide access to the well pad. The unpaved access road is currently used by farmers accessing adjacent agricultural areas.

Potential Risks/Impacts and Magnitude

The area of influence for traffic circulation and safety includes existing paved roads that would be used to provide access to the project site for initial transport of the drill rig and construction equipment and the unpaved access road which would be improved by the project.

Road Expansion (Civil Works)
The existing paved road network from Vieux Fort to Belle Plaine is suitable for access and no paved road improvements are needed for the project. The project would expand an existing unpaved access road leading to the well pad. The unpaved access road improvements would occur within a road that provides access to a few agricultural fields.

Large Vehicle/Equipment Transport (Civil Works and Well Drilling)
The project would involve operating large trucks on public roads to transport construction equipment and materials. Traffic controls, such as pilot vehicles and flaggers, may be necessary to safely maneuver large trucks, particularly the drill rig, through narrow roads and sharp turns. Traffic controls would temporarily impact traffic circulation for a short period during drill rig transport. Temporary lane and road closures would not last more than an hour at any location.

Restoration
Restoration activities would be very short in duration and would be conducted off area roadways within the well pad area. Restoration would require little or no heavy equipment travel on area roads.

Impact Significance and Mitigation

The significance of each impact on traffic circulation and safety and the mitigation measures that would be applied are summarized in Table 5.2-11.

Table 5.2-11 Summary of Traffic Circulation and Safety Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Traffic Circulation	Transport of Large Equipment	Moderate	Moderate	**Potentially Significant**	Traffic-1	Negligible
Community Members	Traffic Safety	High	Moderate	**Potentially Significant**	Traffic-1	Negligible

5.2.10 Utilities and Communications Systems

Sensitive Resources

Low-hanging utilities, including communication cables and electrical distribution lines, are located along area roads that would be used to access the project site.

Potential Risks/Impacts and Magnitude

The area of influence for utilities and communication systems includes low overhead utility lines along the road network that would be used to access the project site and areas of grading and earthwork where any buried utilities could be encountered.

Civil Works, Well Drilling, and Reclamation

The project would involve operating large trucks and transport of a drill rig on roads to access the work area. Low-hanging utilities and communications systems could be damaged in areas where there is inadequate clearance for the drill rig to pass. While initial investigation indicated that there is sufficient clearance along area roads, damage to utilities and communication systems could result in service interruptions to communities that are served by the utility lines and precautions will need to be taken during transport to avoid impacts on utility services.

Impact Significance and Mitigation

The significance of each impact on utilities and communication systems and the mitigation measures that would be applied are summarized in Table 5.2-12.

Table 5.2-12 Summary of Utility and Communication System Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Utility and Communication Lines	Damage to Low-Hanging Utility Lines	Moderate	Moderate	**Potentially Significant**	Utilities-1	Negligible

5.2.11 Hazards and Hazardous Materials

Sensitive Resources

The well pad area is located within an agricultural area. Discharge of hazardous materials has the potential to impact soil and water resources in proximity to the well pad. The project is in an area that is at risk of hurricanes. Workers would also be exposed to hazards and hazardous materials during civil works, drilling, and testing activities (refer also to Section 5.3.5 for worker health and safety and community health and safety).

Potential Risks/Impacts and Magnitude

The area of influence for hazards and hazardous materials includes the well pad area where hazardous materials would be used and stored/contained.

Hazardous Material Use (Civil Works and Well Drilling)

Operation of construction equipment would involve the use of hazardous materials, such as fuels, oils, lubricants, and other chemicals. Hazardous materials would be stored in a designated storage area with secondary containment. An above ground storage tank would house fuels for the generators located on the well pad. The fuel tank would have a masonry wall surrounding the tank for secondary containment and a sump located adjacent to the tank would collect any runoff from the area. All runoff from the fuel tank area would be contained. 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 materials.

The well would be drilled with water and non-toxic drilling mud. Most of materials used in drilling fluids are not harmful for the environment, with the exception of caustic soda which is used in small quantities and lignosulphonate which is used in the chrome free product variation for environmental protection. Hazardous materials, including caustic soda, lignosulphonate, and diesel fuel used to power the generator and equipment will be transported, handled, and stored in accordance with applicable laws of Saint Lucia, World Bank General EHS Guidelines Section 1.5 (2007a), and World Bank EHS Guidelines for Geothermal Power Generation Section 1.1 (2007b).

If hazardous material and waste were not managed correctly, or if incidental leaks or spills occurred, the project could contaminate soil and water quality. Contaminating soil and water quality could affect drinking, natural habitats, and agricultural production.

Drill Cuttings and Effluent (Well Testing)
The drill cuttings could contain concentrations of heavy metals, which while natural, could be considered hazardous to human health. The drill cuttings will need to be characterized prior to any reuse of the material to evaluate whether the materials meet the criteria for reuse or would need to be handled as hazardous material and disposed of at a landfill that can accept hazardous waste. The drilling effluent could contain heavy metals and other constituents as described in Section 5.2.1, water quality. Management of the drilling effluent is described in Section 5.2.1.

Risk of Well Blow Out (Well Drilling)
Although unlikely, well drilling could result in an unanticipated release of geothermal gasses and fluid if a well blow out occurred. An uncontrolled release of geothermal fluid could expose people near the well to air contaminants (see Section 5.2.2), water quality contaminants (see Section 5.2.1), and/or very high temperature fluid, which may be hazardous to community members and workers. The drill rig will be equipped with blow out prevention equipment.

Geothermal Resource Production (Testing)
If the geothermal resource is encountered, geothermal brine would be produced and temporarily discharged to the mud pond and water storage pond. Both the mud pond and water storage pond will be lined with a water resistant and temperature resistant liner to prevent infiltration of any discharged brine to the groundwater. The produced brine could contain heavy metals and radiological elements, which would be considered hazardous. The brine would be reinjected to the geothermal well or evaporated if the well does not have sufficient permeability. If the brine were to escape the mud pond or water storage pond prior to reinjection or evaporation, the discharge of the geothermal brine could contaminate soil and groundwater resources.

Restoration
Restoration would use equipment similar to that used in construction. Site clean-up and restoration would have minimal use of hazardous materials and the risk would be low.

Impact Significance and Mitigation

The significance of each impact on hazards and hazardous materials and the mitigation measures that would be applied are summarized in Table 5.2-13.

Table 5.2-13 Summary of Hazards and Hazardous Materials Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Community Members and Workers, Agricultural Fields, Water Resources	Hazardous Material Discharge	High	Low	**Potentially Significant**	Hazards-1	Negligible
	Drill Effluent Discharge	High	Low	**Potentially Significant**	Water-2	Negligible
	Well Blowout	High	Low	**Potentially Significant**	Water -4	Negligible
	Geothermal Fluid Discharge	High	Low	**Potentially Significant**	Water-3	Negligible

5.2.12 Fires

Sensitive Receptors/Resources

Uncontrolled wildfires can result in substantial damage to property, as well as injury or death. Wildfires can also result in substantial damage to natural habitats and biodiversity. The well pad and adjacent areas have a moderate risk of fire during the dry season or periods of drought.

Potential Risks/Impacts and Magnitude

The area of influence for fires includes the project site and surrounding natural areas where wildfire could spread if a wildfire were sparked during construction.

Civil Works and Well Drilling

The project would have a low potential for causing fires during civil works and well drilling operations. The use of heavy construction equipment and welding could create sparks, which could potentially ignite a wildfire in nearby brush. Workers who smoke could also cause a wildfire if their cigarettes were not properly extinguished or smoking occurred in areas with dry vegetation.

Well Testing

Geothermal testing would not pose a significant risk of fires because gases that are emitted from geothermal systems are not combustible.

Restoration

Restoration activities would consist of trash removal, site recontouring, and revegetation. Restoration activities would be conducted within the well pad, which would be free of vegetation. The risk of fire from site restoration would be very low.

Impact Significance and Mitigation

The significance of fire impacts and the mitigation measures that would be applied are summarized in Table 5.2-14.

Table 5.2-14 Summary of Fire Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Community Members, Natural Habitats, and Biodiversity	Fire from Workers Smoking	High	Low	**Potentially Significant**	Fire-1	Negligible
	Fire from Vehicle or Equipment Ignition	High	Low	**Potentially Significant**	Fire-1	Negligible

5.2.13 Solid Waste

Sensitive Resources

The well pad is located on land used for agricultural production and adjacent to natural forest habitat. The presence of trash or waste in these areas could degrade the existing environment, attract pests/invasive wildlife, and affect existing land uses, such as agricultural land.

Potential Risks/Impacts and Magnitude

The area of influence for solid waste includes the well pad where trash would be stored and the Deglos landfill where solid waste would be transported.

Civil Works and Well Drilling

The project would generate non-hazardous solid waste from worker subsistence (i.e., food trash, water bottles, etc.) and from miscellaneous construction waste, such as material packaging and containers. If the waste was not contained and disposed of properly, the surrounding environment could be degraded by litter, which could also attract and create food subsidies for pest wildlife. Hazardous waste is discussed in Section 5.2.10.

Well Drilling and Testing

The geothermal well drilling and testing process would produce drill cuttings, drilling effluent, and brine that would be stored on site in the mud pond and potentially water storage pond during testing activities. The drill cuttings would not require disposal at the landfill unless the cuttings require treatment as hazardous materials (see Section 5.2.10). The drilling effluent and brine would be reinjected to the geothermal well to the extent feasible or evaporated and would not become a waste product.

Restoration

Site restoration would include site clean-up and restoration. Trash would be hauled away. Limited quantities of waste would be produced during site restoration.

Impact Significance and Mitigation

The significance of solid waste impacts and the mitigation measures that would be applied are summarized in Table 5.2-15.

Table 5.2-15 Summary of Solid Waste Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Farmers, Wildlife	Construction Waste and Debris	Moderate	Low	**Potentially Significant**	Waste-1	Negligible

5.3 Social Risks and Impacts

5.3.1 Livelihoods

Sensitive Receptors

The Belle Plaine well pad is under agricultural production. The livelihoods of farm owners and workers could be impacted, if the project causes a reduction in agriculture production.

Potential Risks/Impacts and Magnitude

The area of influence for livelihoods includes the area of disturbance during construction and all family members affected by economic activities within the area of disturbance.

Direct Impact on Livelihoods (Civil Works and Well Drilling)

The project would temporarily disrupt agricultural production within the well pad. The project would impact row crops and construction of the well pad would remove the area from agricultural production for approximately 1 year during the project construction to site restoration phases. The agricultural activities would be able to resume following site restoration; however, the area within 1 acre area permanently acquired by the RESDP for the project would not revert to agricultural uses.

Short-term impacts would occur through well pad construction, drilling, testing, and restoration phases (months) where annual row crops are present. Where mature crop trees could not be avoided, the impact would occur for a longer period (up to several years) until the new trees matured and reached the same production levels. Impacts on agriculture production and compensation are discussed further in the Section 5.3.3, Resettlement.

The graded well pad could result in the long-term loss of agricultural productivity if the well pad site were not properly restored to pre-construction conditions with productive topsoil.

The project has the potential to create temporary construction jobs for local community members during the civil works and drilling phase. Although the extent of job opportunities and hiring is unknown at this time, providing local communities with job opportunities would be a positive impact.

Indirect Impacts on Livelihoods

Geothermal Emissions (Well Testing)

Geothermal emissions may result in some geothermal steam particulates landing on nearby crops. Some crops are sensitive to boron and could be affected if geothermal steam particulate settle on the crops. Leaf injury must be severe to cause reduced crop quality and yields. Long-term use of irrigation water containing more than 0.5 ppm of boron can reduce yields of bean, onion, garlic, and strawberry; 0.7 ppm can reduce yields of broccoli, carrot, potato, and lettuce; and 2 ppm can reduce yields of cabbage and cauliflower. The amount of boron that would be deposited on crops would be low because the droplets settle out close to the emission point and land on the well pad and the testing would be short duration (days). Impacts to agricultural production and required compensation are described in detail in the RAP (Appendix E).

Water Supply and Topsoil Loss

The project could also temporarily deplete the water supply for agriculture due to use of spring water (refer to Section 5.2.1) and could cause loss of topsoil due to erosion (refer to Section 5.2.3); these project impacts have the potential to adversely affect agricultural production.

Restoration

Restoration activities would restore the sites to agricultural production and would avoid long-term impacts from loss of productive use of the land. The restoration process would likely require local labor, which would also have a positive impact on livelihoods.

Impact Significance and Mitigation

The significance of impacts on livelihoods and the mitigation measures that would be applied are summarized in Table 5.3-1. The RAP also identifies measures to reduce or avoid impacts (refer to Section 5.3.3).

Table 5.3-1 Summary of Livelihood Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Farmers	Short-term Loss of Livelihood	High	High	**Significant**	Social-1 Soils-1 Landscape-1	Negligible
	Long-term Loss of Livelihood	High	Low	**Potentially Significant**	Social-1 Soils-1 Landscape-1	Negligible
Community Members	Temporary Construction Jobs	--	--	Positive	--	--

5.3.2 Tourism

Sensitive Receptors/Resources

Tourism is the primary economic activity in the project region. The protection of the tourist industry and tourist resources is a top priority for the government and community stakeholders.

No tourist destinations, such as hotels or popular places of interest, are located in proximity to the well pad. The nearest tourist destination in the Belle Plaine area is Belle Etolie located 1 km from the well pad and on a hill opposite the well pad. Belle Etolie would have views of the project site as it is situated at a higher elevation than the project.

Potential Risks/Impacts and Magnitude

The area of influence for tourism includes any tourist areas within the viewshed of the project area or within 200 meters of the well pad for noise considerations.

Temporary construction noise (refer to Section 5.2.4) and landscape impacts (refer to Section 5.2.8) could affect tourists in a similar manner as local residents; however, the project would not displace tourism activities or the livelihoods of those working in the tourism industry. The project is not located near any tourist destination. Noise levels at any tourist destination would not exceed ambient noise levels. The project is over 900 meters (3,000 feet) from the PMA at the nearest point and would not affect views from the PMA or noise levels within the PMA.

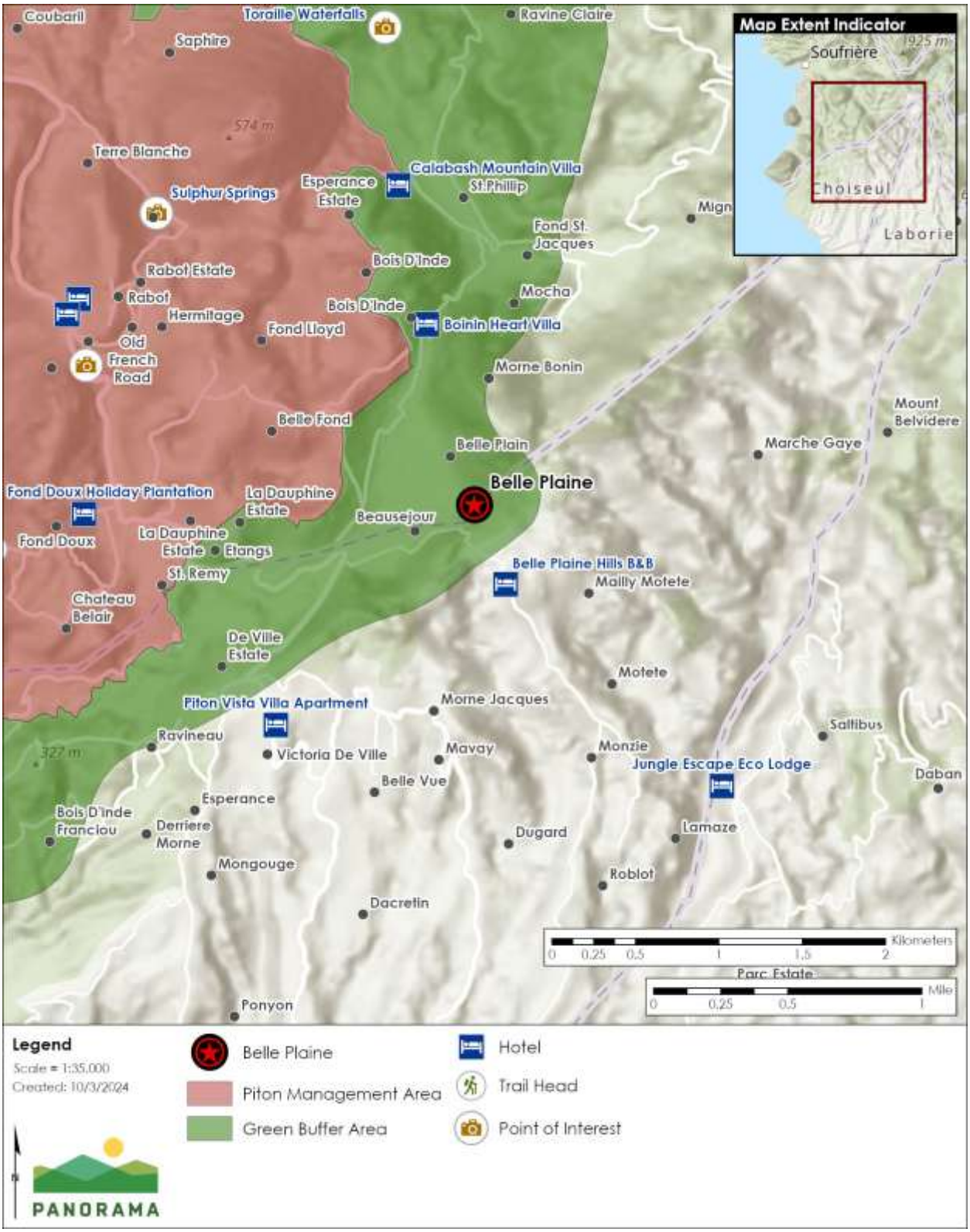
Impact Significance and Mitigation

The significance of impacts on tourism and the mitigation measures that would be applied are summarized in **Error! Reference source not found.**.

Table 5.3-2 Summary of Tourism Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Tourism	Visual	High	Very Low	Negligible	--	--
	Noise	High	Very Low	Negligible	--	--
	Traffic	High	Very Low	Negligible	--	--

Figure 5.3-1 Tourist Destinations in the Project Vicinity



5.3.3 Resettlement

Sensitive Receptors

No structures are located within the well pad or access road. Agricultural land uses in the project area could be temporarily displaced during civil works and well drilling activities.

Potential Risks/Impacts and Magnitude

The area of influence for resettlement includes the area of temporary and permanent impact for project civil works and drilling.

Direct Impacts (Civil Works and Drilling)

Resettlement refers to the potential displacement of people or existing land uses. The project would not require direct resettlement of communities or residences in Belle Plaine because there are no residents on the well pad or access road or adjacent to the well pad or access road.

Indirect Impacts

It may be necessary, for safety reasons or to avoid substantial noise disruption (refer to Section 5.2.4), to temporarily vacate residents during potential emergency situations such as a well blow out. Any evacuation of residents would be very short in duration (a few hours) and would not cause resettlement.

The project would temporarily impact agricultural land during construction and restoration as described in Section 5.3.1. Impacting food supply and the livelihoods of farm owners and farmworkers could cause indirect resettlement. Resettlement without appropriate compensation would be a significant impact.

A RAP was developed to address anticipated resettlement for the project (displacement of agricultural land uses) (provided in Appendix E).

Impact Significance and Mitigation

The significance of impacts on resettlement and the mitigation measures that would be applied to reduce the impact are summarized in Table 5.3-3.

Table 5.3-3 Summary of Resettlement Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Farmers	Displace Agricultural Production	High	Moderate	**Potentially Significant**	RAP	Negligible
Community	Emergency Evacuation	High	Very Low	Negligible	--	--
Farmers	Travel Outside Approved Work Areas	High	Moderate	**Potentially Significant**	Social-1	Negligible

5.3.4 Working Conditions and Equality

Sensitive Receptors

Women are vulnerable to sexual harassment and abuse and should be afforded special considerations and protection. Religious minorities, ethnic minorities, or economically disadvantaged communities are also vulnerable to discrimination and disproportionate impacts. In the workplace, these groups can also be vulnerable to unequal job opportunities, unequal pay, and workplace harassment. Poor labor and working conditions can result in worker exploitation and abuse.

Potential Risks/Impacts and Magnitude

The area of influence for working conditions and equality includes all areas where workers could be employed during construction.

The project would comply with applicable laws and policies governing labor rights and working conditions. The project would also incorporate World Bank EHS Guidelines and policies relevant to working conditions and equality to ensure a safe and equitable environment for all workers.

Impact Significance and Mitigation

The significance of impacts on working conditions and equality and the mitigation measures that would be applied are summarized in Table 5.3-4.

Table 5.3-4 Summary of Equality and Working Conditions Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Community members	Harassment from workers	Moderate	Moderate	**Potentially Significant**	Social-2	Negligible
Workers	Workplace harassment	Moderate	Moderate	**Potentially Significant**	Social-2	Negligible

5.3.5 Labor Influx

Sensitive Resources

The well drilling activity would bring in workers from other countries who would stay in the vicinity of the project. Civil works activities could attract workers from other communities.

Potential Risks/Impacts and Magnitude

The area of influence for labor influx includes the Soufriere region, where workers could be temporarily housed.

The civil works activities could attract locals from surrounding communities and drilling activities would bring in workers from overseas, which could temporarily increase community population and housing demand for the duration of civil works and drilling activities (approximately 6 months). The project would not involve long-term jobs; therefore, it is unlikely

that people seeking work would permanently migrate to communities where project activities would occur.

Impact Significance and Mitigation

The significance of impacts on labor influx and the mitigation measures that would be applied are summarized in Table 5.3-5.

Table 5.3-5 Summary of Labor Influx Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Local communities	Labor Influx	High	Low	Less than Significant	--	--

5.4 Health and Safety

5.4.1 Worker Health and Safety

Sensitive Receptors

Workers would have the greatest potential for health and safety risks as a result of the geothermal exploration activities because workers would be directly engaged in the geothermal exploration process.

Potential Risks/Impacts and Magnitude

The area of influence for worker health and safety includes all areas where construction activities, drilling, and testing would occur.

The project would expose the labor workforce to hazards during construction that pose a risk of bodily injury or death. The primary hazards that may be encountered during construction can be generally categorized as either occupational or environmental. Typical occupational hazards associated construction include working with moving machinery and motorized equipment, working at heights or in confined spaces, open holes and trenches, repetitive motions, falling objects, exposure to heat (i.e., hot weather, fluids, or objects), fires, loud noises, and hazardous materials (refer to Section 5.2.11). Less common occupational hazards that may be encountered during geothermal drilling and testing include exposure to potentially harmful geothermal gases, hot geothermal fluids and drilling materials, and hazards associated with a potential well blowout.

Environmental hazards in Saint Lucia that may be encountered during construction include hurricanes and tropical storms, earthquakes and volcanic eruptions. Workers could also be exposed to biological hazards in the environment such as those associated with dangerous or infectious insects, animals, and plants.

If proper safety precautions were not taken, then workers could be exposed to very high levels of noise that could result in hearing damage. Hearing damage can occur from exposure to moderate noise levels (85 to 100 dBA) over a few weeks, or exposure to high noise levels (>100 dBA) for shorter periods (refer to Table 2.6-5). The frequency of exposure plays a large role in the risk of hearing damage. Workers must wear proper hearing protection when noise levels exceed 85 dBA (refer to Table 2.6-5).

Refer to Section 5.4.2 below for a discussion of potential risks associated with disease.

Impact Significance and Mitigation

The significance of impacts on worker health and safety and the mitigation measures that would be applied are summarized in Table 5.4-1.

Table 5.4-1 Summary of Worker Health and Safety Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Workers	Occupational Hazards	High	High	**Significant**	Safety-1 Safety-2 Safety-3	Less than Significant
	Noise	High	High	**Significant**	Safety-2	Less than Significant
	Geothermal Gases	High	High	**Significant**	Water-4 Air-3	Less than Significant
	Disease	High	Moderate	**Potentially Significant**	Safety-1	Negligible

5.4.2 Community Health and Safety

Sensitive Receptors

The project could expose the local community members to the same hazards as workers; however, the risk of such hazards would generally be reduced with distance from project areas. Community members/farm workers who are using property adjacent to the well pads and access roads would be exposed to the greatest risk of hazards.

Potential Risks/Impacts and Magnitude

The area of influence for community health and safety includes the community of Belle Plaine and the Soufriere region where temporary workers could be housed.

Community Hazards from Civil Works and Drilling Activities

The public would generally be restricted from entering well pads where the hazards are greatest; however, the public could still be exposed to hazards at the periphery of work areas or within access roads. Hazards to the community would include moving vehicles and equipment, hazardous materials, fires, potentially harmful geothermal gases, and hazards associated with a potential well blowout (all described previously).

The project will also provide long-term benefits to the community including resurfacing of the road in Belle Plaine and adding street lighting to the road, which will provide long term safety improvements along the road. Upgrading the spring water storage will provide a water source for the community in the future.

Disease

The project would involve bringing foreign workers to Saint Lucia. Foreign workers could expose people in Saint Lucia to new diseases, and vice versa. The risk of transferring diseases between workers and the local population would not be significantly different that the same risk between tourists and the local population. The project workforce would be limited to approximately 50 people at any given stage of the project, some of whom may be hired from the local population. Bringing up to 50 foreign workers to Saint Lucia would have an insignificant effect on the local population compared to the tourist industry; however, workers could be exposed to new diseases in the region or experience an injury or medical emergency.

Impact Significance and Mitigation

The significance of impacts on community health and safety and the mitigation measures that would be applied are summarized in Table 5.4-2.

Table 5.4-2 Summary of Community Health and Safety Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Community Members	Construction Hazards	High	Low	**Potentially Significant**	Safety-4	Negligible
	Noise	High	High	**Significant**	Noise-1 Social-4	Less than Significant
	Geothermal Gases	High	Moderate	**Significant**	Water-4 Air-3	Negligible
	Disease	High	Low	Less than Significant	--	--

5.5 PMA Attributes

Project impact on each of the PMA attributes are discussed below:

Attribute 1: The high biodiversity value provided by the Pitons, where a combination of slope, climate and soil regimes support significant plant and wildlife populations including endemic and rare species such as the Amazona Versicolour which is usually sighted within areas of the PMA.

The project is located over 900 meters (3000 feet) from the PMA at the closest point. The project would have no impact on slope, climate, or soil regime within the PMA. The project is mostly located in agricultural areas but is along the margin of forested areas that contain higher value habitats for priority bird species. The project would not be expected to affect bird populations

within the PMA due to the distance to the PMA and because the project would implement measures to protect nesting bird species in proximity to the well pad. The project would also implement mitigation measures to avoid introduction of invasive species. As a result, the project would not impact biodiversity within the PMA.

Attribute 2: The reefs found within the coastal portion of the Pitons are among the healthiest and most diverse in St. Lucia.
The project is located approximately 4 kilometers (2.5 miles) from the ocean. The project would not affect the reefs within the coastal portion of the Pitons.

Attribute 3: Due to physical isolation, the Soufriere region has been little affected by mainstream economic and social change that has transformed many other parts of Saint Lucia.
The project would be temporary and would not create any permanent sources of employment. The project would not create any permanent infrastructure that would change the isolated nature of the region. The project does not include modifications to the existing road network.

Attribute 4: Due to the striking landscape provided by the geological features of the area, the Soufriere community benefits from the ability of the area to attract visitors from far and wide. The natural heritage, and more specifically the Pitons, Sulphur Springs, rain forest, coral reefs, botanic gardens and waterfalls, have been touted as the key attractions for the average tourist visitor to Soufriere, which provides economic benefits for the state and livelihood of its citizens.
The project is not located within the viewshed of any tourist area such as Sulphur Springs, coral reefs, botanic gardens, and waterfalls. The project would not be visible from any of the 20 key viewpoints within the PMA and would not affect the visual qualities of the PMA due to mountains separating the project area from the key tourist destinations. The project site would be restored at the completion of the well testing phase where all infrastructure with the exception of a 3 meter by 3 meter well head would be removed and the site would be recontoured and returned to pre-project conditions.

Attribute 5: The area in and around the Pitons, including the Sulphur Springs, continues to be of significant cultural and symbolic value to Saint Lucia, featuring most prominently as a national symbol on advertising and promotional materials.
The project would not affect the use of the Pitons and Sulphur Springs as a national symbol. The project would involve temporary changes to the landscape, which would not be visible from key viewing areas in the PMA.

Attribute 6: Sulfur Springs is the world's only drive-in volcano
The project would not affect any access to Sulphur Springs. The project is separated from Sulphur Springs by a ridgeline/mountain.

Attachment 7: The Pitons are unique in terms of providing an outstanding coastal vista and as the world's only example of closely paired, coastal volcanic cumulo-domes.
The project is not visible from the coast and does not have coastal views. The paired volcanic cumulo-domes are not visible from the project area and the project would not affect any views of these resources.

5.6 Cumulative Impacts

The cumulative project list in Section 4.5 includes a substantial number of application to the DCA within 1 mile of the project. While there are a large number of applications to the DCA, many of these application involve subdivision of property (small sub) and do not involve other activities that would result in environmental effects. The remaining projects are primarily residential projects or small commercial projects that would individually add new residential structures or additions to existing structures or allow for commercial operation at existing facilities. None of the projects are industrial or energy projects. As a result, the impacts of the project would differ substantially from those of the cumulative project. Noise generated during the project would affect areas within 200 meters of the project and there is no proposed development activity involving heavy equipment within 200 meters of the project.

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6 Mitigation Measures

6.1 Overview

This section identifies the mitigation measures that would be implemented to address the risks and potential impacts described in Section 5. Mitigation measures for the project are separated into three categories: environmental, social, and health and safety; however, elements of some mitigation measures are applicable to more than one category.

Mitigation measures were designed to avoid, reduce, rectify, ore compensate/offset impacts to less than significant levels. In addition to the full text of the mitigation measures, the following elements are provided for each measure:

- The issue or potential impact being mitigated identified in Section 5
- The parties responsible for implementing the described requirements
- The general timing when implementation is required

The mitigation has been incorporated into the final design through coordination with the project engineers to optimize the design and avoid or minimize impacts wherever possible (e.g., ensuring sufficient freeboard on the disposal pond). The mitigation measures have been developed on the basis of the mitigation hierarchy discussed in Section 5.1.3. Impacts have been avoided wherever possible. Where it has not been possible to avoid an impact from occurring, the mitigation will reduce the effect to below the level of significance, and only if this is not possible compensatory measures have been considered as mitigation.

The RESDP is responsible for ensuring that the mitigation measures are achieved and has incorporated the measures as appropriate into the civil works and drilling contracts to ensure the project impacts will not exceed those described in this ESIA. A supervising engineer will be appointed to provide day to day supervision of the contractors undertaking the civil works and drilling, and to confirm the project is being undertaken in accordance with requirements. The RESDP would be responsible for monitoring, documenting, and reporting implementation of the mitigation measures. These roles and responsibilities are described in detail in the Environmental and Social Management Plan (ESMP).

6.2 Environmental Mitigation Measures

Table 6.2-1 Environmental Mitigation Measures

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	Water Resources		
• Water Quality • Erosion and Topsoil Loss • Landslides and Mudflows	**Water-1: Stormwater, Erosion, and Sediment Control** Stormwater runoff and drainage shall be properly managed at all work areas using best management practices (BMPs) (e.g., procedural actions and/or material installations). BMPs and drainage systems shall be designed by the engineer to accommodate rapid rainfall events that can be expected in the region. The following procedures shall be implemented to prevent soil loss, erosion, and sediment transport in project areas: • The well pad and access road shall be stabilized with crushed rock to prevent erosion • Sediment and erosion control BMPs shall be installed along the graded well pad slopes to prevent erosion consistent with the approved design plans. • Drainage shall be directed around the well pad to prevent stormwater from flowing onto the site. • Drainage shall be directed around the mud disposal pond to prevent stormwater from flowing into the pond. • Drainage channels shall be stabilized with crushed rock or stone. • Project activities shall be scheduled to avoid the heaviest rain season, to the extent possible. • Soil disturbance shall be limited to the minimum amount necessary. • All disturbed areas shall be stabilized as soon as possible (i.e., covered, compacted, or secured with BMP materials). • Project traffic shall be restricted to designated areas. • Pipelines shall be monitored for leaks and any leaks shall be repaired immediately. • Sediment shall be controlled and prevented from leaving disturbed project areas.	• Civil Works Contractor responsible for implementing BMPs. • Drilling Contractor responsible for maintaining BMPs and conducting inspections.	• During Civil Works • During Well Drilling • During Site Restoration

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	• All drainage channels and erosion control BMPs shall be properly inspected and maintained on a frequent basis to ensure they are functioning properly and any debris that causes backup or blockage of the drainage channels shall be removed.		
• Water Quality • Hazards and Hazardous Materials	**Water-2: Drilling Effluent Management** All drilling fluids shall be contained within the lined mud pond. A minimum of 0.5 meter (1.6 feet) of freeboard shall be maintained on the mud pit to prevent overflow of any drilling effluent. The mud pit shall be covered to prevent rainfall from causing overflow to the pit. A barrier shall be installed along the perimeter of the mud pond to prevent stormwater from entering the mud pond. Drilling effluent shall not be discharged into the environment and shall be left into the disposal pond until the liquid fraction is evaporated and then treated as solid waste and disposed of in the landfill.	• Drilling Contractor	• During Well Drilling
• Water Quality • Hazards and Hazardous Materials	**Water-3: Geothermal Brine Management** Any geothermal brine produced during well testing shall be discharged to either a pond lined with a temperature resistant and water-resistant membrane or to a storage tank. A minimum of 0.5 meter (1.6 feet) of freeboard shall be maintained on any pond used for brine discharge. Any brine pond shall be covered to reduce rainfall and shall have a temporary barrier to prevent rainfall from causing overflowing and discharge from the pond. There shall be no discharge from the pond to the environment. All brines produced during geothermal testing shall be reinjected to the geothermal well.	• Drilling Contractor	• During testing
• Water Quality • Air Quality • Hazards and Hazardous Materials	**Water-4: Blowout Prevention** All drill rigs used during the exploration program shall be equipped with blowout prevention (BOP) equipment to prevent blowout if the geothermal resource is encountered. The drilling contractor or the drilling supervisor shall have experience in geothermal drilling. Drillers shall receive proper training for response to blowouts, should one occur. The drilling contractor shall prepare and implement an Emergency Blowout Well Control Plan. At a minimum, the plan shall address the following: • Proper use of BOP equipment that meets American Petroleum Institute (API) standard 53:2012	• Drilling Contractor	• During Well Drilling

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	• Specific procedures for preventing and controlling an incidental blowout, such as using a blowout preventer stack and stocking material for quelling the blowout • Training requirements for all workers that may be exposed to a well blowout • Staffing requirements to ensure qualified individual(s) who are certified in well control and blowout response are present during all drilling operations including Well Control certification for Assistant Driller level and above (IWCF level 3 or equivalent Well cap Drillers level) and Night Tool Pushers and above (IWCF level 4 or Well cap Supervisors Level) • Blowout documentation and cleanup procedures		
• Water Quality	**Water-5: Worker Latrine Management** The mobile worker latrine shall be serviced regularly to remove sanitary waste and maintain the latrine. All waste from the worker latrine shall be brought to a wastewater treatment facility for management. The worker training program shall include information on use of sanitary toilets.	• Civil Works Contractor • Drilling Contractor	• During Construction
• Water Supply	**Water-6: Water Extraction Strategy** The drilling contractor, in conjunction with the RESDP, shall develop a strategy for obtaining supplemental water supply by truck that does not disrupt the water supply for domestic and agricultural users. Water extraction for the project, including the locations of water pipelines and tanks, shall not deplete water reserves below levels that are required to supply the community. The RESDP and drilling contractor shall consult with Water and Sewerage Company of Saint Lucia (WASCO) and Water Resource Management Agency (WRMA) of Saint Lucia to define the location(s) and approach to supplemental water supply. Supplemental water supply is currently proposed from the L'Ivrogne River where RESDP has a license to abstract water.	• PIU to define strategy • Drilling Contractor to obtain supplemental water if needed	• Before Construction • During Construction
	Air Quality		
• Air Quality	**Air-1: Fugitive Dust Management** The following procedures shall be implemented where dry exposed soils are located in project areas:	• Civil Contractor	• During Civil Works • Restoration

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	• Water shall be applied to disturbed soils to prevent visible dust, to the extent that water is readily available. Water shall not be over applied so that it creates runoff that leaves the site. • Vehicle speeds shall not exceed 25 kilometers (15 miles) per hour on unpaved surfaces. • Inactive areas shall be covered or otherwise stabilized to reduce the potential for wind transporting dust. • Disturbed areas shall be stabilized and restored once project activities are completed.		
• Air Quality	**Air-2: Construction Emissions Controls** The construction contractors shall be responsible for ensuring all vehicles and equipment are properly operated and maintained according to the manufacturer's specifications, and equipped with appropriate emission control devices (i.e., catalytic converters, etc.). Malfunctioning equipment shall be repaired immediately or removed from the site.	• Civil Contractor • Drilling Contractor	• During Civil Works and Well Drilling
• Air Quality • Worker Health and Safety • Community Health and Safety	**Air-3: Air Quality Monitoring and Noxious Gas Management** The drilling contractor shall be responsible for managing risks to workers and local communities from potentially harmful geothermal gas emissions (e.g., hydrogen sulphide, carbon dioxide, boron, arsenic, mercury, and bicarbonate) during well drilling and testing. At a minimum, the following procedures shall be implemented during drilling and testing activities: • Well drilling or testing that could cause the release of potentially harmful geothermal gases shall not occur where the public could be put at undue risk. An appropriate geothermal gas hazard zone shall be established around well pad based on the risk of gas release from the drilling and testing activities. The hazard zone shall be marked with signs and communicated to the local community members. If occupied structures occur within the hazard zone, the occupants of those structures shall be relocated during drilling and testing activities. • Minimize the potential for gas release by using properly weighted drilling mud to keep the well from flowing or by implementing other well head abatement measures such as aerated drilling as a primary measure; BOP equipment are a secondary measure. • Install gas detection and monitoring devices during well drilling and testing activities, that are equipped with alarms that would be triggered if gas concentrations reach unsafe levels.	• Drilling Contractor	• During Well Drilling and Testing

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	• Autonomous respiratory equipment shall be provided in enclosed areas of the drill rig and shall be unlocked. Workers shall receive training in use of respiratory equipment. • The Health and Safety Plan shall specify safety procedures for potential exposure to geothermal gases and emergency response. • The drilling contractor shall implement an air quality monitoring program to monitor air quality during well drilling and testing for signs of unsafe levels of potentially harmful geothermal gases using automated detection and alarm systems. If unsafe gas levels are detected, the area shall be evacuated and properly trained workers wearing appropriate PPE shall attempt to stop the release by shutting in the well according to the procedure in the Drilling contractor's Well Control Manual including use of Blow-Out Preventers (during drilling) or a Master Valve (during testing).		
Geology and Soils			
• Erosion and Topsoil Loss	**Soils-1: Topsoil Preservation and Restoration** Topsoil shall be separated and stockpiled during the construction period. The topsoil stockpile shall be secured with plastic and BMP materials. Following construction, the topsoil shall be applied evenly to the site during the restoration process. Topsoil shall be collected and stored in loose mounds no higher than 3 meters high, using methods that minimize compaction. The topsoil shall be covered to prevent erosion and sediment transport. The topsoil storage area shall be signed or fenced for avoidance throughout the construction period. Topsoil shall be reapplied on the subsoils/restored site using loose tip and spread methods that retain the soil structure. No vehicles shall track over the soils during the reapplication process to avoid compaction.	• Civil Works Contractor	• During Initial Grading/ Stripping and Storage of Topsoil • During Restoration
Noise			
• Noise	**Noise-1: Noise Abatement and Community Coordination** Construction noise and the associated effects shall be reduced or minimized, to the extent possible, by implementing the following procedures: • Select quieter equipment and construction activities, whenever feasible; • Ensure motorized vehicles and equipment are equipped with the greatest possible noise reduction parts, such as mufflers, silencers, insulators, and enclosures; • Limit civil work activities to daytime hours (7:00 to 18:00);	• Civil Works Contractor • Drilling Contractor noise monitoring	• Before Construction • During Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	• Notify and coordinate with residents adjacent to project areas prior to construction to inform them of the possibility of temporary noise disruption, and how to report noise complaints; • If noise complaints are made during nighttime drilling activities, install noise attenuation barriers between the loudest operating equipment (e.g., air compressor or generator) and the sensitive receptor. • Implement a Noise Complaint Program to record and respond to noise complaints during construction. • Install a sound barrier between the well testing location and the sensitive receptors. The sound barrier shall be sound transmission class (STC) rated 25 or higher and be a minimum of 3 meters tall, installed to block the line of sight between the noise source and the receptor. • Install continuous noise meters at the edge of the well pad and at a distance of approximately 100 meters from the well pad. Monitor noise levels throughout the duration of drilling and testing activities.	• PIU coordinate with residents and respond to noise complaints	
• Noise	**Noise-2: Noise Control During Well Testing** • A drum silencer shall be used during well testing; • The wellhead and associated venting of the resource shall be conducted as far from sensitive receptors as possible; • At least 2 weeks prior to testing activities that involve venting of the resource, notify community members within 500 meters of the well pad of the timeframe for testing and predicted noise level at their residence. Provide information on measures to reduce noise levels during the testing such as use of earplugs, noise canceling headphones or closure of windows. • Supply earplugs and noise canceling headphones to all residents within 200 meters of the well pad. • Provide notice to the Soufriere area of the planned timing of geothermal resource venting/testing to avoid community alarm	• Drilling contractor • PIU notify community	• Prior to Resource Venting

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	Natural Habitats and Biodiversity		
• Natural Habitats	**Biodiversity-1: Invasive Weed Control** The drill rig and any equipment from overseas shall be sanitized prior to arrival in Saint Lucia. The equipment shall be inspected at the port of entry to ensure it is free of caked mud and plant material.	• Drilling Contractor	• During Construction
• Nesting Birds	**Biodiversity-2: Nesting Bird Avoidance and Impact Minimization** All vegetation clearing activities shall be conducted outside of the bird nesting season (March to August). Project activities shall be scheduled outside of the prime bird nesting season (March to August) to the extent feasible. If project civil works, drilling, or testing activities commence during the nesting bird season or if there is a work stoppage of more than 72 hours, a qualified biologist shall survey potentially suitable nesting habitat within 100 meters of the well pad for priority species birds. If active nests are identified, a qualified biologist shall monitor the nesting birds' responses to the loudest level of construction noise for an appropriate duration. If work occurs during the nesting season, a sound barrier (noise blankets attached to the fence) shall be installed along the portion of the well pad adjacent forested areas to reduce noise levels. Monitoring will be conducted within 100 meters of the civil works activity throughout civil works activities occurring during the nesting season. Monitoring is not required for continuous drilling activities as any birds that nest in the area after drilling has commenced would be assumed to be adapted to the constant 24-hour noise level from drilling.	• PIU	• Before Construction During the Nesting Season
• Natural Habitats, Biodiversity	**Biodiversity-3: Worker Training** All workers on the project site would be required to attend a Workers Environmental Awareness Program (WEAP) training. Training would inform all construction personnel of the mitigation measures to be implemented, habitats for avoidance, priority and endemic species that could occur in the area, as well as procedures to be followed upon the discovery of environmental resources. The WEAP training would include, at a minimum, the following topics so crews would understand their obligations: • Environmentally sensitive area boundaries,	• PIU verifies training meets requirements and workers are trained • Civil Works and Drilling Contractors	• Prior to workers being allowed to work on the project site

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	• Housekeeping (i.e., trash and equipment cleaning), • Safety, • Work stoppage, • Communication protocol, and • Consequences of non-compliance.	implement training	
	Archaeological and Cultural Resources		
• Archeological and Cultural Resources	**Cultural-1: Inadvertent Discovery of Cultural Resources** The civil works contractor shall hire an archaeologist to monitor initial ground disturbing activities including any excavations or grading activities that could uncover cultural resources. A Chance Find Management Plan shall be developed by the contractor prior to implementation of the work. The Chance Find Management Plan shall be developed in accordance with requirements for protection of cultural resources in St. Lucia as well as World Bank Environmental and Social Framework and shall address: • Steps for temporary work stoppage in the event of a potentially significant discovery • Steps to protect chance finds from the impacts of further project activities • Contractor code of conduct with worker training on how to respond to chance finds • A monitoring system for implementation of the chance find procedure • Relevant government authorities and indigenous groups to contact depending on the nature of the resource. At a minimum, the chance find procedure will require that in the event that cultural resources are discovered at the site of construction, the following procedures shall be instituted: • Discovery of historic-era or Amerindian archaeological resources requires that all construction activities shall immediately cease at the location of discovery and within 15 meters of the discovery. The Contractor shall immediately contact an archaeologist to evaluate the find. If it is determined that the Project could damage a historical or Amerindian resource, construction shall cease in an area determined by the archaeologist until a management	• Civil Works contractor to develop Chance Find Management Plan • Civil Works Contractor to halt work in the event of a chance find • civil works contractor to hire archaeologist	• During Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	plan has been prepared and implemented to the satisfaction of the archaeologist. In consultation with PIU, the archaeologist will determine when construction can resume.		
• Archeological and Cultural Resources	**Cultural-2: Worker Cultural Resource Sensitivity Training** Workers shall be properly trained on identifying potential archeological and cultural resources that could be uncovered during construction, including procedures for reporting potential discoveries to the archeological monitor. If potential resources are discovered, they must be left in place or turned over to the archeological monitor for proper record keeping and cataloging. A training log shall be kept on the job site as a record of all training provided.	• PIU to provide training. • Civil Works contractor to attend training and maintain log.	• Before Construction • During Construction
Landscape and Visual Character			
• Landscape and Visual Character	**Landscape-1: Site Restoration** The following restoration activities shall be completed following construction: • Prior to construction the contractor shall take photos of the well pad to document pre-construction conditions. • The contractor shall restore grades on site to match pre-construction conditions. • The proper restoration of the site shall be documented by the contractor in a post-construction report containing pre- and post-construction photos. • All temporary stockpile and storage areas shall be recontoured to match pre-project conditions. • Heavily compacted areas should be appropriately de-compacted to facilitate faster vegetation regrowth.	• Civil Works Contractor	• Before Construction • After Restoration
• Light Pollution	**Landscape-2: Dark Sky Lighting** • Lighting will be installed for worker safety and security. To the extent reasonable and while protecting worker safety, the contractor will direct lighting downward onto the site and work areas only and will reduce light spill over onto adjacent properties.	• Drilling contractor	• During nighttime activities

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	Traffic Circulation and Safety		
• Traffic Circulation and Safety • Community Health and Safety	**Traffic-1: Traffic Control** Proper traffic controls shall be in place during transport of large equipment to minimize impacts on traffic circulation and for traffic safety. If any road closures are necessary a Traffic Management Plan shall be developed and coordinated with local emergency responders to provide advance notification of temporary one way traffic or road closures. Traffic flaggers and pilot cars shall be used to safely transport equipment. The unpaved access road shall be stabilized with crushed stone per the plans and the turning apron to the paved road network shall be designed to accommodate the construction vehicle turning radius to the unpaved road. Signs shall be posted to warn drivers of slow-moving vehicles entering and exiting during deliveries. Local traffic laws and speed limits shall be followed at all times.	• Civil Works Contractor to stabilize access road, post signs, and obey traffic laws • PIU to coordinate with emergency responders • Drilling Contractor to develop Traffic Management Plan for mobilization of drill rig	• During Construction • Before Drilling (for Traffic Management Plan, if needed)
	Utilities and Communication Systems		
• Utilities and Communication Systems	**Utilities-1: Protect Overhead Utility Lines** The drilling contractor shall identify and mark any overhead utility and communication lines that hang over access roads to ensure the lines are not inadvertently damaged during construction. A minimum of 1 meter of clearance shall be maintained between construction equipment and low-hanging lines. If the minimum clearance cannot be maintained, the contractor shall work with the applicable system providers to temporarily disconnect or reposition the lines for the duration of construction.	• Drilling Contractor	• Before and During Mobilization of Drilling Equipment
	Hazards and Hazardous Materials		
• Water Quality	**Hazards-1: Hazardous Materials Management Plan** The construction contractors shall prepare and implement a Hazardous Materials Management Plan. The Hazardous Materials Management shall identify proper	• Civil Works Contractor	• Before Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
• Hazards and Hazardous Materials • Worker Health and Safety • Community Health and Safety	management procedures for all hazardous materials and wastes that may be encountered during construction, including handling, labeling, transporting, and storing procedures. In addition, the Hazardous Materials Management Plan shall address the following: • Non-toxic and biodegradable produces will be used whenever possible. • Hazardous materials shall be transported and stored in appropriate containers with clearly visible labels. Hazardous materials shall be stored at least 100 feet from any downgradient drainage or within secondary containment capable of containing its entire volume. • Stormwater flows shall be directed away from hazardous material storage areas. • Equipment and work areas shall be regularly inspected for signs of leaks and spills. Spill containment and cleanup kits shall be available wherever hazardous materials are being used or stored. Any incidental spills or leaks shall be contained and cleaned up as soon as it is safe to do so. Any contaminated soil shall be collected and disposed of in an appropriate land fill. • Equipment refueling and maintenance shall be limited to designated areas at least 30 meters (100 feet) from any downgradient drainage. • All workers shall receive training on proper handling and storage of hazardous materials, as well as spill response and cleanup procedures, prior to working on the project site.	• Drilling Contractor	• During Construction
• Hazards and Hazardous Materials • Community Health and Safety	**Hazards-2: Drill Cutting Characterization** The material representing the residue of drilling operations (cuttings, drilling mud and additives) stored into the disposal pond at the drilling site must be characterized in its chemical composition so that it can be reused or disposed of in appropriate landfills. Testing should be conducted in accordance with St. Lucia's waste management regulations. Materials that contain concentrations of hazardous materials in excess of St. Lucia and international standards for reuse or disposal at a standard landfill shall be treated as hazardous waste and properly disposed at the Deglos Sanitary Landfill, which can accept hazardous waste.	• Drilling contractor • EMC	• During drilling/logging
	Fires		
• Fires	**Fires-1: Fire Prevention and Response**	• Civil Contractor	• During Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	Fire prevention and response equipment shall be available at the well pad, such as shovels, axes, and fire extinguishers. All workers shall be trained in proper fire prevention and response procedures prior to working on the site. Any smoking on site shall be restricted to barren areas away from ignitable or combustible material. Smoking waste shall be fully extinguished and disposed of appropriately.	• Drilling Contractor	
Solid Waste			
• Water Quality • Hazards and Hazardous Materials • Solid Waste	**Waste-1: Waste Management Plan** The construction contractors shall prepare and implement a Waste Management Plan. At a minimum, the plan shall address the sources of waste; waste minimization, reuse, and recycling opportunities; and waste collection, storage, and disposal procedures. The Waste Management Plan should distinguish between solid and liquid waste, as applicable, and include procedures for addressing waste that may be hazardous to health and the environment. In addition, the Waste Management Plan shall address the following: • All food waste shall be contained in covered bins and disposed of on a frequent basis to avoid attracting wildlife. • Trash bins shall be accessible at all locations where waste is generated. • The project area shall be kept clean and free of litter and no litter shall be allowed to disperse to the surrounding area. • Solid waste shall be removed from the site and transported to a municipal landfill. • Waste shall not be dumped or buried in unauthorized areas or burned. • Human waste associated with the worker camp and latrines shall be properly contained and disposed of. The construction contractors shall ensure all workers receive training on proper disposal of all waste prior to working on the project site.	• Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction

6.3 Social Mitigation Measures

Table 6.3-1 Social Mitigation Measures

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
• Livelihoods	**Social-1: Agriculture Production** The limits of all access roads and well pads shall be clearly identified and marked, if necessary, to ensure impacts from ground disturbance are limited to approved properties and work areas. Where farmland and crops are impacted by the project, farm owners and farmworkers shall be compensated for the loss in pay and agriculture production for affected growing seasons in accordance with the Resettlement Action Plan (RAP). Male and female farm owners and farmworkers shall be compensated for impacts to agriculture production equally.	• Civil Works Contractor mark limits of work areas • PIU responsible for compensation under the RAP	• Before Construction
• Working Conditions and Equality	**Social-2: Working Conditions and Equality** Employment opportunities created by the project shall be equally available to men and women. If locals are hired for construction jobs, job postings and/or notices shall be disseminated that foster participation from women and men. The RESDP shall include a preference for hiring from the project region in the civil works contract. The construction contractors shall provide safe and equal working conditions and comply with the World Bank's social policies regarding age, gender, ethnicity, and religious equality. Workers shall be provided with: • Information on their rights regarding safety and payment prior to working on the site • Gender-specific latrines at each project area that are maintained in a sanitary condition with adequate capacity • Gender-specific sleeping quarters at the worker camp • Clean drinking water at all times • Adequate training for their position	• Civil Works Contractor • Drilling Contractor • PIU responsible for grievance redress and hiring preference in contract documents	• Prior to Construction preference for hiring • During Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	Violence, sexual harassment, discrimination, and drug abuse shall not be tolerated. Workers engaging in such activities shall be dismissed immediately. Any concerns and complaints regarding workplace or community harassment shall be addressed with respect and due diligence by a grievance and redress committee designated by the RESDP; women shall be appointed to the grievance and redress committee. Workers and community members who issue concerns or complaints shall be protected from retaliation. Prior to working on the project site, all workers shall receive equality and harassment awareness training, for both workplace and community relations, in conjunction with other social trainings for the project.		
• Working Conditions and Equality • Noise • Community Health and Safety	**Social-3: Community Engagement and Sensitivity** **Pre-construction Meeting.** Prior to the start of construction activities, the PIU shall hold a public meeting for the affected communities to explain the project activities, schedule, possible inconveniences that may be experienced during construction, and safety considerations associated with drilling operations (refer to Health and Safety-4). The affected communities shall be informed of how they can submit complaints about the project should they arise. **Informational Signs.** The PIU shall install an informational sign at the entrance of each project area to inform the public about the project, construction schedule, and important information about health and safety related to project activities, such as evacuation areas in the event of an emergency. The sign shall include procedures and contact information for submitting complaints about the project to the community liaison officer (CLO). **Community Complaints.** Complaints that relate to the requirements set forth in the ESIA shall be recorded and addressed as set forth in the Grievance Redress Mechanism (GRM), and the underlying issue shall be corrected, to the extent feasible. **Worker Sensitivity Training.** The PIU shall prepare a social and community sensitivity training that would be provided to all workers. The	• PIU hold meetings, install informational sign, address community complaints, and lead worker sensitivity training • Civil Works Contractor (attend training) • Drilling Contractor (attend training)	• Before Construction • During Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	training shall be designed to inform all workers of the local customs, traditions, and community considerations for each area affected by the project. The construction contractors shall be responsible for providing the social and community sensitivity training to all workers prior to initiating work.		

6.4 Health and Safety Mitigation Measures

Table 6.4-1 Health and Safety Mitigation Measures

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
• Fires • Worker Health and Safety • Community Health and Safety	**Safety-1: Health and Safety Plan** The civil works and drilling contractors shall prepare and implement a Health and Safety Plan that addresses the applicable risks and prevention procedures applicable to each contractor's work. At a minimum, the Health and Safety Plan shall address hazards that may be encountered during construction, including prevention and response procedures, for the following topics: • General occupational hazards that may be encountered (e.g., moving machinery and motorized equipment, working at heights or in confined spaces, repetitive motions, falling objects, exposure to heat, loud noises, and hazardous materials, protective clothing); • Unique occupational hazards associated with drilling activities (e.g., exposure to potentially harmful geothermal gases, hot geothermal fluids and drilling materials, and hazards associated with a potential well blowout); • Minimum training requirements for operating vehicles, equipment, and machinery, in accordance with applicable laws and industry standards; • Fire prevention and response procedures, including compliance with Fires-1: Fire Prevention and Response; • Natural hazards that may be experienced during construction (e.g., hurricanes and tropical storms, landslides, earthquakes, volcanic eruptions, and flooding), including	• Civil Works Contractor • Drilling Contractor	• Before Construction prepare plans • During Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	designated response procedures and evacuation areas for each project area that are consistent with the GoSL's natural hazards and emergency response plans; • Biological hazards in the environment (e.g., dangerous or infectious insects, animals, and plants); • Disease risk and prevention (i.e., HIV/AIDs, etc.); • Community safety considerations (e.g., traffic, harmful geothermal gases, and unsafe areas); • Emergency preparedness and response procedures, including the locations of hospitals and medical services in the region in the event of an injury or medical emergency. The construction contractors shall provide all workers with training on the contents of the Health and Safety Plan prior to working on the site. Refresher trainings shall be given on an occasional basis and before beginning work in new project areas.		
• Worker Health and Safety	**Safety-2: Personal Protective Equipment** The construction contractors shall supply all workers with personal protective equipment (PPE), and ensure workers use the proper PPE during all work activities. At a minimum, PPE for workers shall include: • Safety headgear • Steel toed boots • Safety glasses or impact-resistant eye protection • Ear protective devices • Harnesses for workers operating at heights • Respirators • Gloves • High visibility clothing or vests • Other specialized protective equipment for the drilling, welding, etc. All PPE shall be properly fitted for each worker, including body size and gender, and workers shall be trained in the proper use of PPE, prior to working on the project site. PPE shall be effective in protecting worker health and safety from noise levels greater than 85 dBA. Respiratory equipment and air monitoring per Air-3 shall ensure workers are not exposed to hydrogen sulfide levels in excess of 20 ppm.	• Civil Works Contractor • Drilling Contractor	• During Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
• Worker Health and Safety	**Safety-3: First Aid and Emergency Response Equipment** The construction contractors shall provide first aid training to all workers prior to working on the project. The construction contractors shall ensure all project sites are equipped with first aid and emergency response equipment. The drilling 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.	• Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction
• Community Health and Safety	**Safety-4: Community Safety** Communities that may be exposed to hazards from drilling activities (communities within 500 meters of well pads) shall be informed of the risks and provided information regarding emergency preparedness and response. If and where necessary at drilling areas, alarms shall be installed for major emergencies that could require evacuation, such as a well blowout or geothermal gas emission. Evacuation procedures during an alarm shall be communicated to community members during the Pre-construction Information Meeting and on applicable display panels (refer to Social-3). The construction contractors shall install temporary signs and fences around all unsafe areas to prevent members of the public from entering the areas. If installing fences is not feasible, the area shall be clearly identified as unsafe with signs and flagging.	• PIU • Civil Works Contractor • Drilling Contractor	• Before Construction PIU to communicate evacuation procedures • During Construction install and maintain alarms, signs, and fences
• Worker Health and Safety • Community Health and Safety • Air Quality • Hazards and Hazardous Materials	**Safety-5: Emergency Response Plan** The drilling contractor shall prepare an Emergency Response Plan that includes: • A description of the project facilities with site plans identifying areas of potential hazards such as storage of hazardous materials, and description of hazardous activities conducted at the site such as production of geothermal brines and drilling activities that are in contact with the geothermal resource under pressure. • Location and contact information for emergency service providers who are available to respond to an emergency and the nearest medical facility. • A description of individuals on site responsible for responding to an emergency. • A description of potential project emergency situations such as loss of well control, chemical spills, fire, hydrogen sulfide exposure, etc.	• Drilling Contractor	• Before Construction prepare plan • During Construction implement plan as warranted

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	• For each hazard define the nature of the hazard, warning/detection systems used to identify the hazard, procedures to alert personnel of the hazard, and procedures to respond/address the hazard. • Natural hazard response plans including procedures to shut down activities in the event of a hurricane. • Evacuation plans, including meeting points and escape routes. • Training requirements for personnel, including procedures for emergency shutdown, handling of emergency equipment, spill prevention, first aid and rescue, fire response, and evacuation training. The drilling contractor shall provide training for personnel working on the site consistent with the training requirements in the Emergency Response Plan.		

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7 Analysis of Alternatives

7.1 Overview

This section describes alternatives that were considered when developing the proposed project. The alternatives include different locations for exploration activities within the geothermal resource area. Each alternative would avoid at least one significant impact, but would include different or greater impacts of their own. Project alternatives, including a "without project" alternative, are described below, including their pros and cons as well as potential differences in mitigation.

7.1.1 Approach to Definition of Potential Geothermal Exploration Areas

Jacobs conducted geophysical investigations in the Soufrière and Choiseul regions to assist the GoSL in defining areas for geothermal resource exploration outside of Sulphur Springs (2016). Jacobs identified three target areas for geothermal resource investigation. These target areas spanned a large area to the east of Sulphur Springs.

7.1.2 Refinement of Drilling Areas to Minimize Impacts in 2017

GeothermEx/POWER Engineers and Panorama Environmental, Inc. conducted reconnaissance surveys of the three target resource areas defined by Jacobs. GeothermEx/POWER and Panorama considered key environmental and social constraints when defining the geothermal resource target drilling areas considered in this ESIA. These constraints included:

- Stable and relatively flat topography within the drilling area
- Drill rig transport/access via the existing road network
- Access to water supply
- Avoidance of existing homes/structures
- Avoidance of native habitats
- Avoidance of the PMA Policy Areas

7.1.3 Selection of Well Pad Site

The drilling strategy specifically focuses on small diameter wells in order to minimize the time required to complete the wells and the area needed for the well pads. The specific well pad site in Belle Plaine was selected after investigation into land ownership and ability to acquire lands for the well. The site has a single owner with the ability to sell 1 acre of land for the geothermal well. The site is also in proximity to a spring with water supply for drilling.

7.2 Alternatives Considered but Rejected

7.2.1 Alternative 1: Avoid PMA Green Buffer Zone

The proposed project is located in an agricultural area at the edge of the PMA green buffer zone. Locating the well pad outside of the green buffer zone would require relocating the well to the south or east. The areas to the south and east of the proposed well pad include hill slopes and forested areas. Construction in the hill slopes and forested areas would require greater amounts of civil works/earth moving activities to create a flat well pad and construct access as well as greater impacts on the forest, which provides habitat for priority and endemic species. The proposed well pad location is within agricultural land and would avoid removal of forested habitat. Nine priority species were found occurring in the forested habitat that would be affected by Alternative 1. Two of the priority species are classified as endangered species and one is classified as vulnerable. By avoiding development in the green buffer zone, the alternative would increase impacts to important biological resources. The alternative would also increase the risk of landslide and erosion due to the location of the area on steep slopes that would have greater risk of landslide. As a result the alternative of locating the well pad in forested areas outside of the PMA green buffer was rejected. There are homes in the area to the south and east of the project and relocation of the well pad outside of the green buffer zone could result in greater air quality and noise impacts on residential receptors as the well pad would likely be closer to receptors than the current location. There is no direct access to water supply in areas to the south and west of the well pad and the relocation would likely involve greater need for trucking of water supply and associated traffic impacts and conflicts in the community. The potential environmental advantages and disadvantages of the alternative are summarized as follows:

Pros

- Avoids direct impacts to farmland and livelihoods
- Avoids areas that are sensitive for cultural resources

Cons

- Greater impacts associated with grading, ground disturbance, and vegetation disturbance
- Greater risk of erosion and sediment transport
- Reduced access to water resulting in greater water resource imports and greater impacts on water supplyGreater potential for noise and air quality impacts on residential receptors
- Increase truck traffic for water supply

- Greater impact on viewsheds due to increased vegetation removal
- Greater impacts on habitat for wildlife and nesting birds, including nine priority species
- Greater impact on forest
- Risk of landslides and mudslides
- Longer construction period due to extensive earthwork/grading
- Greater construction costs due to extensive earthwork/grading

This alternative would require greater mitigation for loss of forest habitat for priority species. The mitigation would likely include specific timing for removal of trees and requirements for replacement planting and habitat offsets. Mitigation to compensate farm owners and farmworkers for a loss in livelihoods would not be needed, but there may be other compensation needed depending on the specific location. Additional mitigation would be needed to address grading and risks of landslide and erosion from developing the well pad on a slope in a forested area where trees would be removed. The civil works costs would be substantially greater.

7.2.2 Alternative 2: Drilling in Pitons Management Area

The proposed project does not include drilling areas within the PMA, which was intentionally avoided to:

- Avoid conflicts with the Environmental Protection Area policy adopted in 2024
- Avoid conflicts with tourism
- Protect the PMA

An alternative to the proposed project would be locate one or more of the drilling areas within the PMA, which is closer to Sulphur Springs and surface manifestations of the geothermal resource. There were previous investigations of geothermal within the PMA near Sulphur Springs. The alternative to drill within the PMA is not considered feasible due to conflicts with the Environmental Protection Area. While the alternative is considered infeasible, the pros and cons of this alternative are summarized as follows:

Pros

- May reduce direct impacts on farmland
- Location would be closer to known geothermal areas

Cons

- Prior geothermal investigation/drilling in Cresslands and Diamond did not produce commercial quality geothermal fluids

- Impacts on the PMA and conflict with national policy and UNESCO guidance
- Could affect the PMA's designation as a World Heritage Site
- Greater impacts on tourism
- Greater impacts on habitat for wildlife and nesting birds
- Visual impacts in a tourist area
- Closer to known area of high-acidity geothermal fluids identified during previous drilling investigations
- Possible impacts to surface manifestations of the Soufriere volcanic area
- Visual impacts on the PMA
- Noise and air quality impacts on the PMA

This alternative is not feasible due to conflicts with the PMA and thus mitigation would not be able to offset the impacts on the PMA. Potential additional mitigation would likely include increased mitigation for biological resource impacts visual resources, tourism, and others to preserve the World Heritage Site designation. The project conflicts with national policy to protect the PMA would ultimately be unresolved and thus this alternative is not a viable option.

7.2.3 Alternative 3: "Without Project" Alternative

The World Bank Environmental and Social Framework states that a "without project" alternative should be addressed in the analysis of alternatives section. A "without project" alternative considers if the project was not implemented and no exploration drilling occurred at all. The pros and cons of this alternative are summarized as follows:

Pros

- Avoids all environmental impacts, the majority of which are temporary and would not result in lasting effects.

Cons

- No information would be obtained about the feasibility of developing the geothermal resource
- Geothermal development would not occur and energy use in the region would continue as it is now

- The socioeconomic benefits to the Saint Lucia work force would not be realized.

No mitigation would be required under this alternative.

7.3 Alternative Comparison

Table 7.3-1 summarizes the magnitude of impact predicted for the proposed project and each alternative by resource.

Table 7.3-1 Summary of Alternative Comparison and Magnitude of Impact

Resource	Project	Alternative 1	Alternative 2	No Project
Water Resources	Low to High; mitigation applied	Moderate to High; greater impact than project	Moderate to High; greater impact than project	No Impact
Air Quality	Low to Moderate	Low to High; potentially greater impact than project	Low to High; potentially greater impact than project	No Impact
Geology and Soils	Low to High; mitigation applied	High; greater impact than project	High; greater impact than project	No Impact
Vibration	Low; mitigation applied	Low; similar impact to project	Low; similar impact to project	No Impact
Natural Habitats and Biodiversity	Low to Moderate; mitigation applied	High; greater impact than project	High; greater impact than project	No Impact
Archaeological and Cultural Resources	Moderate; mitigation applied	Low; less impact than project	High; greater impact than project	No Impact
Landscape and Visual Character	Low to Moderate; mitigation applied	Moderate; greater impact than project	High; greater impact than project	No Impact
Traffic Circulation and Safety	Moderate; mitigation applied	Moderate; similar impact to project	Moderate; similar impact to project	No Impact
Utilities and Communication Systems	Moderate; mitigation applied	Moderate; similar impact to project	Moderate; similar impact to project	No Impact
Hazards and Hazardous Materials	Low; mitigation applied	Low; similar impact to project	Low; similar impact to project	No Impact
Fires	Low; mitigation applied	Moderate; greater impact than project due to slope	Moderate; greater impact than project due to slope	No Impact

Resource	Project	Alternative 1	Alternative 2	No Project
Solid Waste	Low; mitigation applied	Low; similar impact to project	Low; similar impact to project	No Impact
Livelihoods	Low to High; mitigation applied	Low; less impact than project	Low; less impact than project	No Impact
Tourism	Very Low	Very Low; similar impact to project	High; greater impact than project	No Impact
Resettlement	Low to High; mitigation applied	Low to Moderate; less impact than project	Low; less impact than project	No Impact
Working Conditions and Equality	Moderate; mitigation applied	Moderate; similar impact to project	Moderate; similar impact to project	No Impact
Labor Influx	Low	Low; similar impact to project	Low; similar impact to project	No Impact
Worker Health and Safety	Moderate to High; mitigation applied	Moderate to High; similar impact to project	Moderate to High; similar impact to project	No Impact
Community Health and Safety	Low to High; mitigation applied	Low to High; similar or greater impact than project	Low to High; similar impact to project	No Impact

8 Stakeholder Engagement and Community Consultations

8.1 Project Stakeholders

Project stakeholders include individuals, groups, organizations, and institutions interested in and potentially affected by the project as well as those having the ability to influence the project, either positively or negatively. The primary stakeholders are comprised of persons that are directly or indirectly affected by the project impacts and other community individuals and groups. The secondary stakeholders are the institutional (the government agencies, non-profit, community-based) organizations and other people who have an interest in the project including potential beneficiaries (such as consumers for the geothermal energy). Table 8.1-1 presents a brief analysis of the various stakeholders of the project.

Table 8.1-1 Project Stakeholders

Stakeholder Type	Individuals/Groups/Organization	Level/Influence
Community	Residents, landowners, and workers in proximity to the project	Primary key stakeholders (individuals and groups) High stake, but low influence
Project Affected Persons	Residents, landowners and farmers/ farm workers, agricultural squatters at the well pad and along the access road	Primary key stakeholders (individuals and groups) High stake, moderate influence
Other Affected Persons	Vulnerable persons (women, children, disabled); local community advisory groups; parliamentary representatives; drive-in, drive-out workers and fly-in, fly-out workers	Primary stakeholders Advocates/supporters Blockers/critics
Other Stakeholders in Soufriere district	Project Affected Communities Local private businesses, schools, hoteliers; tour operators The unemployed (potential workforce seeking employment) Local recreational users including national & foreign tourists	Primary stakeholders Advocates/supporters Blockers/critics

Stakeholder Type	Individuals/Groups/Organization	Level/Influence
National, International, and local NGOs & CBOs/ Regulators/organizations (Legal mandates)/ interest groups	Pitons Management Area Office; UNESCO; Soufriere Regional Development Foundation; Saint Lucia National Trust; Saint Lucia Archaeological & Historical Society; WASCO	Secondary key stakeholders Advocates/supporters Blockers/critics
Government/Institutional/ Authorities/supporting organization (Legal mandates)/facilitators	Government Departments/Ministry of: • Ministry of Forestry • Water Resources Management Agency • Agriculture, Fisheries, Physical Planning, Natural Resources & Co-operatives • Economic Development, Housing, Urban Renewal, Transport & Civil Aviation • Education, Innovation, Gender Relations & Sustainable Development • Equity, Social Justice, Empowerment, Youth Development, Sports & Local Government • Finance, Economic Growth, Job Creation, External Affairs & the Public Service • Health and Wellness • Tourism, Information, and Broadcasting • Soufriere Town Council	Secondary stakeholders Advocates/Supporters
Customer/Client/ Implementing Agency/Implementer	RESDP within Department of Infrastructure, Ports and Transport (DIPT) of the Ministry of Infrastructure, Ports, Transport, Physical Development and Urban Renewal	Secondary project partners/ Advocates/ Supporters
Project Sponsor/Fiduciary Support/facilitator	RESDP; World Bank	Secondary Advocates/Supporters

8.2 Stakeholder Engagement During Preparation of this ESIA

8.2.1 St. Lucia Government Consultations

Table 8.1-1 below identifies the stakeholder consultations and meetings that were held the week of August 26 to August 29, 2024.

Table 8.2-1 Stakeholder Consultation and Timing

Stakeholder	Meeting Date
Ministry of Equity, Social Justice, Empowerment, Youth Development, Sports and Local Government	26 August 2024

Stakeholder	Meeting Date
Water Resource Management Agency	26 August 2024
Forestry Division	26 August 2024
Department of Physical Development and Urban Renewal	26 August 2024
Pitons Management Agency	27 August 2024
Forestry Division	28 August 2024
Water Resource Management Agency	28 August 2024
Belleplaine Community Consultation	27 August 2024
Fond St. Jacques Community Consultation	28 August 2024
Saltibus Community Consultation	29 August 2024

8.2.2 Community Meetings

The RESDP and Panorama conducted community meetings and presented the proposed geothermal project in each of the local communities (Belle Plaine, Fond St. Jacques, and Saltibus) in August 2024. Community comments were obtained during each meeting and subsequent surveys were conducted with community members. Notes from each of the community meetings are provided in the Scoping Studies Report (Appendix C).

8.2.3 PMA Office Comments

The PMA Office expressed concerns about any disturbance with the Green Buffer Zone that could affect the PMA. The PMA Office also provided reviewed and provided input on the PMA Values and Attributes that are applied in this ESIA. The PMA Office discussed that due to the temporary nature of the project and full restoration of the site, the impact of the project within the green buffer was not anticipated to affect the PMA. The PMA Office also confirmed that the viewpoints of concern are the 20 key viewpoints referenced in the Limits of Acceptable Change Report (The Landmark Practice 2013). The project is not visible from any of those 20 key viewpoints.

8.2.4 Other Stakeholder Comments During Consultation Meetings

The DCA provided comments on the ESIA Terms of Reference and topics covered in the ESIA. The DCAs comments are addressed throughout this ESIA. The Water Resources Management Authority (WRMA) and the WASCO expressed concerns about the use of water, drinking water infrastructure, and water quality. The WRMA and WASCO comments are addressed in Section 5.2.1 Water Resources and associated mitigation measures. Local stakeholder representatives' comments included concerns about noise, geothermal hazards, dust control and job opportunities for the local community. Each of these issues are addressed in this ESIA (see Sections 5.2.4, 5.2.11, 5.2.2, and 5.3.5, respectively) and mitigation measures were defined consistent with World Bank guidance.

8.3 Communications and Outreach Campaign

Separate from the ESIA, the RESDP has conducted on-going outreach and engagement with the community to increase public awareness for geothermal exploration and the proposed project.

8.4 Grievance Redress

The RESDP has a community liaison officer (CLO) to conduct stakeholder outreach during project implementation and respond to any grievances or complaints that may arise. The CLO acts as the key point of contact to resolve project grievances from construction workers, local residents, and community members. The CLO 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 ESIA.

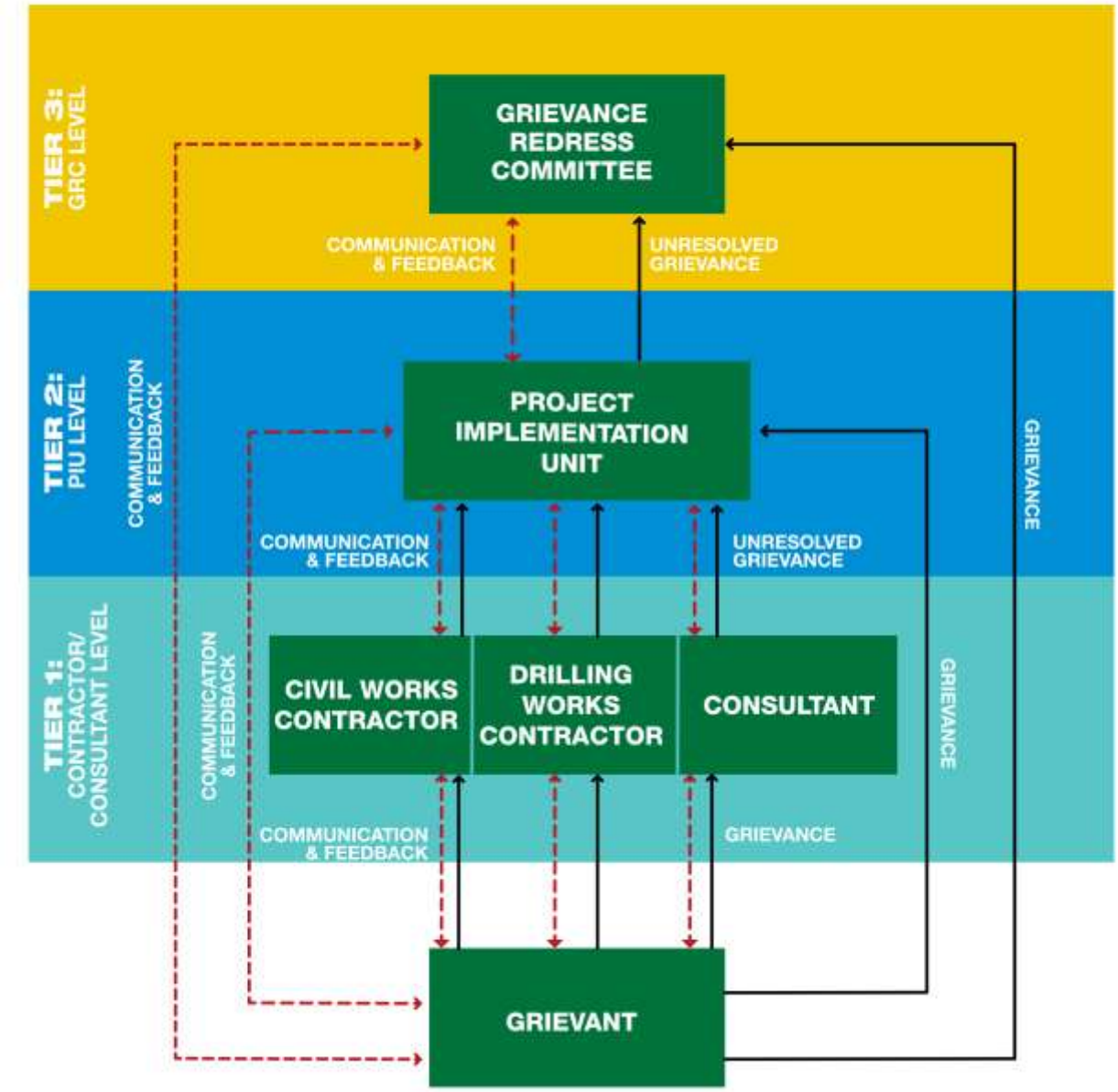
8.4.1 Grievance Redress Mechanism

A grievance redress mechanism is necessary for addressing the legitimate concerns of the PAPs. It is anticipated that some of these concerns may include eligibility criteria, and compensation entitlements for loss of livelihood or use of land, and for noise associated with drilling. The mechanism for grievance redress shall thus include:

- Provision for the establishment of a grievance redress committee that includes women
- A reporting and recording system
- Procedure for assessment of the grievance
- A time frame for responding to the grievances filed
- The mechanisms for adjudicating grievances and appealing judgments

In the interest of all parties concerned, the grievance redress mechanisms are designed with the objective of solving disputes at the earliest possible time. World Bank OP. 4.12 emphasizes that the project affected persons (PAPs) should be heard and as such, they must be fairly and fully represented. Further, the mechanism should implicitly discourage referring matters to the court system for resolution. The grievance redress procedures is illustrated in Figure 8.4-1.

Figure 8.4-1 Grievance Redress Procedures



8.4.2 Grievance Redress Procedures

Table 8.4-1 outlines the process for registering and addressing grievances and provides specific information regarding registering complaints, response time, and communication modes.

Table 8.4-1 Grievance Redress Procedures

Issue/Action	Procedure
Establishment of a Grievance Redress Committee (GRC)	• The GRC shall be established by the Project Steering Committee (PSC) and sanctioned by the Permanent Secretary (PS), Department of Sustainable Development (DSD) prior to civil works activities in each community. • The members of the GRC shall comprise the following: – CLO; – Social Transformation Officers (STO) for the affected communities (e.g., Belle Plaine, Fond St. Jacques, and Mondesir/Saltibus); – The Authorized Officer or his/her representative – DCA; – One member of a recognized community-based organization from the affected community (e.g., Belle Plaine, Fond St. Jacques, and Mondesir/Saltibus); – The Legal Officer – Chief Technical Officer – Representative of the Department of Agriculture, Fisheries, Natural Resources and Cooperatives (only required for grievances involving loss of agricultural production); – Commissioner of Crown Lands or his/her representative (only required for grievances involving Crown Lands); – Quantity Surveyor (only required for grievances involving loss of land or livelihood); – Valuation Surveyor (only required for grievances involving loss of land or livelihood).
Reporting, recording, and Transmission of Grievances.	• Grievances must be filed with the PIU, though the project office or the determined location; • Grievances must be made in writing and be signed and dated by the PAP • Grievances received verbally must be documented, verified and signed by the PAP and the officer receiving the report; • The CLO shall establish a grievance log or register; all reports must be recorded in the log; • The grievance log shall outline the name of the PAP and the reason for the complaint; • The grievance report shall be submitted to the chairperson of the GRC within 24 hours of receipt. The report shall also be copied to the PIU; • Acknowledgement of the grievance shall be issued by the CLO to the PAP in writing, within 2 working days of receipt.

Issue/Action	Procedure
Assessment of the Grievance and Timeframe for Response. Mechanisms for Adjudicating Grievances and Appealing Judgments	• The first assessment of the grievance shall be conducted by the GRC; • The nature of the grievance would ascertain the period (not exceeding 3 working days) necessary for the GRC to address the grievance. • The 3-day timeframe shall not apply in the case of complaints and grievances that specifically pertain to the valuation of affected assets, since these may be determined by a Board of Assessment or the courts; • Where resolution is not reached at the level of the GRC or if the PAP does not receive a response or is not satisfied with the outcome within the agreed time he/she can appeal to the Permanent Secretary, DIPT; • If the PAP is not satisfied with the decision of the GRC or the response to the appeal to the Permanent Secretary, he/she as a last resort may submit the complaint to a court of law. • The PAP shall be exempt from all administrative and legal fees incurred pursuant to the grievance redress procedures.

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Appendix A List of ESIA Preparers and Contributors

Appendix A List of ESIA Preparers and Contributors

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Appendix B References

Appendix B References

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Appendix C Scoping Studies Report

Appendix D Environmental and Social Management Plan

Appendix E Resettlement Action Plan