Government of Saint Lucia

Renewable Energy Sector Development Project
Environmental and Social Impact Assessment
Saltibus and Fond St. Jacques Sites

January 2025

RENEWABLE ENERGY SECTOR DEVELOPMENT PROJECT
RESDP
"PURSUING ENERGY INDEPENDENCE"

PANORAMA
ENVIRONMENTAL, INC.

Government of Saint Lucia

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Prepared for:

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Prepared by:

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Acronyms and Abbreviations

ARAP	Abbreviated 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
ESS	Environmental and Social Standards
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
km	kilometer
l/s	liter/second
LAC	Limits of Acceptable Change

LUCELEC	Saint Lucia Electricity Services Limited
MS-1	material stockpile and storage area for Saltibus
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
S-5	Saltibus well pad
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 two of the sites, Saltibus and Fond St. Jacques (and the associated but distinct material storage area also at Saltibus). The environmental and social impacts associated with the third geothermal investigation site (Belle Plaine) are assessed in a separate ESIA.

This Environmental and Social Impact Assessment (ESIA) was prepared for geothermal exploration drilling and testing at the Saltibus and Fond St. Jacques sites (project) in accordance with Government of Saint Lucia laws, World Bank 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.

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 Saltibus and Fond St. Jacques drilling targets. 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 reclamation 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. The steep slope along the Saltibus well pad is a risk to sedimentation due to grading activities. Mitigation specific to Saltibus includes retaining large trees and/or root systems along the slope and installing an underdrain system to reduce pressure on the slope. Site reclamation activities will restore the well pads and avoid long-term soil loss.

- **Water Supply.** Constructing the well pad and access roads would require water for dust control and well construction will require water during drilling. Water will be obtained from rivers near each well pad, which could impact downstream water supplies. The water supply at Fond St. Jacques would be supplemented with water trucked to the well pad site, if water supply from the river is insufficient to support drilling operations. Existing water supply pipelines in the Fond St. Jacques area would be protected or relocated if necessary to protect WASCO water supply. Discharged brine could contain heavy metals and elements that could be released into the environment. Mitigation also includes monitoring of the water supply and providing replacement water if the drainage at the well pad affects WASCO water supplies.
- **Air.** Geothermal testing could result in a temporary increase in carbon dioxide (CO_2) and hydrogen sulphide (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 Saltibus site is in an area that is prone to landslides due to the steep slope of the area. Fond St. Jacques has topsoil that supports agricultural production. The mitigation includes retaining trees and/or root systems along the perimeter of the well pad to the extent feasible, installing a drainage system per geotechnical engineering requirements, and site reclamation including stockpiling of topsoil materials. The mitigation adequately manages the risk.
- **Noise and Vibration.** Operating construction and drilling equipment would result in a temporary increase in noise and vibration in proximity to the well pads and along the access roads. Well drilling and testing would occur 24 hours a day and would result in elevated noise levels at residences near both well pads. The mitigation includes installing noise barriers between stationary equipment and nearby residences, locating noise sources as far from residences as feasible, coordination with receptors that would experience increased nighttime noise

during testing and providing noise canceling devices, and a mechanism to receive and respond to noise complaints. Mitigation also includes pre- and post-project surveys to evaluate structures in proximity to access roads and equipment activities. The mitigation would adequately manage temporary noise impacts.

- **Natural Habitats and Biodiversity.** The well pad at Saltibus is in a forested area that provides habitat for several priority and endangered bird species. The Saltibus well pad was previously reforested and contains common forest vegetation. The well pad at Fond St. Jacques is in an open agricultural and previously disturbed area absent of natural and sensitive habitats. Vegetation removal at Saltibus could impact bird nests if the vegetation removal was not properly timed to avoid the nesting season. Project noise could impact bird nesting behavior in forested habitat adjacent to the drilling area. Mitigation includes avoiding vegetation removal at Saltibus during the nesting season, pre-construction surveys for sensitive bird species, buffers from active nests for activities that commence during the nesting season (May to August), and replacement of habitat at Saltibus through planting of trees that provide habitat for priority birds during site reclamation. The mitigation would adequately manage the risk to biodiversity.
- **Archaeology and Cultural Resources.** The central portion of the staging area for Saltibus contains both prehistoric and early colonial artifacts; the well pads are not sensitive for archaeological resources. Grading and excavation activities could impact resources if encountered during construction. 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 Saltibus and Fond St. Jacques well pads and material storage area are outside of the Pitons Management Area and green buffer zone and would not be in view from established tourist viewpoints. The drill rigs and equipment would have a minor and temporary impact on the landscape and views in direct proximity to the well pads given the topography of the area. Grading and vegetation removal could impact the landscape. Mitigation includes reclamation of the well pad and revegetation after the project is completed. Implementation of site reclamation 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. In addition, the access roads to each well pad from the paved road would require improvement and widening. Mitigation includes use of traffic controls and flaggers. The mitigation would adequately manage the risk on traffic and safety.
- **Utilities.** Transporting large equipment could damage low-hanging utility lines. The mitigation requires minimum clearance for overhead utilities or temporary relocation of the line. WASCO has water supply lines in proximity to the well pad and access road improvements. Travel over the access road could impact WASCO water pipelines. The mitigation involves temporary shutoff of any utility lines

lacking adequate clearance, and protection or relocation of WASCO water supply pipelines. 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. The construction equipment would also require the use of small quantities of hazardous materials, such as fuel, oils, and lubricants as well as caustic soda. Drilling will produce drill cuttings that will be tested and buried on site if non-hazardous; any hazardous drilling waste would be removed and disposed of in an appropriate facility. Produced geothermal fluids (if the well encounters the geothermal resource) would be contained in the lined pit with freeboard to prevent overflow. Effluent (liquid waste) from drilling activities would be tested and disposed of appropriately. Mitigation includes preparation and implementation of a waste management plan and hazardous materials management plan to adequately manage the risk from solid, liquid, and hazardous waste.
- **Livelihoods and Resettlement.** The project will require resettlement of one landless farmer at the material storage area for Saltibus and one household along the access road to Fond St. Jacques. The well pad at Fond St. Jacques and the material storage area for Saltibus are located in areas where active agriculture production occurs, and the project could temporarily impact the livelihoods of individual farm owners and farmworkers. Mitigation includes compensation for loss of agricultural production in accordance with the Abbreviated 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 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 Safeguard Policies through implementation of the mitigation measures listed in Table ES.5-0-1.

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

Resource	Mitigation Measure
Water Resources	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 for Fond St. Jacques Water 7: Water Monitoring
Air Quality	Air-1: Fugitive Dust Management Air-2: Construction Emissions Controls Air-3: Air Quality Monitoring and Noxious Gas Management
Geology and Soils	Soils-1: Saltibus Slope Stabilization Measures Soils-2: Saltibus Site Reclamation Soils-3: Topsoil Preservation and Reclamation
Noise	Noise-1: Noise Abatement and Community Coordination Noise-2: Drilling Noise Control Monitoring and Mitigation Noise-3: Well Testing Noise Mitigation Noise-4: Vibration
Natural Habitats and Biodiversity	Biodiversity-1: Invasive Weed Control Biodiversity-2: Vegetation Removal Timing Biodiversity-3: Nesting Bird Avoidance and Impact Minimization

Resource	Mitigation Measure
Archaeological and Cultural Resources	Cultural-1: Protection of Cultural Resources at the material storage area for Saltibus Cultural 2: Inadvertent Discovery of Cultural Resources Cultural 3: Worker Cultural Resources Sensitivity Training
Traffic Circulation and Safety	Traffic-1: Traffic Control Traffic-2: Maintain Community Access
Utilities and Communication Systems	Utilities-1: Locate and Protect Buried Pipelines Utilities-2: Protect Overhead Utility Lines
Hazards and Hazardous Materials	Hazards-1: Hazardous Materials Management Plan Hazards-2: Drill Cutting Characterization
Fires	Fires-1: Fire Prevention and Response
Solid Waste	Waste-1: Waste Management Plan
Livelihoods and Resettlement	Social-1: Resettlement and Livelihoods
Working Conditions and Equality	Social-2: Working Conditions and Equality Social-3: Community Engagement and Sensitivity
Worker Health and Safety	Safety-1: Health and Safety Plan Safety-2: Personal Protection Equipment Safety-3: First Aid and Emergency Response Equipment
Community Health and Safety	Safety-4: Community Safety Safety-5 Emergency Response 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 with the World Bank Safeguard Policies.

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 Fond St. Jacque project site is located in the Soufrière district of Saint Lucia and the Saltibus project site is located in the Choiseul district, as shown in Figure 1.3-1. Neither the Fond St. Jacques nor the Saltibus sites including proposed staging and stockpile areas are located within the Pitons Management Area or green buffer zone (that have been established by the GoSL) to protect the features of outstanding universal value for which this internationally important site is recognized. The project sites are bounded by residential areas, agricultural uses, and undeveloped land. The project sites would be accessed via existing unpaved access roads and paved road network. Materials would be delivered to the project site from Vieux Fort via existing paved roads.

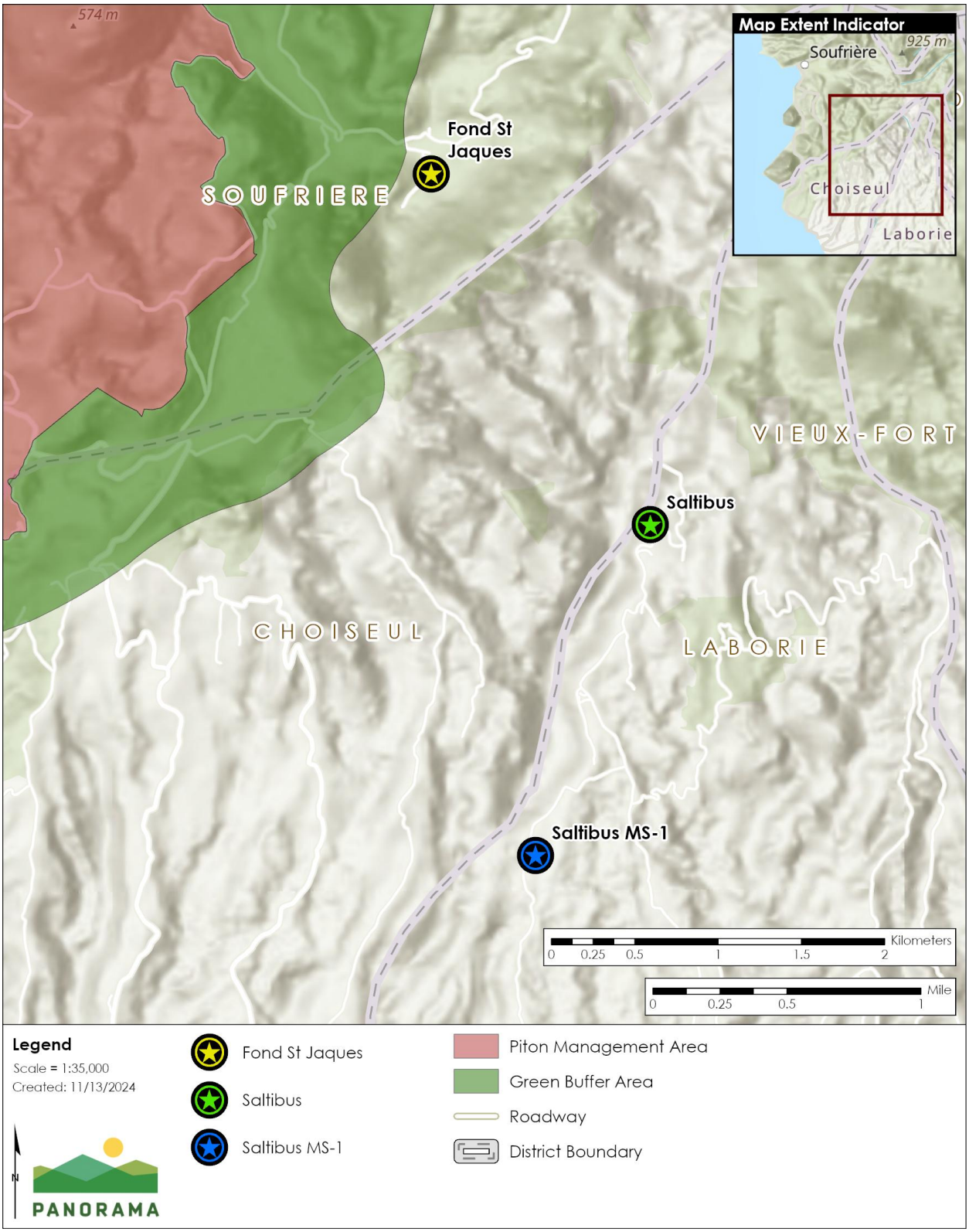
1.3 Project Need

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 Project 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 safeguard policies, which include 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.

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 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 (2010). The objective of the National Energy Policy is to create an enabling environment, both regulatory and institution, for the introduction of indigenous renewable energy to the national energy mix, thus achieving greater energy security and independence.

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

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). The project is not located within the PMA or green buffer zone as shown on Figure 1.3-1.

Because the project consists of temporary activities located outside of the PMA and green buffer zone, the project would not have an impact on the PMA and further assessment is not required

for the drilling sites in Fond St. Jacques or Saltibus. Nevertheless, the project planning has involved participation with local communities and the PMA office.

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
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

Pollutant	Threshold Standards (mg/L)
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
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, 2006). Table 2.6-3 summarizes the WHO's threshold standards for air emissions.

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 2.6-3 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)
	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

Pollutant	Averaging Period	Threshold Standards (µg/m^3) [1]

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: (World Health Organization, 2021)

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)

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 reclamation that will be undertaken during implementation of the project at the Saltibus and Fond St. Jacques geothermal exploration sites.

The project involves drilling slim-diameter wells 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 pads, access roads, water supply, and staging/storage areas 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.

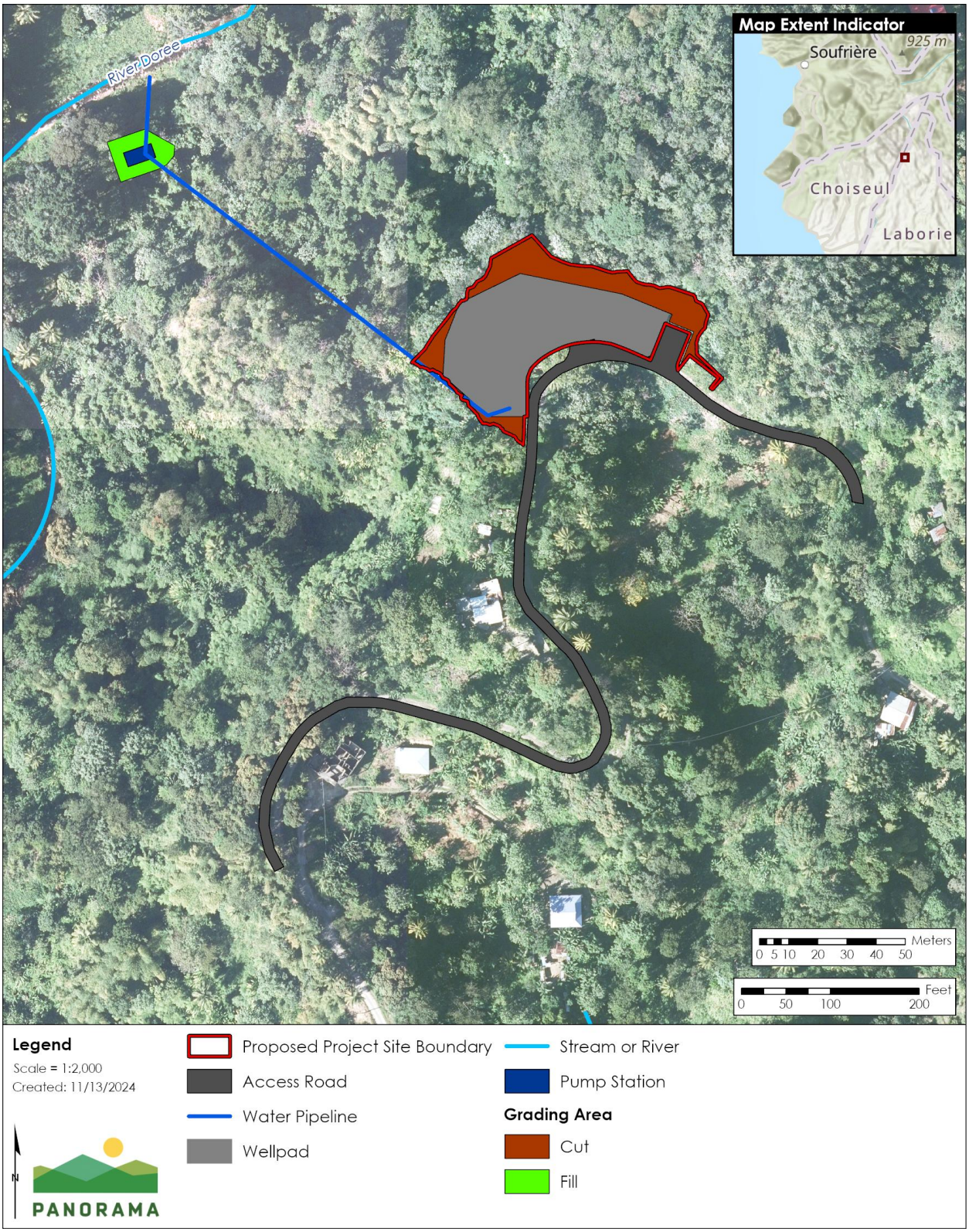
3.2 Project Location

The proposed geothermal well pad in Saltibus (S-5) as shown in Figure 3.2-1and proposed staging and stockpiling area (MS-1) are shown on Figure 3.2-2. The proposed geothermal well pad in Fond St. Jacques is shown on Figure 3.2-3

3.2.1 Saltibus

The well pad at S-5 is approximately 0.2 hectare (0.5 acre). Due to steep terrain in the S-5 site, it is not feasible to construct a larger well pad at the MS-5 location. As a result, material, storage, staging, and stockpiling will occur within MS-1. MS-1 is approximately 1.8 hectares (4.5 acres) and contains sufficient space for storage of topsoil, staging of all piping for delivery to the S-5 site daily, and staging of any other materials that are not necessary for daily drilling operations at the S-5 site. S-5 is located on a private parcel that is currently undeveloped. A storage shed is located adjacent to the S-5 site. No residential uses are adjacent to the S-5 drilling site. The S-5 well pad site will be acquired by the RESDP for the project. A water supply intake will be located within the River Doree approximately 150 meters from the well pad. The water supply pipeline and pumps will be located on the same private parcel as the S-5 well pad. MS-1 is located on Crown lands that are currently used for agricultural production.

Figure 3.2-1 Saltibus S-5 Well Pad

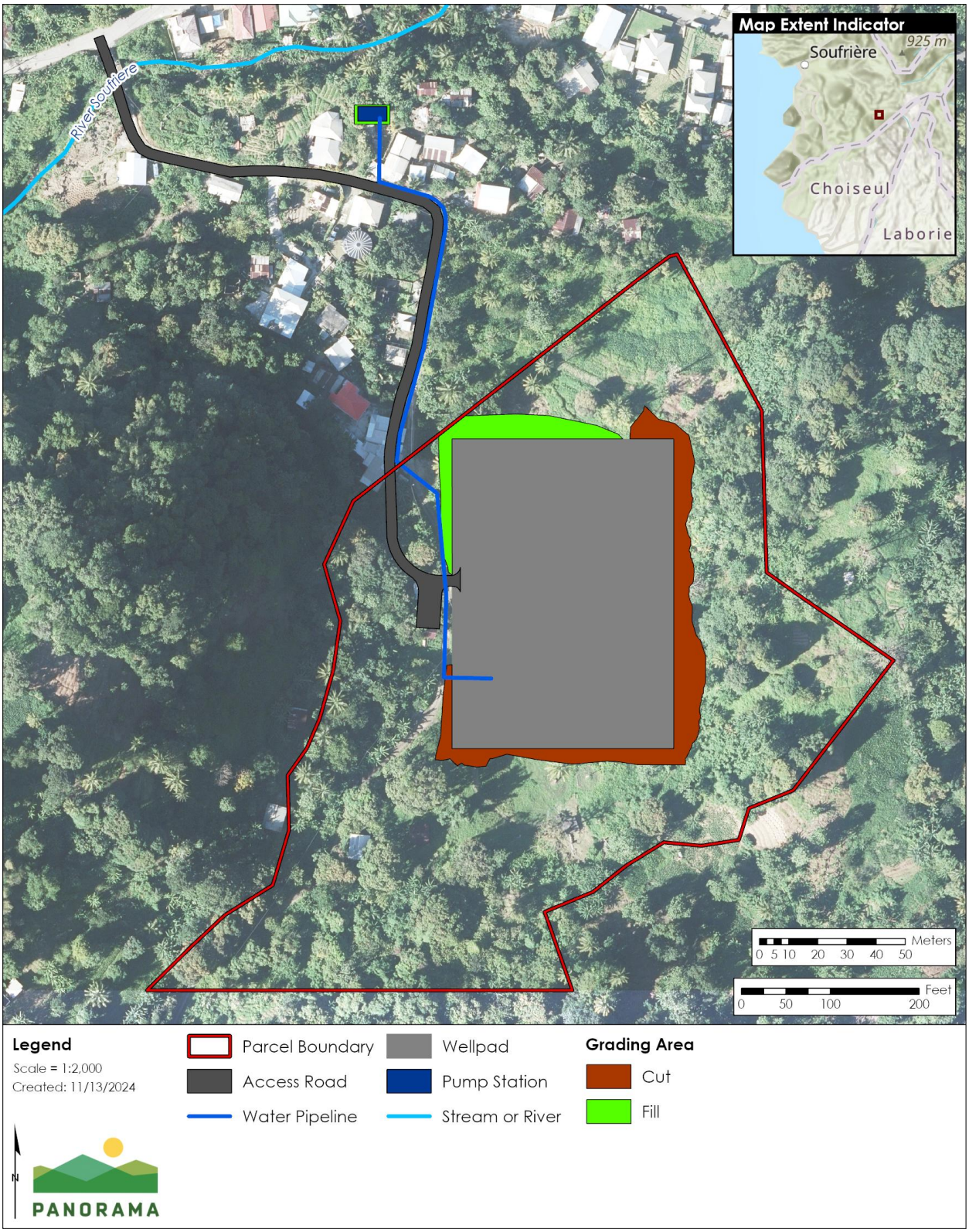


Source: (ELC, 2024)

Figure 3.2-2 Staging/Storage Area at MS-1

Source: (ELC, 2024)

Figure 3.2-3 Well Pad at Fond St. Jacques



Source: (ELC, 2024)

3.2.2 Fond St. Jacques

The proposed geothermal well pad in Fond St. Jacques is approximately 0.8 hectare (2 acres). The well pad is located entirely on private land. 0.4 hectare (1 acre) of the well pad site will be permanently acquired, and 0.4 hectare (1 acre) 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 adjacent to a spring and water storage infrastructure managed by Water and Sewerage Company, Inc. (WASCO). The well pad is also located near residential and commercial uses to the north and west of the well pad site. The area south of the well pad is an open hill slope. The access road to the well pad will require improvements to widen the road for drilling access. The expanded access road will be located on private lands, which are being acquired by the State.

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.

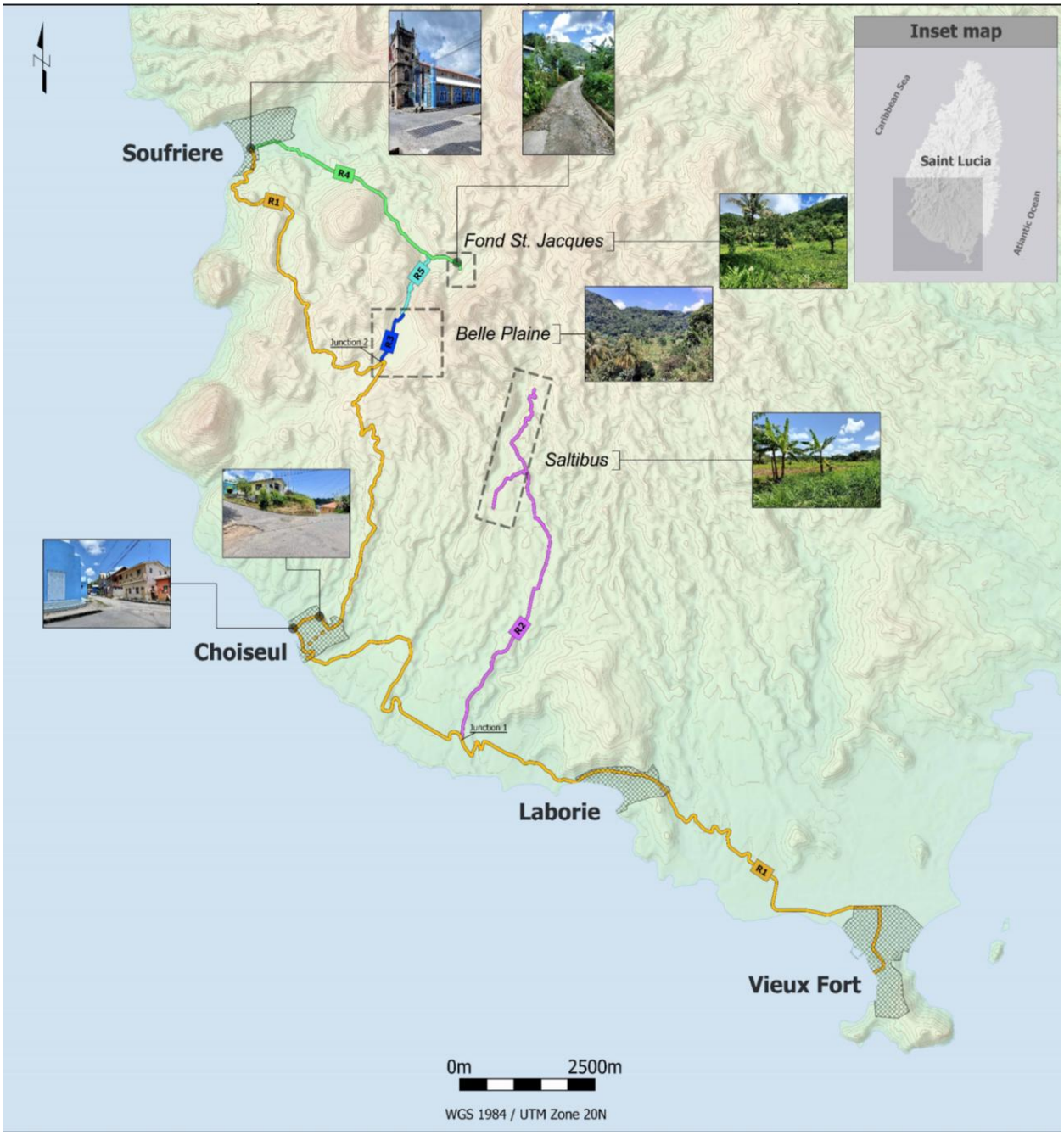
3.3.2 Access Roads

The equipment and materials will be transported from the port to the well pad and staging areas 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.

Saltibus

The access road network to the MS-1 staging and storage site is suitable for transport of materials and supplies and no access improvements are proposed for MS-1. Approximately 370 meters of the existing unpaved road to the S-5 site 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 width and alignment as the existing road, but the road surface and drainage will be stabilized. The road will remain accessible to individuals residing along the road throughout the duration of construction. Measures to maintain road access are further described in Section 5.2.8.

Figure 3.3-1 Access Roads from Vieux Fort to Saltibus and Fond St. Jacques



Source: (ELC, 2024)

Fond St. Jacques

Approximately 290 meters of the existing road will be improved to allow access to the Fond St. Jacques well pad. The unpaved road is currently 2 meters wide. The road width will increase to 3.5 meters and the road width will be wider at the turn adjacent to one residence. A residence and electric utility pole will need to be relocated to allow for the increased turning radius and vehicle passage. The road surface will be stabilized with crush rock and subbase. The drainage will be improved on both sides of the road and a turnout will be added to allow for vehicle passing. The increased road will be located on private property.

3.3.3 Equipment and Material Storage

Saltibus

Equipment and material storage will occur at site MS-1. The MS-1 storage and staging site will be approximately 1 hectare (2.5 acres). The further northern portion of the site of approximately 0.8 hectare (2 acres) will be used for storage of stockpiled soil removed from the well pad. The southern portion of the staging area will be used for storage of casing for the geothermal well and other materials that lack sufficient space at the well pad. A temporary storage warehouse/facility will be located at the MS-1 staging area to house equipment and parts. The MS-1 storage/staging site will be cleared of vegetation/crops prior to use and leveled. A driveway will be constructed to provide access to the MS-1 site. Gravel and drainage materials may also be installed to facilitate all weather access. Equipment and materials will be transported from the MS-1 site to the S-5 well pad site daily as needed during drilling activities. A security fence and lighting would be installed around the MS-1 storage site, and security guards may be stationed at the sites.

Fond St. Jacques

Equipment and material storage will generally occur within the Fond St. Jacques well pad site. Some materials/parts may be stored at a temporary storage area on the Belle Plaine site and transported to Fond St. Jacques as needed. 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.

3.3.4 Well Pads

Well pads will be developed at each drilling location where the drilling equipment and materials will be positioned. The well pads 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 (located at MS-1 for S-5 well pad)

- Offices (located at MS-1 for S-5 well pad)

Well pad development will include removing vegetation including trees from the well pad site include the area of grading. The grading plan and well pad layout for Saltibus (S-5) and Fond St. Jacques are shown on Figure 3.3-2 and Figure 3.3-3, respectively. At Saltibus (S-5) a terrace will be excavated into the hill slope and large trees (e.g., greater than 36 inches diameter at breast height) on the outside edge of the well pad shall be retained, if possible, to provide slope stability. The excavated materials from MS-5 will be stored at MS-1.

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

At Saltibus (S-5) a drainage system is essential to prevent possible erosion and landslide along the pad slopes. Surface rainwater shall be collected by a network of drainage ditches to be constructed on the slopes and berms at the perimeter of the well pad. Horizontal slotted pipes shall be inserted in the slopes in order to release the soil pore pressure and ensure efficient drainage around the well pad. At Fond St. Jacques drainage ditches will be trenched into the hill slope above the well pad to help collect shallow groundwater and direct the water to the water storage pond.

Concrete Cellar and Laydown

A reinforced concrete cellar will be constructed around the well within each 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. A laydown area (14 x 12 meters) will be located adjacent the drilling rig for temporary laydown of casing and other components required for the drilling operations.

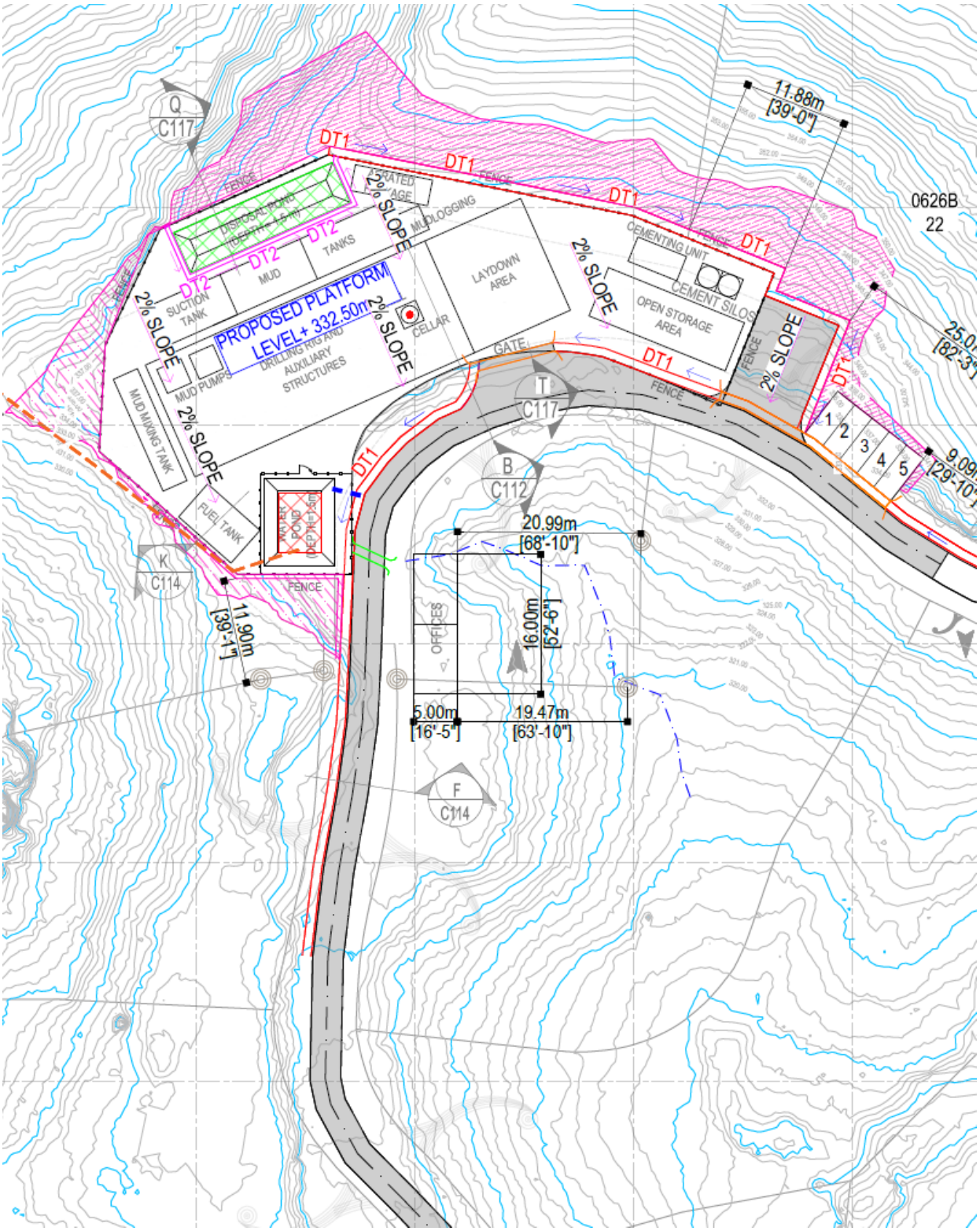
Mud System

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), 1 suction steel tank (10 x 5 meters), 1 steel mixing tank (3 x 14 meters), and 2 mud pumps (3 x 3meters). A mudlogging unit container (9 x 3 meters) 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

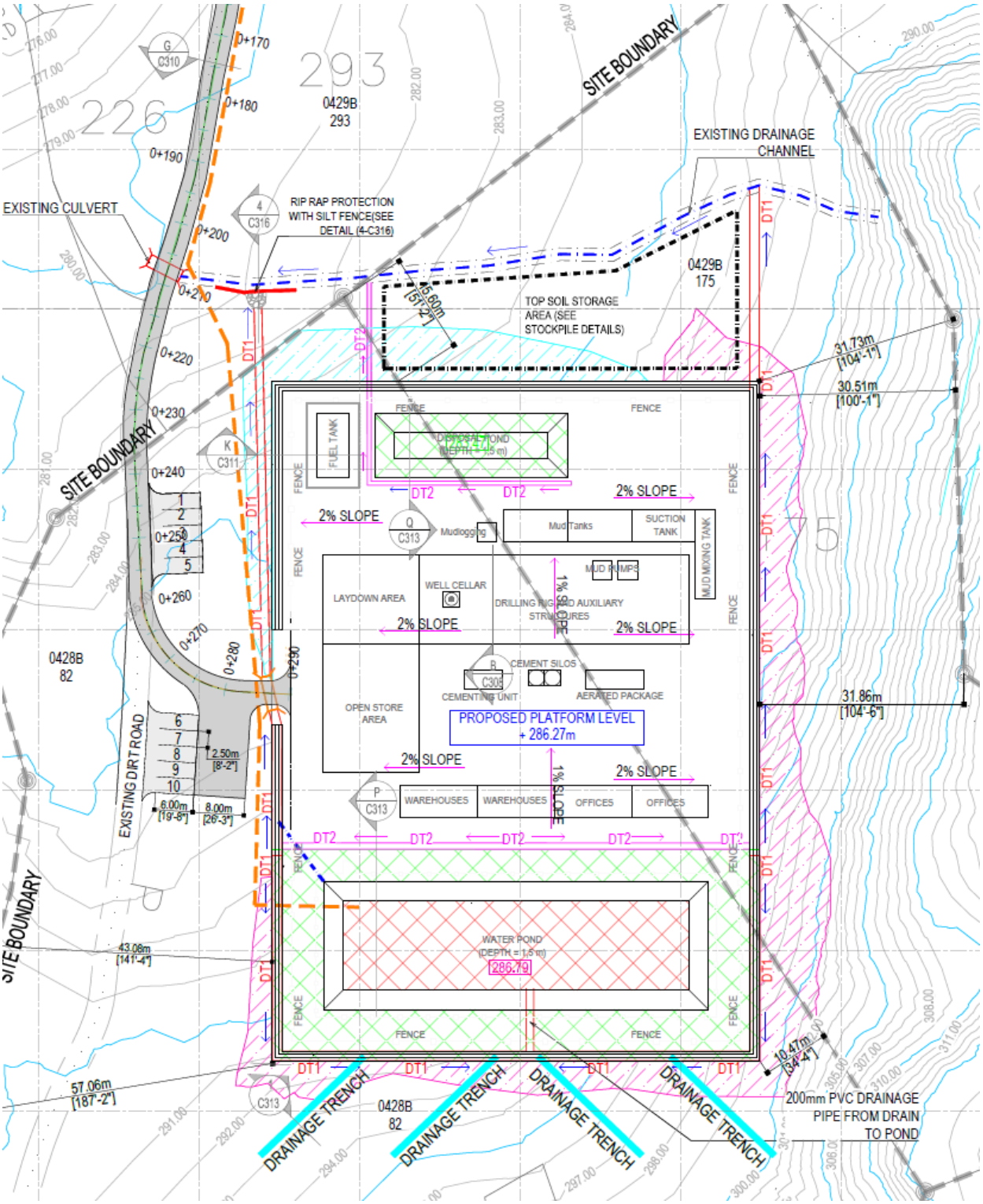
The air system will be located near and at the same elevation as the drilling rig. A typical aerated drilling package consists of compressors, air dryer unit, boosters, soap tank, soap pump and an air-water (or mud) separator.

Figure 3.3-2 Saltibus (S-5) Well Pad Grading and Site Layout



Source: (ELC, 2024)

Figure 3.3-3 Fond St. Jacques Well Pad Grading and Site Layout



Source: (ELC, 2024)

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) 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 waterproof membrane in order to prevent any leakage of the drilling waste/drill cuttings into the groundwater. The pond at Saltibus (S-5) is approximately 20 x 5 meters and approximately 30 x 10 meters at Fond St. Jacques. 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. At the Fond St. Jacques site, the water collected by the drainage ditches uphill of the pad will also be conveyed into the water pond to allow for use of the water and to prevent run-on to the main pad site. The water pond will be lined with a temperature resistant and waterproof membrane to prevent any contact with the groundwater. The dimensions of water pond are approximately 10 x 8 meters at Saltibus (S-5) pad and 60 x 20 meters at the Fond St. Jacques pad. The water pond will be approximately 1.5 meters 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. This area is very small at Saltibus (S-5) due to the limited area available at the pad, while it is larger at Belle Plaine and Fond St. Jacques.

Offices and Workshops

Offices will be made of standard containers of 12 x 2.5 x 2.6 meters (length x width x height). The office at Saltibus (S-5) will be located adjacent to the S-5 well pad.

Fence

The well pad site shall be secured with a vinyl coated chain link fence approximately 2.4 meters (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 at the well pad. 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 each 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 high during transport and can be extended to a maximum height during drilling of 32 meters for super-single type drilling rigs and 45 meters for telescopic double drilling rigs.

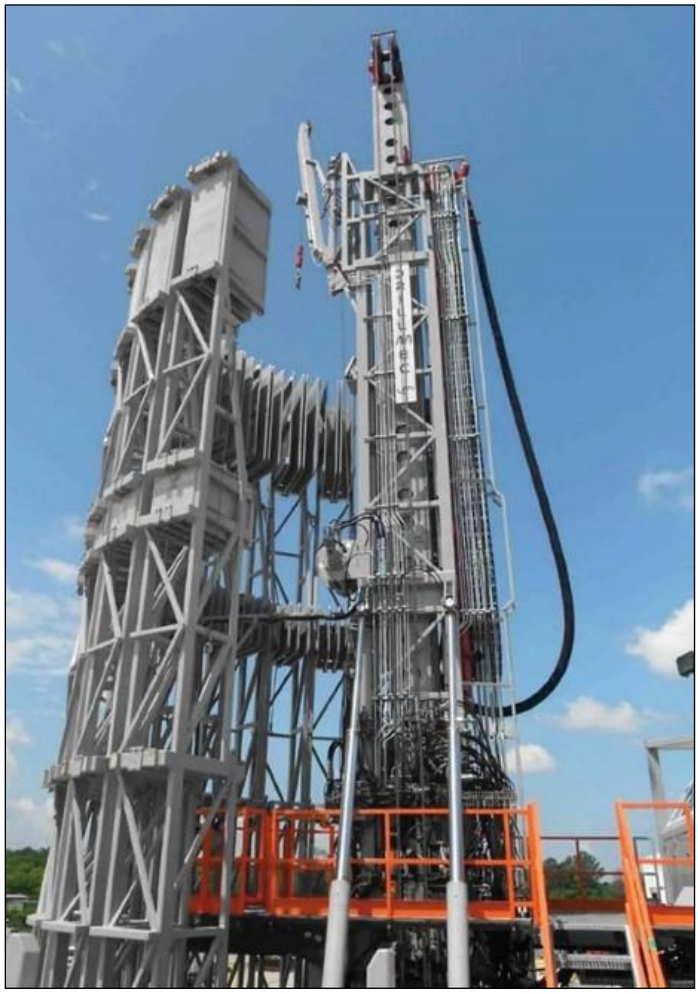
The slim hole wells are planned to reach a total depth of 1,500 to 1,800 meters (approximately 5,000 to 6,000 feet). The deepest cemented casing string will be set to approximately 750 meters depth (approximately 2,500 feet). A blowout-preventer (BOP) would be installed within the cellar above the 7-inch casing. The 7-inch casing will be set to a depth of approximately 250 meters (approximately 820 feet). Two 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.

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 required for drilling activities shall be pumped from streams flowing nearby the well pads. Water demand for drilling is estimated to range from 4 to 11 liters/second (l/s) and water supply will need to be continuous to ensure continuous drilling. The water pond on each well pad will provide water supply for well drilling.

[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 lps. 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.

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



At Saltibus (S-5) a temporary sandbag weir will be installed in the River Doree below the well pad. At Fond St. Jacques a temporary sandbag weir will be installed within the stream approximately 200 meters north of the well pad. The temporary weir will be approximately 1.5 to 2 meters high. At each water supply site, two pumps rated 15 l/s will be housed adjacent to the river and outside of the normal high water. A temporary HDPE water pipeline will be installed to transport the water from the abstraction site to the well pads.

If the available flow from the water supply is not sufficient for the drilling needs at Fond St. Jacques, the additional water will be delivered to the site by water tank trucks of about 20,000 liter capacity. Considering that the drilling activities may require a peak demand of water of 11 l/s, 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 each 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 use of 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. This will assure a strong reduction of noise of high frequencies. Flow testing would be conducted as allowed by the temporary storage volume 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 Well Abandonment and Site Reclamation

The commercial potential of each 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) will remain in place for future testing or monitoring. The well head 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.

If a well is not determined to have commercial potential, monitoring of the well may continue or the well may be abandoned. Well abandonment typically involves plugging the well bore with enough cement to ensure that fluid in the reservoir would not flow into different aquifers;

the casing would remain in place. Any wellhead equipment would be removed from the well, and a metal cap would be welded to the casing.

At Saltibus (S-5), the well pad site will be graded to provide slope stabilization. At Fond St. Jacques 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. The materials at the Saltibus (MS-1) site will be removed and excess topsoil removed from site S-5 may be applied to the MS-1 site to enrich the soil conditions or the clean soil materials may be used in other commercial uses. 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 of shipping containers with a roof structure will be built at MS-1 storage area to protect construction materials from the rain. Wells 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 however 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 would 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. Any drill cuttings that exceed the toxicity threshold for hazardous waste would be treated as hazardous waste and disposed of off-site. Drill cuttings that do not exceed the toxicity threshold will be reused in commercial applications such as in road construction. Testing will occur prior to disposition of the material.

A sanitary toilet cabin with mobile septic tank seized for the planned workforce will be installed by the contractor at each well pad and will be maintained in a clean condition.

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	3 months	Up to 50
Well Drilling (per well)	2 to 3 months	Up to 45
Well Production Testing (per well)	1 week to 1 month	Up to 15
Well Abandonment and Pad Reclamation	1 month	Up to 15
Grand Total	**2 to 8 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

At the national level, Saint Lucia benefits from an extensive water supply network managed by the Water and Sewage Company (WASCO). Water supply in rural areas like Belvedere, Fond St. Jacque, and Saltibus 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 like Fond St. Jacque, 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.

In both Soufrière and Laborie, 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, with Soufrière and Laborie 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 Fond St. Jacque and Belvedere. This access enhances the community's overall quality of life, reducing the burden of water scarcity. Laborie showcases a similar trend in water access, with around 90 percent of households connected to a public piped water supply. Laborie also has a reliance on springs, and rivers, especially in outlying areas like La Clay and parts of Saltibus.

A household survey conducted in 2017 indicated that the majority of households in the affected communities 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.

Surface Water Resources

Saltibus

The Saltibus S-5 site is located near the crest of a ridge along the east side of the Doree River. S-5 is located 130 meters from the river, and the slope from the site to the river is steep (54 percent grade). WASCO operates a diversion from the river approximately 0.5 kilometer upstream of the project. There is no permitted extraction or intakes on the River Doree downstream of the project. River flow is not measured at the WASCO intake location. Flow data from a gage near the mouth of the river 6 kilometers downstream of the project site indicates a dry-season baseflow consistently around 150 l/s. Thirty-six percent of the Doree River watershed is upstream of the S-5 site, and it is reasonable to estimate base flow at the project site as 36 percent of base flow at the gage, or 54 l/s.

Fond St. Jacques

The primary surface water resources in the Fond St. Jacques area include two small streams/drainages that flow adjacent to the project site and Soufriere River approximately 100 meters north of the project site. A spring discharge is also used by WASCO as a water supply. WASCO maintains a collector vault to collect spring discharge immediately uphill from the project site. WASCO does not extract water from the river downstream of the project (King, 2024). There are no permitted water extractions downstream of the project.

Groundwater

Saltibus

The Saltibus well pad site is located at the top of a hill slope along a ridgeline. No groundwater resources are present within the well pad site. MS-1 is located within a flat area that is used for agricultural production. No groundwater resources are known to occur in the area and the geotechnical test pits were dry at the time of excavation (ELC, 2024b); however, groundwater may be present in the area at depth.

Fond St. Jacques

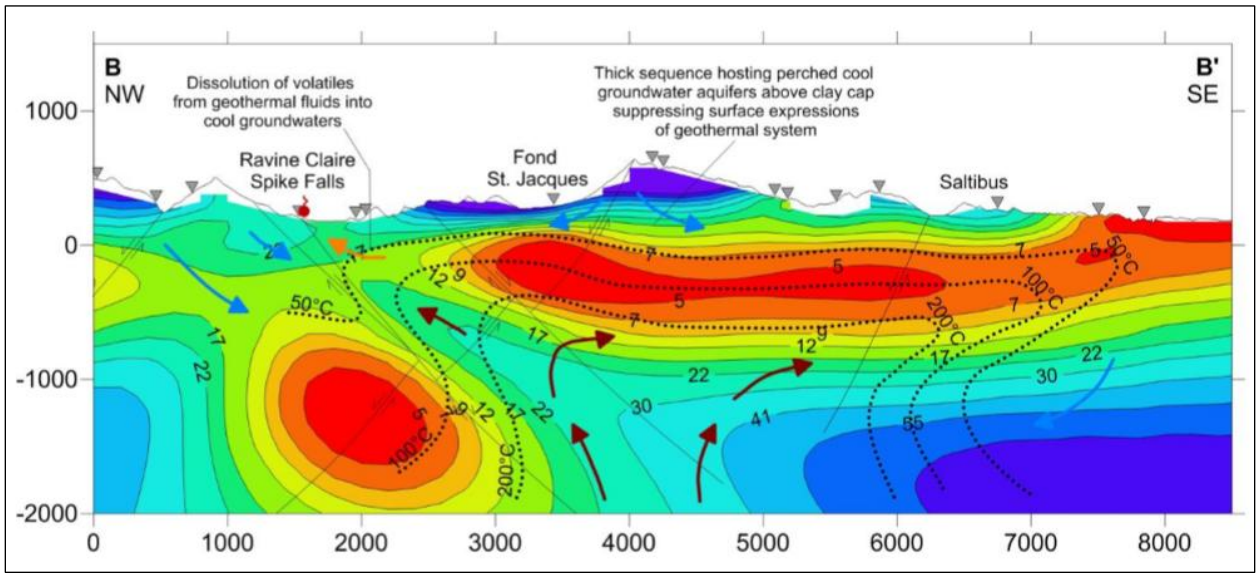
Shallow groundwater occurs within the Fond St. Jacques well pad area. Soils were saturated and shallow groundwater penetrated the test pit at the time of geotechnical investigation in 2024 (ELC, 2024b). WASCO maintains a catchment uphill and southwest of the proposed well pad location. The catchment collects water from a spring uphill of the well pad and transfers the captured water to a water storage tank downgradient and northwest of the well pad

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.

Figure 4.2-1 Schematic Conceptual Hydrogeologic Model



Source: (Jacobs 2016)

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.

Saltibus

No water quality data were found for the Doree River near the project site. Eight samples from the Doree River near its mouth (6 kilometers downstream of the Saltibus S-5 site) were all low in turbidity and in regulated constituents that were measured (total dissolved solids, chloride, nitrate, iron and zinc).

Fond St. Jacques

The Fond St. Jaques project site is in the headwaters of the Soufriere River watershed, with only 0.69 km^2 of upslope drainage area (4.5 percent of total Soufriere watershed area). Data for 10 raw and 22 treated water samples collected during 2010 to 2017 from two sampling locations in the Soufriere River watershed were provided by WASCO. At both locations, the raw and treated data sets included positive results for fecal coliform. Other constituents occasionally detected above the U.S. secondary drinking water maximum contaminant levels were aluminum, iron and manganese. Nine samples from the Soufriere River in the town of Soufriere

(6 kilometers downstream of the drill site) during 2022 to 2024 were consistently high in turbidity (greater than 5 NTU).

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. Levels of particulate matter 10 microns or less (PM_{10}) and 2.5 microns or less ($PM_{2.5}$) were measured in the Saltibus and Fond St. Jacques areas in September 2024 (Table 4.2-1). Both levels were below the World Bank guideline for PM_{10} and $PM_{2.5}$ of 50 µg/m³ and 25 µg/m³, respectively.

Table 4.2-1 PM_{10} and PM2.5 Measurements

Location	24-hour Average PM_{10} (µg/m³)	24-hour Average $PM_{2.5}$ (µg/m³)
Saltibus	6.1	3.5
Fond St. Jacques	16.4	9.3

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 hydrogen sulphide (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/m³. It should be noted that the WHO guidelines are for annoyance, with potential eye irritation likely caused when concentrations reach 150 µg/m³ or above. A 20-day SO_2 average concentration of 292 µg/m³ 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/m³ 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 either Saltibus or Fond St. Jacques. Therefore, ambient levels of SO_2 in the project area would be de minimis.

4.2.3 Geology and Soils

Geology

A geotechnical investigation was conducted at the Saltibus S-5 well pad, MS-1 storage area, and Fond St, Jacques well pad in 2024. The results of the geotechnical investigation are discussed below.

Saltibus

Saltibus S-5 well pad is located at the top of a ridge line perched above the River Doree. The slopes along the edge of the well pad drop off steeply toward the River Doree. There is evidence of prior landslides on the hill slopes near the well pad. Due to the steeply sloping terrain of the site, the area is generally at risk of landslide and erosion. The geotechnical investigation indicates soils have a plasticity index of 6 to 7 and low in three of the 4 bore pits and 28 in the fourth bore pit. The soils are suitable for the well pad (ELC, 2024b).

The MS-1 staging and storage area is located on a large, raised field. The geology of the area is composed of pyroclastic flows containing pumiceous and andesitic deposits. The outcrops of these units can be found along the road cuts on the eastern side of the main road adjacent to the area. MS-1 soils are currently supporting agricultural production. The geotechnical investigation indicates soils at MS-1 have a plasticity index of 6 to 9 and are suitable for storage of materials (ELC, 2024b). Soils in the MS-1 are currently used for agricultural production but have reduced nutrient loads and are not of high value.

Fond St. Jacques

Fond St. Jacques is located in a depression surrounded by steep mountains. The geology of the area is composed of block and ash flow deposits that possess a high permeability, through which several freshwater springs emanate. It is evident that this area has extensive agricultural activity located on both flat and mountain slopes; crops include bananas, coconuts, and cocoa, among others.

Soils in the Fond St. Jacques well pad are saturated due to shallow groundwater and spring flows. The geotechnical investigation in Fond St. Jacques found that soil conditions and drainage would need to be remediated due to oversaturation of the well pad soils (ELC, 2024b).

Soil Erosion

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 ambient noise levels were measured in the project area. 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 4.2-2 provides the average and the extreme high and low noise levels measured at Saltibus S-5 and Fond St. Jacques during daytime and nighttime hours.

There are numerous residents living in the vicinity of the well pad at Fond St. Jacques, which are considered noise-sensitive receptors. Planning contours at intervals of 100, 200, 300, and 400 meters from the outer edge of the Saltibus and Fond St. Jacques well pads are shown on

Figure 4.2-3 and

Figure 4.2-3, respectively.

Table 4.2-2 Existing Daytime Ambient Noise Levels

Area of Impact	Average (dBA)	Range (dBA)	Extreme Noise Sources during Measurements
Saltibus (daytime)	44.2	33 to 70	High noise levels due to falling breadfruit.
Saltibus (nighttime)	55.7	43 to 73	High noise levels due to falling breadfruit. Frogs and wildlife contributed to elevated nighttime noise levels.
Fond St. Jacques (daytime)	46	38 to 65	High noise levels due to vehicles.
Fond St. Jacques (nighttime)	54.5	40 to 62	Frogs and wildlife contributed to elevated nighttime noise levels.

Figure 4.2-2 Saltibus Noise Planning Contours

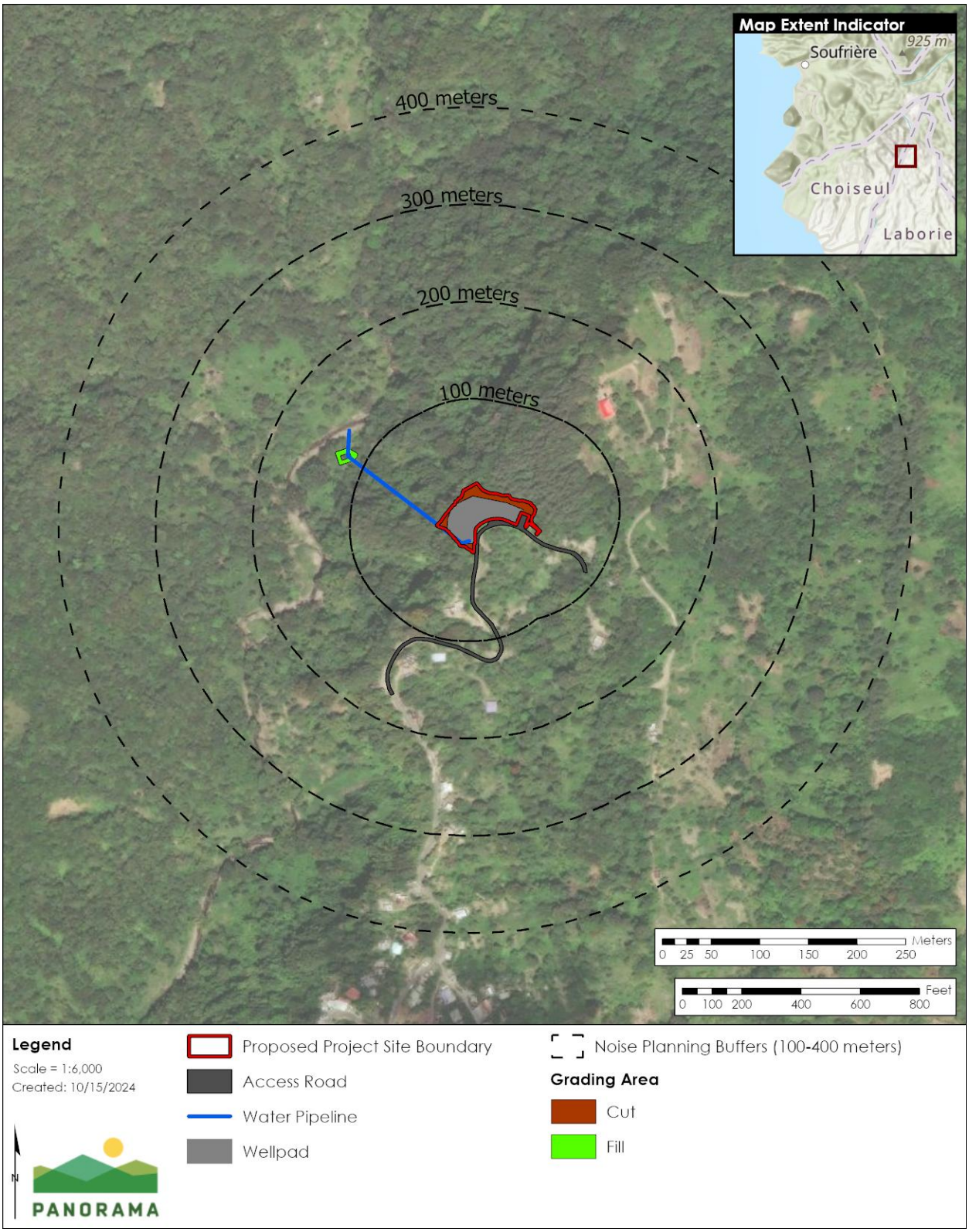
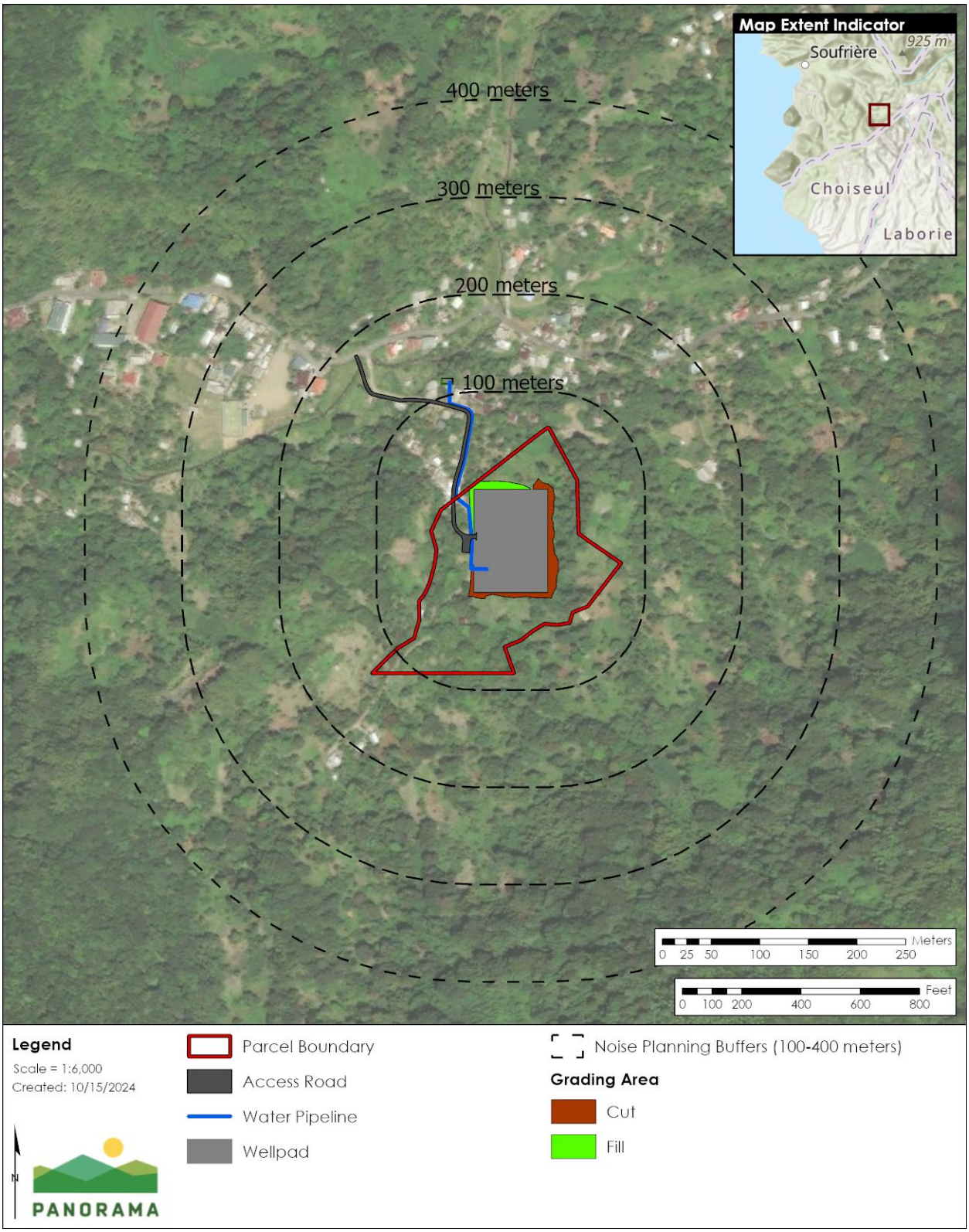


Figure 4.2-3 Fond St. Jacques Noise Planning Contours



4.2.5 Natural Habitats and Biodiversity

Flora and fauna species observed within the project area are provided in the Scoping Studies Report (Appendix C). No endangered or priority floristic, mammalian, herpetofauna, or insect species were encountered during surveys at Fond St. Jacques or MS-1 storage area. Several priority bird species and endangered bird species were observed in the forested habitat at Saltibus S-5 and numerous native plants were observed on the S-5 site.

Vegetation Communities/Habitat Characteristics

The dominant vegetation types and habitat characteristics of each project area are summarized in Table 4.2-3, below. The Saltibus well pad consists of forest habitat, which was cleared at some point in the past and replanted. Seventy-five species of flowering plants and ferns were recorded on the S-5 site, mostly tree and shrub species. Common weedy species were not recorded. Eleven species appear to be cultivated, although some of these species may also be self-seeding. Eight species are naturalized and fifty-six species are native. A total of 49 trees > 10 centimeters diameter at breast height (dbh) occur on the site. No endemic Saint Lucia trees occur on the site. The only tree species that was rare for the region is *Turpinia occidentalis* (IUCN least concern). No endangered species occur on the site.

The MS-1 storage area is subject to agricultural cultivation and does not contain native species or habitats due to the active agricultural activities on the site. Similarly, the well pad at Fond St. Jacques consists of a generally fallow agricultural area with areas of coconuts and agricultural production. Both MS-1 and Fond St. Jacques are characterized by a lack of native habitats or vegetation communities. Forested areas occur on the hill slope to the east of the Fond St. Jacques well pad.

Fauna

Table 4.2-4 provides a summary of the common faunal species documented in each project area and surrounding area of influence (i.e., habitat areas within approximately 300 meters [1,000 feet] of the potential drilling sites). The MS-1 storage area and Fond St. Jacques well pad areas were characterized by a lack of native habitats. Both MS-1 and Fond St. Jacques well pad are characterized by a lack of suitable habitat due to agricultural production on the site and surrounding development; however, the surrounding forested edge east of Fond St. Jacques provides natural habitat for bird species.

Table 4.2-3 Habitat and Dominant Floristic Species by Area

Area Name	Description of Vegetation/Habitat Conditions	Dominant Vegetation
Saltibus S-5	The site is steep and partially forested with an incomplete upper canopy. There were relatively few tall trees interspersed among smaller tree species, saplings, shrubs and arborescent herbs. The species mix indicated that there has been agricultural clearance in the past with some persisting planted trees, and some planted reforestation species. Wild plants and cultivated species typical of disturbed forest edge were also regenerating with seeds spread from surrounding areas	The site probably was cleared of the native forest in the past to enable crop species to be planted. Given the history of clearing and replanting, the area the site does not contain "natural habitats" as defined in World Bank OP 4.04. The ridge area with some large specimens of *Ocotea leucoxylon* was spared this clearance. The site seems to have been abandoned for several years and is reverting to a mix of wild, naturalized and persisting cultivated species. Thirty species of tall trees were identified. Three were naturalized crop trees and twenty-seven were native. Of the natives, five were Caribbean endemics, with one of these being a Lesser Antillean endemic. Fourteen species of small trees were recorded of which five could be planted or self-seeding. Of the wild species present, six species were Caribbean endemics of which five are Lesser Antillean endemics and one was a Saint Lucian endemic. There were some very large specimens of the Caribbean endemic *Anthurium cordatum, sidjinn*, an epiphyte often found on cliffs, and the Lesser Antillean endemic *Lobelia cirsiifolia,* often found on wet roadsides, was also present. *Hedychium coronarium, lavende*, the invasive ginger family species, was growing in large clumps.
.MS-1 (Storage Area)	The MS-1 area is a formerly intensive agricultural area that is now limited to sparse cultivation. There are many common weedy herbs and shrubs found on the site.	The area is dominated by herbs and shrubs including *Andropogon bicornis, Urena lobata* and *Ipomoea tiliacea* along with grasses such as *Andropogon bicornis, Cenchrus purpureus, Chloris ciliata* and *Eragrostis pilos.* Additional cultivated vegetables and fruit trees are present.
Fond St. Jacques	The Fond St. Jacques east area is very swampy and most of the site is saturated. The area is covered by an herbaceous flora of mainly grasses and sedges, with some weedy shrubs and scattered fruit trees. The area is bordered by some large trees except where it forms a boundary with the road. There are patches of cultivated dasheen (*Colocasia esculenta*), a crop that thrives in swampy conditions. Cows graze in the area.	The area is dominated by the grass *Paspalum paniculatum* and large areas covered by the sedge *Fuirena umbellata.*

Sources: (Panorama Environmental, Inc., 2017; Graveson R. a., 2024).

Table 4.2-4 Faunal Species and Conditions in the Area of Influence

Area Name	Birds	Mammals	Herpetofauna	Insects
Saltibus S-5	A total of 24 bird species were recorded in the S-5 study area. The results indicated that 5 endemics, and 9 of 16 Saint Lucia Priority Bird Species were occurring in the study area with varying geographic distribution and behavior. Three avifauna species occurring on S-5 are listed in the International Union for the Conservation Nature (IUCN), Red List of threatened Species. The Saint Lucia Oriole, and the Saint Lucia Black finch are listed as endangered (EN); and the Saint Lucia parrot is currently listed as Vulnerable (VU) in IUCN Red List of threatened Species. The remaining species found occurring are classified as Least Concerned (LC), meaning that there is no immediate threat to the survival of these bird species.	None recorded.	None recorded.	Not recorded.
MS-1	A total of 20 species of birds were recorded in the MS-1 study area. The bird species encountered were very similar to Belle Plaine and Fond Saint Jacques East, owing to the similar biodiversity and rich ecotone in the forest edge surrounding the potential drilling sites, which provide an ideal habitat. Four of these species are classified as priority species, two of which are Saint Lucia endemic species: Saint Lucia pewee (*Contopus oberi*) and Saint Lucia warbler. Both Saint Lucian endemics were common for the site, which is consistent at the national level.	None	Three reptile species were recorded in the study area, including: • Saint Lucia anolis lizard (*Anolis luciae*) • Common House Gecko (*Hemidactylus mabouia*) • Slipperyback Skink, known as Zandoli tarre (*Gymnopthalmus pleei*)	Very few insects were observed and none were identified to a species level.
Fond St. Jacques	A total of 29 bird species were detected in the Fond St. Jacques east area. The majority of the detected bird species are resident species. Five Saint Lucia endemic species were observed during surveys. Three priority species were observed including: • Saint Lucia parrot (*Amazona versicolor*) • Saint Lucia black finch (*Manospiza richardsoni*) • Saint Lucia oriole (*Icterus laudabilis*)	Seven mammal species were recorded in the study area. These include, the small asian mongoose (*Herpestesou ropuntatus*) the opossum (*Didelphis marsupialis*), rats, and mice. All species are introduced to Saint Lucia and are classified as alien invasive wildlife. Two species of bats, a fruit bat (*Monophyllus plethodon*) and an insectivorous bat (*Bracyphyllus cavernum*) were found in this study area. These species are not considered endangered.	Three reptile species were recorded in the study area including • Saint Lucia anolis lizard (*Anolis luciae*) • Common house gecko (*Hemidactylus mabouia*) • Slipperyback skink, known as Zandoli tarre (*Gymnopthalmus pleei*) One amphibian, the cane toad (*Rhinella marina)* was encountered in the study area. The habitat is ideal for this species, which is considered an invasive species.	Butterflies, dragonflies, and bees were the most common insects observed in the study area. Dragonfly species were the most common insect group. The presence of a wet surface provides ideal habitat for the majority of dragonfy species.

Sources: (Panorama Environmental, Inc., 2017; Graveson R. , 2017)

4.2.6 Archeological and Cultural Resources

Saltibus

surveys conducted by Leiden University between 2002 and 2004 identified several pre-Columbian sites near Saltibus and Londonderry. These findings underscore the significance of the region in terms of its archaeological heritage. The S-5 site lies further into the interior of the island. The interior of Saint Lucia, densely vegetated and challenging to explore, contains only a few known pre-Columbian sites. The field survey of the site revealed no evidence of pre-Columbian occupation. This absence suggests that the site was not a settlement or activity area during pre-Columbian period. In addition, there was no evidence of material remains from the colonial or plantation period (Phulgence, 2024).

The MS-1 site contains both prehistoric and early colonial artifacts. Areas within MS-1 that are contain historical and prehistoric resources are shown on Figure 4.2-4 . There is a strong likelihood that the storage area at MS-1 is within the eighteenth and early nineteenth century slave village at Parc Estate, one of the largest plantations and slaveholdings in Saint Lucia. A fairly sizeable amount of prehistoric Amerindian materials were observed during pedestrian surveys at MS-1 including within the storage area. 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.

Fond St. Jacques

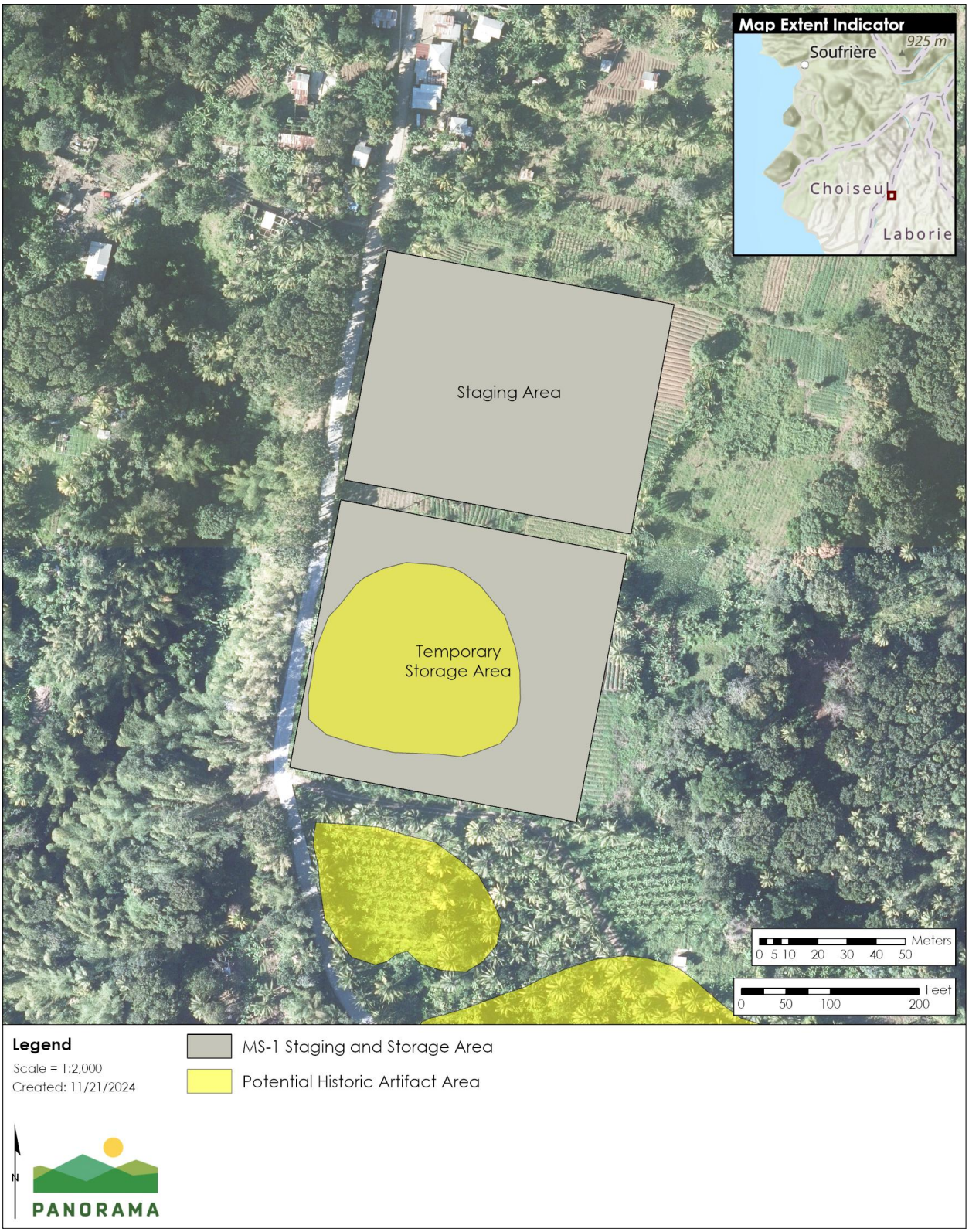
The drilling areas at Fond St. Jacques have been heavily developed or located in a historically swampy area where settlement is unlikely. No archeological artifacts were identified at the Fond St. Jacques areas during pedestrian surveys. For these reasons, the well pad at Fond St. Jacques is not considered sensitive for archeological sites.

4.2.7 Landscape and Visual Character

The visual resources and landscape views within the S-5 site are limited due to the steep topography and dense vegetation in the area. There are no tourist destinations or scenic vista points in proximity to S-5. A storage shed and storage of coal are visible on the site adjacent to the existing unpaved roadway. Representative photos of the S-5 site are provided on Figure 4.2-5 and Figure 4.2-6.

The MS-1 and Fond St. Jacques sites are typical of agricultural areas in Saint Lucia and provide views of trees, row crops, and fallow agricultural fields. There are no scenic vistas or viewpoints in proximity to MS-1 staging area or Fond St. Jacques well pad. The Fond St. Jacques well pad is only visible within the valley surrounding the potential drilling area due to the steep surrounding hillslopes and topography. Representative views of MS-1 are provided on Figure 4.2-7. Representative views of the Fond St. Jacques well pad and surrounding agricultural areas are provided on Figure 4.2-8 and Figure 4.2-9. Neither Saltibus nor Fond St. Jacques are located within the PMA or green buffer zone and thus would not affect visual resources within the PMA.

Figure 4.2-4 MS-1 Historically Sensitive Areas



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

Figure 4.2-5 View of S-5 Site from Adjacent Roadway

Figure 4.2-6 Storage Shed At S-5 Site

Figure 4.2-7 View of MS-1 Site

Figure 4.2-8 View of Agricultural Area Near Fond St. Jacques Well Pad

Figure 4.2-9 View of Fond St. Jacques Well Pad Area

4.2.8 Geohazard and Natural Disaster Vulnerability

Hurricanes and Tropical Storms

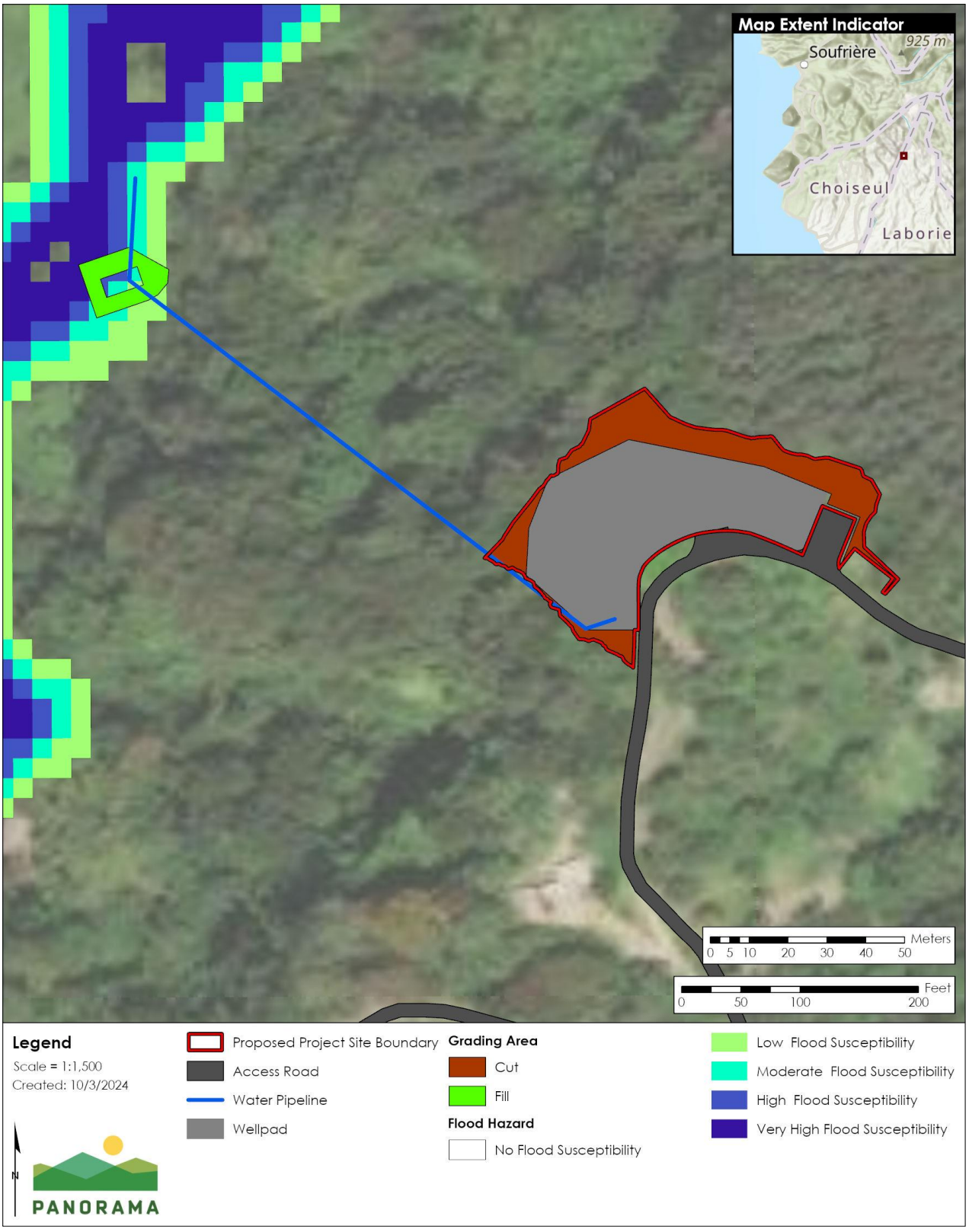
Saint Lucia faces a constant threat from hurricanes and other tropical storms; hurricanes have historically been the most common hazard to impact Saint Lucia (Government of Saint Lucia, 2006). Hurricanes are also the primary cause of widespread slope failure (Government of Saint Lucia, 2006). Recent 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). Floodplains have been designated along the River Doree where the water supply intake for S-5 would be located and along the stream corridor adjacent to the water supply intake for Fond St. Jacques as shown on Figure 4.2-10 and Source:

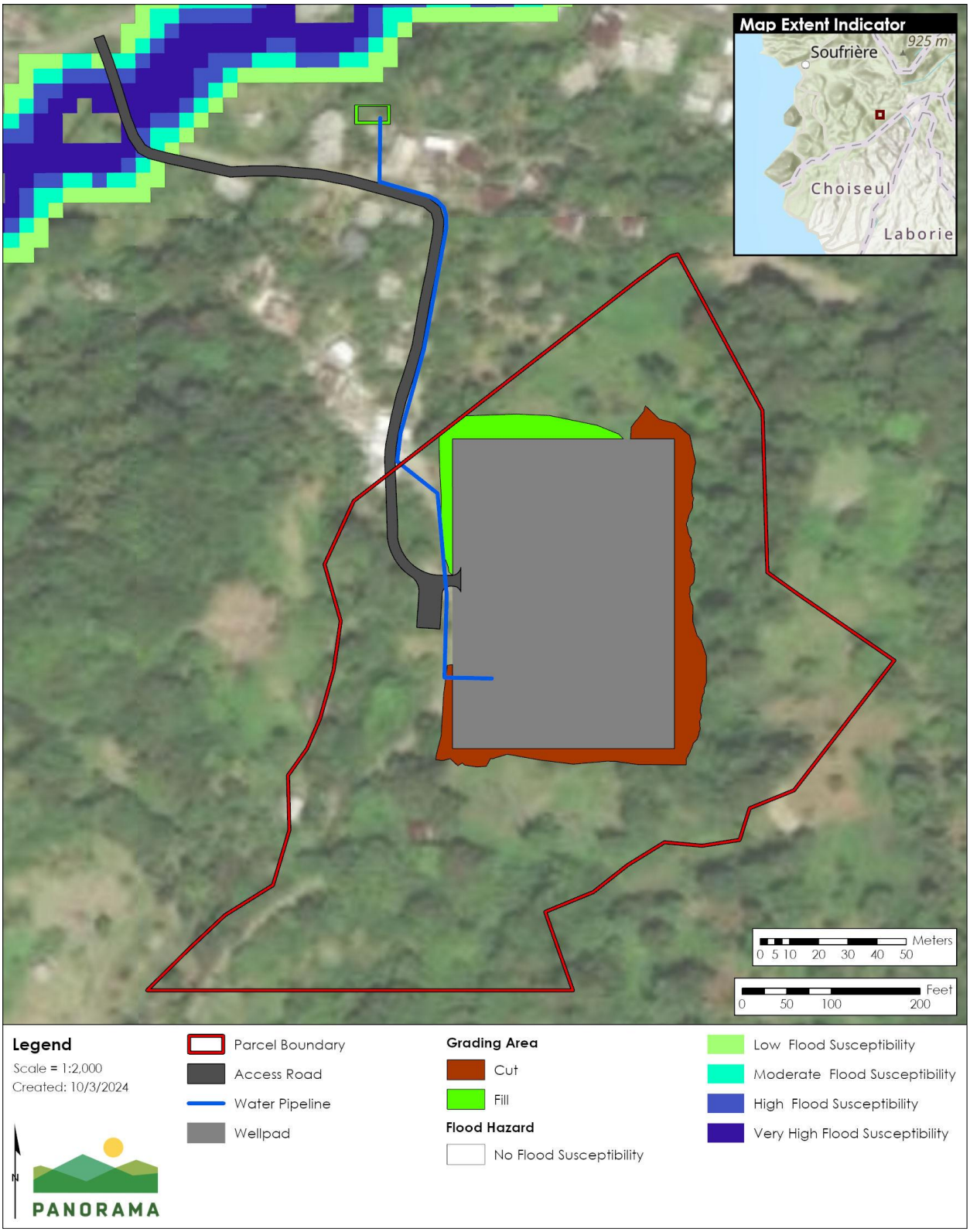
Figure 4.2-11.

Figure 4.2-10 S-5 Flood Hazard Areas



Source: (ELC Electroconsult-SPA, 2024; University of Twente, 2018; ELC Electroconsult-SPA and Theobalds Consulting, 2024)

Figure 4.2-11 Fond St. Jacques Flood Hazard Area



Source: (ELC Electroconsult-SPA, 2024; University of Twente, 2018; ELC Electroconsult-SPA and Theobalds Consulting, 2024)

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 S-5 site is located in a steeply sloping area perched above the Doree River that is prone to landslides as indicated in Figure 4.2-12. The MS-1 site and Fond St. Jacques well pad are located on flat areas where landslide is not a risk. However, the hill slope south and east of Fond St. Jacques could be at risk of landslide particularly due to saturated soil conditions and steep slope. The landslide susceptibility of the area around Fond St. Jacques is shown on Figure 4.2-13.

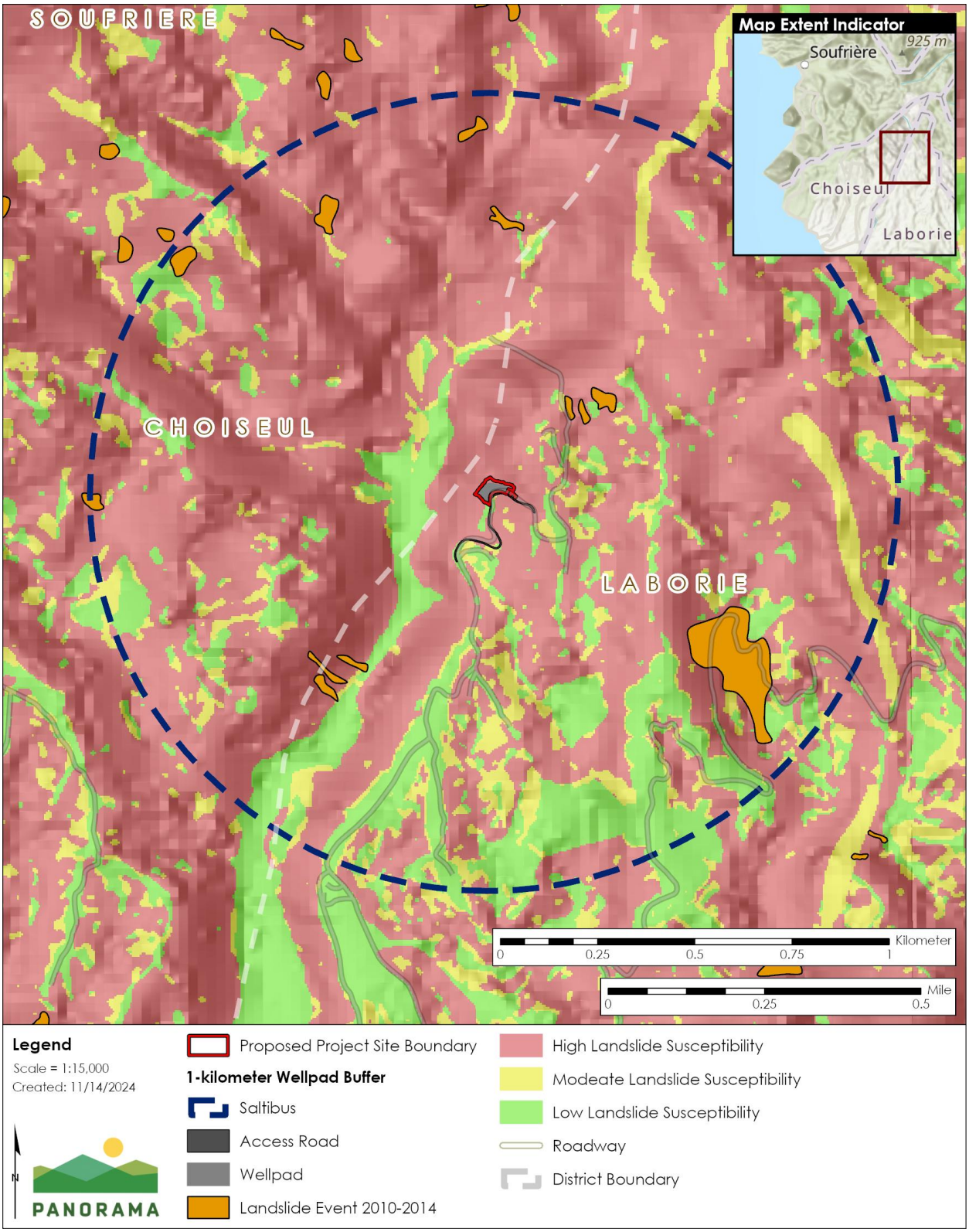
Seismicity and Earthquakes

There are no known active faults within the Saltibus or Fond St. Jacques sites, 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

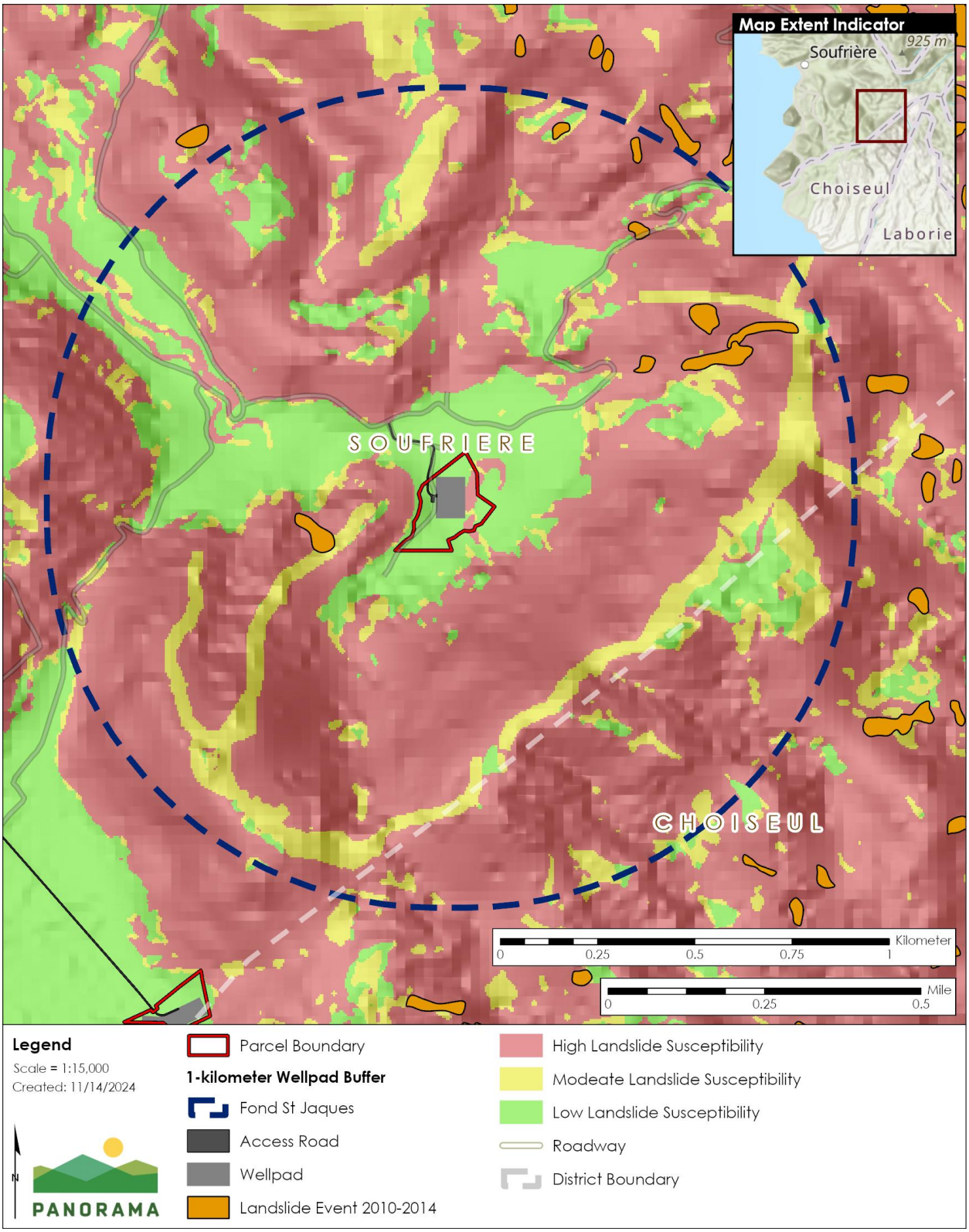
Approximately one third of Saint Lucia is within a moderate, high, or very high volcanic hazard zone identified on volcanic hazard maps (Jan Lindsay, 2002). The drilling area at Fond St. Jacques is in a ‘very high hazard zone.’ The S-5 well pad is in a ‘high hazard zone.

Figure 4.2-12 Landslide Susceptibility Saltibus S-5



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

Figure 4.2-13 Landslide Susceptibility Fond St. Jacques



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

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. In Soufrière, the population declined as a percentage of the national population 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. In contrast, Laborie experienced substantial growth, with its population rising from 4 percent to 5.5 percent. This increase may have been driven by increasing employment opportunities in areas like construction and tourism, as well as improved roads and infrastructure.

At the community level, the trends were even more pronounced. Belvedere witnessed a significant 36 percent population decline, which may be attributed to several factors, including outmigration due to limited economic opportunities, particularly in agriculture, which has been declining in the region. In contrast, Saltibus and Parc Estate saw varying population growth of 22 percent, and 10 percent, respectively. These increases may be linked to emerging economic activities in these areas, particularly in construction and infrastructure projects.

The population estimates for the broader project area communities of Saltibus and Fond St. Jacques in 2022 are listed in Table 4.3-1.

Table 4.3-1 Population and Unemployment Rates of Affected Communities

Affected Communities	Households	Estimated Population		
		Male	Female	Total
Soufrière District	***3,021***	***4,241***	***4,081***	***8,322***
Belvedere (Fond St. Jacques)	120	181	123	304
Laborie District	***3,251***	***4,248***	***4,259***	***8,507***
Saltibus (S-5)	219	265	253	518
Parc Estate (MS-1)	44	60	60	124

Source: (Government of Saint Lucia, 2022)

Several demographic trends and emerging issues have become evident over the past five to six years. One key issue is the rural-urban migration pattern, where rural areas like Belvedere are experiencing population declines as residents move to urban centres or other parts of the island in search of better economic opportunities. This migration is exacerbated by the decline in agriculture, which historically employed many rural households.

Conversely, Laborie's population growth, particularly in Saltibus, suggests that this region is benefiting from increased economic activity, likely linked to construction and infrastructure

projects. The increase in population in these areas could also signal improvements in living conditions, such as better access to services and employment.

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 2022 census data, 49 percent of households are headed by men and 51 percent 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 50 percent) and are more likely than men t 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 (Central Statistics Office of Saint Lucia, 2022).. 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.

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

Gender disparities in employment have also persisted over the past six years. In 2023, the female unemployment rate stood at 17.3 percent, notably higher than the 11.2 percent for males. While both genders experienced reductions in unemployment, the gap remains significant. However, data suggests that as education levels rise, the disparity between male and female unemployment rates narrows.

Females consistently experienced a higher rate of unemployment, countrywide, and at the district and settlement levels. This gender disparity appears to have persisted; whereas the overall unemployment rate for 2022 was estimated at 16.5 percent, unemployment rates for females remained typically higher at 18.5 percent compared to 14.8 percent for males. The difference between the average unemployment rate of females and males decreases as the highest education level attained increases (Central Statistics Office of Saint Lucia, 2022).

The employment rate for population aged 15-plus years is 63 percent for males and 43 percent for females, with a total employment rate of 53 percent[3]. Women are less likely (49 percent versus 69 percent) than men to want to work (labor participation rate). Among those who want to work, they are more likely to be unemployed (12 percent versus 8 percent) (Budlender, 2012). Table 4.3-2 provides a breakdown of employment by gender (aged 15-plus years) for various industries.

Table 4.3-2: Gender Breakdown by Industry

Industry	Male	Female	Total
Agriculture	16%	6%	12%
Manufacturing	4%	6%	5%
Construction	21%	1%	12%
Trade	5%	13%	9%
Hospitality	5%	7%	6%
Transport	8%	2%	6%
Services	29%	36%	32%
Administration/Social Security	5%	9%	7%
Educational/Social Services	2%	11%	6%
Other	5%	9%	7%
Total%	100%	100%	100%
Total Number	34,655	26,856	61,511

Source: (Budlender, 2012)

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 decade, Latin

[3] Employment rates include those who report having done employment-related work over the past seven days, the international standard period for asking about employment.

America and the Caribbean have progressed toward women in high governmental positions. St. Lucia has had considerable 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). Gendered roles are most obvious in the differentiation of cabinet positions held by men and women, where women are more likely to sit in social or cultural-related cabinets rather in economic or political cabinets (Gandini, 2013).

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 percent 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

The majority of the individuals in the Fond St. Jacques area that participated in the 2024 project census reported agriculture/farming and tourism as their primary source of income. Several individuals in the area are pensioners or have informal employment. Of the 26 individuals surveyed in the area, six reported income in the range of $100 to $500 per month, five reported income in the range of $500 to $1,000 per month, 13 reported income greater than $1,000 per month, and two declined to report income.

In La Claye and Parc Estate (Saltibus), the majority of the individual that participated in the 2024 project census reported agriculture/farming as their primary source of income. A few individuals are pensioners. Of the 18 individuals surveyed, three reported income in the range of $100 to $500 per month, ten reported income in the range of $500 to $1,000 per month, three reported income exceeding $1,000 per month, and one respondent was a child with no individual income.

Saint Lucia's economy and livelihoods continues to be 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% of GDP, a significant rise from 8% 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% of GDP in 2023. The sector faced significant challenges in 2023, witnessing a sharp decline of 17%, 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%. 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 Belvedere, 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, especially in Fond St. Jacques, which is closer to the tourist hubs.

Laborie, which includes Parc Estate and Saltibus, is another district where agriculture is a critical livelihood. Similar to Belvedere, farming remains the backbone of the local economy. Parc Estate and Saltibus primarily engage in farming, growing crops for both local consumption and small-scale trade. However, compared to Soufrière, Laborie has a slightly lower integration with tourism.

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 labour 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 4.3-3 presents the results of a sample survey of household employment conducted in 2024 for the affected communities.

Table 4.3-3 Household Employment of Affected Communities

Affected Communities	Percentage of Household Population				
	Employed	Self-employed or Farmer	Unemployed	Retired or Student	Total
Soufrière District					
Belvedere	21.2	36.4	28.8	13.6	100
Laborie District					
Parc Estate	31.8	13.6	40.9	13.6	100
La Clay/Saltibus	25.0	25.0	37.5	12.5	100

The findings of the sample survey are consistent with a similar survey conducted in 2017 and reflect the community/regional situation where a significantly larger share of the household population in Belvedere are either farmers or self-employed.

The income levels in both Soufrière and Laborie are generally low, reflecting the challenges posed by the high unemployment rates. According to the census data, Laborie has an unemployment rate that ranges between 11.9 percent and 12.7 percent, while Soufrière experiences a higher rate of 13.9 percent to 24.6 percent, particularly in the more rural communities such as Belvedere.

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, with some rural communities such as Belvedere and Fond St. Jacques relying on natural spring sources. 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 and Laborie 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

The Fond St. Jacques Primary School and the Soufrière Comprehensive Secondary Schools serves the community of Belvedere and Fond St. Jacques. Saltibus falls within District 7, which has a total of 11 primary schools and 2 secondary schools. Saltibus Combined School serves the community of Saltibus and neighboring communities. Piaye Secondary School is the nearest secondary school to Saltibus.

The 2022 Census Report reveals that education levels in Soufrière and Laborie 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, including Belvedere, 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. Laborie, including Parc Estate and Saltibus, exhibit similar trends in educational attainment.

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 and Laborie.

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. Male enrolment slightly surpassed female enrolment. Notably, Belvedere, one of the affected communities, has experienced a population decline, which has impacted the student population. This mirrors broader national trends where 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. Communities like Fond St. Jacques and Saltibus, which are directly impacted by development projects, face educational challenges due to socioeconomic pressures that affect student enrolment. Gender disparities in educational performance are also evident, with females generally outperforming males across various subjects.

The educational distribution indicates a significant proportion of residents in Belevedere without formal education. Parc Estate shows a similar trend. Both communities have a lower representation of secondary and tertiary education qualifications compared to the national

averages. Saltibus reports higher educational attainment, although a significant proportion still have no formal education.

The 2024 sample household survey revealed that 57 percent of the population across the four impacted communities 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 the WASCO. Water supply in rural areas like Belvedere, Fond St. Jacque, and Saltibus is generally stable, but during the dry season, challenges such as water rationing and shortages are common.

In both Soufrière and Laborie, 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 and Laborie following this trend (Central Statistics Office of Saint Lucia, 2022). 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 Fond St. Jacque and Belvedere. This access enhances the community's overall quality of life, reducing the burden of water scarcity. Laborie showcases a similar trend in water access, with around 90 percent of households connected to a public piped water supply. Laborie also has a reliance on springs, and rivers, especially in outlying areas like La Clay and other parts of Saltibus.

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 Belvedere has high levels of electricity access, consistent with broader trends observed in the region. Laborie which includes Parc Estate and Saltibus also enjoys a high rate of electricity access, with 93 percent of households having public electricity (Central Statistics Office of Saint Lucia, 2022).

Nationally, access to healthcare in Saint Lucia is centred around district hospitals and smaller health centres in rural communities. For residents of Soufrière and Laborie, 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. Both Fond St. Jacques and Saltibus have functioning health centers.

4.3.6 Health and Disease

Saint Lucia faces several health challenges, and like much of the country, the communities of Soufrière (Belvedere and Fond St. Jacques) and Laborie (Parc Estate and Saltibus) 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 and Laborie faced unique challenges due to 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.

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.

Secondary level medical care for the Fond St. Jacques community is available at Victoria and St. Jude Hospital, both of which are about 45 kilometers (28 miles) away. The residents of Saltibus (Parc Estate and Saltibus), have access to the Saltibus health center, which is approximately 5 kilometers (3 miles) away. The St. Jude Hospital is about 30 kilometers (18 miles) from Saltibus and is available for secondary level medical care to the community.

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.

4.3.7 Land Ownership and Housing

In the Fond St Jacque area, according to the 2024 project census, with the exception of one individual who rents their residence, the remaining 25 surveyed reported that they own, or their family owns their primary dwelling unit. Six of the dwelling structures for those who responded to the project survey are in good condition and the remaining structures needed minor to major repairs.

In the La Claye and Parc Estate area (Saltibus and MS-1) two individuals who responded to the survey are squatters and the remaining respondents own, or their family own their primary dwelling unit. Nine of the dwelling units for those who responded to the 2024 project survey are in good condition and seven dwelling units need minor to major repair.

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 and Laborie. These areas, especially Fond St. Jacques and Saltibus, 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.

The predominant building materials for dwellings include concrete blocks, with many homes constructed post-2000. Many residents engage in small-scale farming, supported by the arable land available. The community's housing primarily consists of concrete and wood, with a mix of traditional and modern styles.

Likewise, in Laborie, particularly in Parc Estate and Saltibus, housing development has been impacted by land ownership systems, where family plots are common. In Parc Estate, especially

near the staging site, several farmers cultivate crops on lands leased from Government (Crown lands). Saltibus remains primarily agricultural, and housing patterns are closely tied to farming activity. The community relies heavily on agricultural land, with many residents participating in farming and livestock rearing. The housing structure varies, with a mix of concrete and wooden dwellings, often reflecting the economic status of the occupants.

4.4 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 4.4-1

Table 4.4-1 Cumulative Projects within 2 Kilometers

Application Number	Block and Parcel	Applicant/Developer	Development Type
662/09	0627B 43	Henry Monrose Et Al	Small Sub
7/16	0627B 53	Wasco	Commercial Storage
1070/23	0627B 62	John Baptiste Saltibus Et Al	Small Sub
136/08	0427B 79	Brigette Faucher	Resd. Renovations -
416/03	0427B 74	Thelma Prospere	Residential
797/03	0427B 3	Romeus Abraham	Liquor Licence
158/04	0427B 3	Romeus Abraham	Residential
709/04	0427B 80	Thecla Best	Residential
1122/04	0427B 97	Jeanviera Abraham	Small subdivision
1328/04	0427B 92	Ester Claircin	Residential
56/05	0427B 164	Evarista Abraham	small subdivision
963/05	0427B 28	Perretua Edwardson & Margaret Jerriff	Residential Re Approval-
695/06	0427B 77	Michael Joseph	Liquor Licence
880/06	0427B 74	Thelma Prospere	Residential
1304/07	0427B 74	Thelma Prospere	Small Subdivision
460/08	0427B 20	Margaret Augustin	Residential
643/09	0427B 15	Josephine & Terry Moses	Residential
186/10	0427B 34	David Prospere	Residential
1246/10	0427B 165	Julian Mathurin	Residential

Application Number	Block and Parcel	Applicant/Developer	Development Type
63/11	0427B 123	Garfield Knight	Small Sub
597/11	0427B 35	Margueritte Ann William	Residential
931/11	0427B 123	Margueritte Ann William	Small Sub. Ext.
309/12	0427B 31	Desmond Montoute	Residential
439/13	0427B 67	Joan Alexander	Residential
1079/13	0427B 19	Canisius Marcellin	Residential
1002/16	0427B 18	Florina & Korina Hippolyte	Residential
49/17	0427B 172	Daphney & Evarista Abraham	Small Sub
551/17	0427B 174	Daphney Abraham Et Al	Residential
766/17	0427B 29	Kindall Z. Hippolyte	Residential
707/18	0427B 125	Department Of Youth.	Sign
57/19	0427B 35	Garfield Knight	Residential
184/19	0427B 154	John & Linda Charles	Residential
307/19	0427B 62	Chyr & Justin Alcee	Residential
790/19	0427B 357	Joseph Frankey	Small Sub
170/20	0427B 14	Sulphur Spring Organic	Residential
522/20	0427B 62	Chrys & Justine Alcee	Residential
589/20	0427B 202	Vianney Abraham	Residential
363/21	0427B 175	Mary Louisa Abraham Et Al	Small Sub
421/21	0427B 155	George Johnny	Small Sub
426/21	0427B 75	Simonia Jean	Residential
74/22	0427B 59	Shantel Didier	Residential Ext.
730/22	0427B 15	Kimbert Atil	Residential
733/22	0427B 205	Efedencia Jules	Residential
398/23	0427B 36	Al Aubrey Alexis	Residential
547/23	0427B 197	Margueritte Ann William	Small Sub
1015/23	0427B 213	Luvorn Asha Vitte	Residential
220/24	0427B 29	Kindall Z. Hippolyte	Residential
780/24	0427B 68	Albert-Leonard & Rita Alexander	Residential

Application Number	Block and Parcel	Applicant/Developer	Development Type
636/03	0429B 62	Heirs Of Auguste Gonzague Et Al	Small Sub
651/03	0429B 315	Joseph Popo	Small Sub
873/03	0429B 67	Augustine Gonzague	Small Sub
473/02	0429B 57	Michael Gaiety Production	Residential
386/03	0429B 66	Rachael Poleon	Small Sub
636/03	0429B 62	Heirs Of Auguste Gonzague Et Al	Small Sub
651/03	0429B 315	Joseph Popo	Small Sub
843/03	0429B 67	Cable & Wireless	Commercial
873 /03	0429B 67	Augustine Gonzague	Small Sub
1082/03	0429B 198	Asayma Gabriel	Small Sub
1096/03	0429B 218	Anthony + Louisy Prospere	Residential
269/04	0429B 248	Augustin Gonazque	Small Sub
601/04	0429B 155	Langford Prospere	Small Sub
1121/04	0429B 54	Maxius & Christine Nicholas	Small Sub
1289/04	0429B 2	Leon Calixte	Small Sub
62/05	0429B 253	Lana Baptiste	Residential
105/05	0429B 237	Guillaune Faucher	Small Sub
203/05	0429B 239	Michel Prospere	Residential
245/05	0429B 254	Cecelia Donaie	Small Sub
246/05	0429D 245	Augustin Gonzaque	Small Sub
1002/05	0429B ?	Genise Prospere	Small Sub
1138/05	0429B 209	Cyprian & Seate Jones	Small Sub
1139/05	0429B 254	Augustin Gonzaque	Commericial
1175/05	0429B 13	Donatienne Prospere	Small Sub
175/06	0429B 254	Augustin Gonzaque	Small Sub
1430/06	0429B 126	Augustin Gonzaque	Small Sub
515/07	0429B 252	Joseph Popo	Residential
600/07	0429B 168	Lennox Modeste	Residential

Application Number	Block and Parcel	Applicant/Developer	Development Type
680/07	0429B 43	Julian Emmanuel	Residential
1355/07	0429B 27	Joseph & Mary Popo	Small Sub
336/08	0429B 233	Jean Hepburn Reseduree	Residential
580/08	0429B 278	Augustin Gonzague	Small Sub
252/09	0429B 279	Norbert Francis	Residential
650/09	0429B 226	Bibianus &Celine Joseph	Residential
873/09	0429B 291	Kevin Joseph	Residential
885/09	0429B 22	Maris Auguste	Residential
1037/09	0429B 282	Maxius & Christine Nicholas	Small Sub
1348/09	0429B 281	Cornelius D' Auvergne & Claudette Alfred	Residential
151/10	0429B 25	Orneville Richardson	Residential
269/10	0429B 269	Calixte Anthony & Aldona	Residential
1190/10	0429B 223	John Rose Mary	Small Sub
344/11	0429B 223	Mrs John Rosemary	Residential
388/11	0429B 290	Augusta Dymphma	Residential
394/11	0429B 276	Popo Joseph	Small Sub
463/11	0429B 127	Ministry Of Economic Affairs	Large Sub
523/11	0429B 294	Mark And Pearl Evans	Residential
640/11	0429B 127	Ministry Of Finance	Residential
641/11	0429B 127	Ministry Of Finance	Commercial
1205/11	0429B 227	Emmanuel Julian	Residential Extension
1223/11	0429B 29	Fond St. Jacques Sda Church	Small Sub
148/13	0429B 226	Bibianus & Celine Joseph	Residential Reapproval
284/13	0429B 7	Harold Henry& Andrew Prospere	Residential
421/13	0429B 279	Norbert Francis	Residential
566/13	0429B 246	Rachael Poleon	Residential
754/13	0429B 233	Jean Hepburn	Commercial Extension
178/14	0429B 317	Kerry Ann- & Strain Victor	Residential

Application Number	Block and Parcel	Applicant/Developer	Development Type
421/14	0429B 288	Julian Emmanuel	Small Sub
638/14	0429B 37	Anne Marie Gidharry	Small Sub
912/14	0429B 316	Henry Boniface	Residential
99/15	0429B 349	Anne Gidharry	Small Sub
131/15	0429B 199	Frankey Joseph	Small Sub
416/15	0429B 55	Cletus Prentice & Ricardo Alexander	Small Sub
517/15	0429B 288	Julian Emmanuel	Residential
619/15	0429B 288	Julian Emmanuel	Small Sub
690/15	0429B 96	Cecilia Anatole & Mary Francois Et Al	Small Sub
701/15	0429B 204	Titus And Veran Faucher	Residential
773/15	0429B 40	Angel Jean	Small Sub
812/15	0429B 34	Loretta George & Augustin Henry	SMALL SUB
820/15	0429B 304	Najumar And Ubacuu Alphonse	Residential
1152/15	0429B 356 & 113	Columbus & Sylvarius Philippe	Residential
773/15	0429B 40	Angel Jean	Small Sub
265/16	0429B 362	Loretta George	Residential
365/17	1446B 266	Lucelle Joseph Et Al	Small Sub
441/17	0429B 360	Cletus Prentice& Ricardo Alexander	Small Sub
685/17	0429B 188	Cyril Emmanuel & Thecla Alexander-	Residential
849/17	0429B 344	Leon Isidore	Small Sub
179/18	0429B 295	Kevin Joseph	Small Sub
234/18	0429B 373	Julian Emmanuel	Small Sub
463/18	0429B 217	Christian Joseph	Liquor Licence
601/18	0429B 343	Nigel & Glenda Isidore	Residential
618/18	0429B 196	Seventh Day Adv. Church	Tent (Temporary)
994/18	0429D 262	Stephen Calixte	Residential

Application Number	Block and Parcel	Applicant/Developer	Development Type
1062/18	0429B 210	Marie J. Jaunai	Liquor License
206/19	0429B 374	Bernard & Cristina Herman	Large Sub
538/19	0429B 26	Oswals & Mary Eustave	Residential
729/19	0429B 385	Kimberly Garzagane	Residential
951/19	0429B 156	Peter Michael Jn.Phillip	Small Sub
8/20	0429B 271	Christine Joseph	Liquor License
431/20	0429B 65	Marie J Didier Et Al	Small Sub
734/20	0429B 388	Julian Emmanuel	Small Sub
989/20	0429B 346	Joseph Poleon	Small Sub
997/20	0429B 259	David Brian Anatole	Residential
21/21	0429B 256	Christina Gill Et Al	Large Sub
553/21	0429B 367	Ireneus & Francine Clovis-Henry	Residential
600/21	0429B 356, 393	Colombus & Sylvarius Philippe	Residential
1134/21	0429B 41	Alexander Dunstan	Small Sub
486/22	0429B 362	Loretta George & Henry Augustin	Small Sub
501/22	0429B 405	Joseph M.Poleon	Small Sub
721/22	0429B 272	Mary & Camillus Jones	Residential
802/22	0429B 397	Kevin Joseph	Small Sub
86/23	0429B 44	Robert Emmanuel Et Al	Small Sub
480/23	0429B 421	Kevin Joseph	Small Sub
999/23	0429B 371	Angel Jean	Small Sub
1036/23	04298B 417	Wayland & Charline Leon	Residential
1039/23	0429B 165	Crownlands	Small Sub
0143/24	0429B419	Joseph Poleon Teresa & Prospere	Small Sub
0294/24	0429B247	Tara Alexander Hippolyte	Residential
0441/24	0429B355	Anne Marie Inde	Small Sub
0671/24	0429B168	Cherise Taylor	Residential
0676/24	0429B165	Commissioner of Crown Lands	Small Sub

4.5 Data Gaps

The estimates of base flow within the River Doree and Soufriere River are estimates; no data on flow rates at the proposed points of water extraction is available.

As previously stated, this ESIA focuses on the exploration phase of geothermal development and does not address development of a power plant in the event that a commercially viable geothermal resource is identified. A separate ESIA would be prepared to address potential impacts from power plant development, although much of the information presented in this ESIA could serve as a starting place for evaluation of environmental conditions.

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 River Doree is adjacent to the Saltibus drilling area, and two rivers flow near the Fond St. Jacques drilling area. The Fond St. Jacques drilling area is also located near water storage infrastructure and springs, which supply drinking and non-drinking water to the local community. The rivers and water resources near the proposed drilling areas are important water supply sources for the communities near the project area and downstream. These resources are very important to the local communities and considered highly sensitive.

Potential Risks/Impacts and Magnitude

Water Quality

Civil Works

Saltibus. The well pad is located on a steep slope above the River Doree. The well pad construction would require significant grading to create a stable well pad surface. Drainage would be constructed to convey stormwater around the well pad. Due to the steeply sloping hillside and need to remove mature trees and vegetation that provide slope stabilization, construction of the well pad could destabilize the slope and result in erosion or sedimentation. Stockpiled soil material from the S-5 site would be stored at MS-1. The stockpiled soil materials could become a source of sediment discharge. Erosion or sedimentation to the stream would have the potential to degrade surface water quality. Due to the steep slope of the hillside, trees on the margin of the site would be retained to the extent feasible to minimize erosion. In addition, subsurface drainage would be installed to stabilize the slope.

Fond St. Jacques. The project would involve construction of an expanded access road and grading of a well pad. While the well pad site is located at the base of a hill slope and in a gently sloping area, the soils within the well pad are saturated and drainage would be required to remediate the oversaturation of the onsite soils and soils would need to be imported to create a suitable work surface for the drilling rig and equipment. In addition, the well pad is located adjacent to a stream fed by spring flow and drainage would need to be redirected around the well pad to avoid erosion or sedimentation to downstream waters. 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. Topsoil removed from the well pad site would be stockpiled adjacent to the well pad. The stockpiled soil materials could become a source of sediment discharge. Erosion and sedimentation that reaches the drainage network has the potential to degrade surface water quality.

Both Sites. Sanitary waste would be generated by workers during civil works and drilling and testing phases. A mobile latrine would be housed on each 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

Saltibus and Fond St. Jacques. During the drilling process drilling mud would be discharged to the mud pond on each 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 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. 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 nearby streams, which could degrade water quality downstream from the well pad.

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

Saltibus and Fond St. Jacques. 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.

Fond St. Jacques. Surface pollution upgradient of springs or well drilling within connected aquifers could impact water quality for the spring at Fond St. Jacques. The spring at Fond St. Jacques is likely a surface manifestation of ground water collected from the hillside upslope of the spring and well pad, and the well pad is located downgradient from the spring; however, the potential for underground connectivity between spring source and aquifers that may be encountered during drilling has not been determined. Since the geothermal well would be cased within the groundwater aquifer and would not come in contact with the groundwater aquifer, there is no potential for well drilling to impact groundwater quality at the spring.

Reclamation

Reclamation would involve earth moving activities that would have a potential to cause erosion prior to vegetation establishment. The equipment used during reclamation would also require small quantities of hazardous materials (e.g., oil, grease, and hydraulic fluid). The S-5 site would not be returned to pre-existing contours. The focus of reclamation at the S-5 site would be soil stabilization and to avoid long-term risk of landslide or mudflow. A reclamation plan focused on stabilizing the soil surface would be needed to prevent long-term impacts from sedimentation to waterways.

Water Supply

Civil Works

Saltibus. Water would be required during civil works for soil compaction and dust control. An intake structure would be installed within the River Doree to supply water for the project. The minimal water required for dust control and compaction would not affect the water supply within the River Doree. There is no water supply infrastructure within the well pad site or at MS-1 that would be affected by the project.

Fond St. Jacques. WASCO captures spring water supply at a vault located on the hillslope immediately above well pad. During the civil works phase, drains would be installed to reduce saturation at the well pad. By lowering the groundwater level at the well pad at the bottom of the hillside during civil works, the drains could accelerate the downslope flow of shallow groundwater and decrease discharge from the spring into the WASCO collector vault.

Construction equipment and grading could directly damage WASCO water supply systems within the project area. The well pad is downslope of water storage infrastructure at a spring and a pipeline connects the water storage infrastructure to a larger WASCO water storage tank. Buried pipelines occur within the limits of grading and heavy equipment travel over the access road could damage buried pipelines within the roadway. Effects to the water supply system would have an adverse effect on water supply in the community if not promptly repaired.

Water would be required for dust control during road and well pad construction. An intake structure would be installed within the Soufriere River to supply water for the project. The minimal water required for dust control and compaction would not affect the water supply within the Soufriere River.

Well Drilling

Saltibus. Drilling water would be extracted from the River Doree. Water extraction would occur downstream from WASCO's raw water intakes and would not affect WASCO water supplies. Base flow at the drill site is estimated at 54 l/s (856 gpm). Maximum water use of 11 l/s (174 gpm) would equal 20 percent of typical base flow and the withdrawal would be temporary during drilling (3 months). There are no known/permitted users of water downstream of the project. Due to the limited volume of water that would be extracted relative to the overall river flow and the lack of any known downstream water uses, the temporary extraction of river water for drilling supply would not affect downstream water uses.

Fond St. Jacques. The project would require fresh water for drilling. Water for the drilling operation will be supplied by a pipeline extending from a stream approximately 125 meters north of the well pad. The proposed extraction point is at the upper reaches of the watershed (only 4.5% of the watershed is upstream of the project) and the base river flow is not currently known at the point of extraction. Base river flow was estimated by evaluating river flow within 14 streams in Saint Lucia relative to watershed size. The total watershed size upstream of the proposed extraction site in Fond St. Jacques is 2.26 square kilometers. The watershed size is less than the size for any measured streamflow location in Saint Lucia; however, based on available

data for streams in Saint Lucia, the estimated base flow is anticipated to range from 10 to 50 l/ (160 to 800 gpm) and is likely less than 25 l/s (400 gpm). Representatives from the WASCO have indicated that diversions from that creek would not impact WASCO's water supply for the community, which derives from two springs in the area (King, 2024). There are no known water uses downstream of the project on the river. The volume of water within the river north of the project site is not currently known as there is no gauging on the river. The project water demand of 11 l/s (174 gpm) could exceed the available water within the river in which case supplemental water supplies would be required during the drilling process. Due to the small volume of the total watershed that contributes to the river upstream of the extraction point for the project (4.5%) and the lack of any known downstream water uses, the extraction of water for the project would not affect water supply downstream.

Reclamation

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

Flooding

Civil Works and Well Drilling

The well pads at S-5 and Fond St. Jacques are not located within a 100-year floodplain as shown in Figure 4.2-10 and Figure 4.2-11. The intake structure at the River Doree would be located within the 100-year floodplain. Energy for the water supply pumps would be obtained from a generator housed at the drill rig to avoid placing any fuel within the 100-year floodplain. Table 5.2-1 below provides the approximate hydraulic flow rates for each watershed using the rational method.

Table 5.2-1 Estimated Hydraulic Flow Rates

Project Area	Catchment	Area (ha)	Top Elevation (m)	Slope	Runoff Coefficient	Intensity (mm/hr)		Runoff (m^3/s)	
						5-yr	10-yr	5-yr	10-yr
Saltibus	Doree	1,095	570	0.055	0.15	50	70	23	32
Fond St. Jacques	Soufrière	1,556	520	0.071	0.15	62	85	40	55
	Sub-Soufrière	226	240	0.14	0.15	108	215	10	20

The minimal surface recontouring to construct a well pad would not measurably effect runoff in any of the effected drainages. The well pads are small in size and would remain largely pervious so that they would not concentrate downstream flow or cause any increase in downstream flooding.

Reclamation

The project site at Fond St. Jacques would be returned to pre-existing contours and vegetation types during site reclamation with the exception of the well cellar. The S-5 site would not be returned to its prior grade; however, after reclamation of the S-5 site only the well cellar would remain impervious. After reclamation there would be no impact on flood intensity at either site.

Impact Significance and Mitigation

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

Table 5.2-2 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 (FSJ) High (S-5)	**Significant**	Water-1 Soils-1 (S-5) Soils-2 (S-5) Water-8	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	Dewatering at FSJ	High (FSJ)	Moderate	**Significant (FSJ)**	Water-7	Less than Significant
	Damage Water Supply Infrastructure	High (FSJ) Low (S-5)	Moderate (FSJ) Low (S-5)	**Significant (FSJ)** Negligible (S-5)	Utilities-1 (FSJ)	Negligible
	Water Use (Dust Control)	High	Very Low	Negligible	--	--
	Water Use (Well Drilling)	High (FSJ) Moderate (S-5)	High (FSJ) Moderate (S-5)	**Significant (FSJ)** Less than Significant (S-5)	Water-6 (FSJ) Water-7 (FSJ)	Less than Significant
Flooding	Well Pad Construction	Low	Low	Negligible	--	--

5.2.2 Air Quality

Sensitive Receptors

Residential dwellings are located in proximity to the well pad in Saltibus includes one residence within 100 meters and three additional residences within 200 meters. At Fond St. Jacques, a community with several residences are located within 100 meters of the well pad. Sensitive receptors within 305 meters (1,000 feet) of the well pad at Saltibus and Fond St. Jacques are shown on Figure 4.2-2 and

Figure 4.2-3, respectively. Elderly individuals and people who may be more sensitive to air quality were documented in the communities surrounding Fond St. Jacques. The residences are therefore considered highly sensitive to air quality impacts.

Potential Risks/Impacts and Magnitude

Equipment Emissions and Fugitive Dust

Civil Works and Drilling

Saltibus and Fond St. Jacques. 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. At Fond St. Jacques fugitive dust could settle onto adjacent agricultural products. Fugitive dust 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.

Reclamation

The air quality effects of reclamation would be similar to those of civil works but likely short in duration (less than one week) during site recontouring. Reclamation activities would stabilize the site to avoid long-term emissions of fugitive dust.

Geothermal Gas Emissions

Saltibus and Fond. St. Jacques. 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 hydrogen sulphide (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 area 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 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 5.2-3.

Table 5.2-3 Summary of Air Quality Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Residences and Community Members	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 Noise-1	Negligible to Less than Significant

5.2.3 Geology and Soils

Sensitive Resources

The well pad in Saltibus is located at the top of a ridge with a steep hillslope along the edge of the well pad above the River Doree. The MS-1 staging area is located on a flat area that is currently used for agricultural production. Fond St. Jacques is located on a gently sloping site

with agricultural use. Productive topsoil is important to agricultural production and topsoil is considered a highly sensitive resource to the community. The well pad at S-5 and access road to S-5 is located within areas that are prone to landslides and slope failure. The risk of landslides is high at S-5 due to evidence of past landslides in the area and the steep slope above the river. Landslide potential at the Fond St. Jacques well pad is low, but there is a potential for landslides to occur on the hillslope south of the well pad.

Potential Risks/Impacts and Magnitude

Erosion and Topsoil Loss

Civil Works

Saltibus. The Fond St. Jacques site is currently stabilized by large and small trees as well as understory vegetation growth. Vegetation removal and grading of the ridgeline to create a flat well pad could cause erosion. Top soil from the Saltibus site would be stockpiled at MS-1 during the civil works phase. The well pad construction includes benching of the well pad site to help create a stable pad surface and reduce the likelihood of erosion causing slope instability. However, given the extent of grading at the site there is increased risk of erosion, particularly along the edge of the well pad where large trees protect the hill slope and manage erosion and soil loss. Removal of large trees and their root structure from the hill slope would increase the rate of erosion along the hill side.

Fond St. Jacques. Well pad grading and vegetation clearing activities could cause soil erosion and loss of topsoil. 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 could affect agricultural land and crop production at Fond St. Jacques. Soil compaction could also result in loss of soil productivity. Development of the well pad involves stripping and stockpiling of the topsoil adjacent to the well pad at Fond St. Jacques. The topsoil would then be reapplied to the site after well drilling and testing activities have been completed.

Well Drilling and Testing

Saltibus. Well drilling and testing activities would be conducted within the stabilized well pad. The equipment and infrastructure would be located entirely within the existing geology/soils and would not be located on any fill slope areas. The new areas of fill would remain at risk of erosion during the well drilling and testing phase if erosion and sediment control BMPs were not properly maintained. Due to the removal of vegetation at the site, the well pad would remain at increased risk of erosion during the well drilling and testing phases. Well drilling and testing do not cause induced seismicity as the activities are not conducted under pressure.

Fond St. Jacques. 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. Well drilling and testing do not cause induced seismicity as the activities are not conducted under pressure.

Reclamation

Saltibus. Reclamation activities would not restore the existing grade of the site and would seek to provide more stable slopes for long-term site management. Some topsoil removed from the site could be reapplied to the site to help start revegetation of the site. The site would be planted with trees to provide successful soil stabilization and minimize erosion after the project.

Fond St. Jacques. Reclamation would involve replacing topsoil at the Fond St. Jacques site to allow for revegetation of the area. A gentle slope would also be restored to the area to minimize potential for soil erosion after the project is complete. The removal of gravel could temporarily destabilize the soil and cause soil erosion; however, the reclamation activities would provide long-term stabilization of the site and involve replacement of topsoil to minimize or avoid effects from topsoil loss.

Landslides, Mudflows, and Unstable Soil Conditions

Civil Works

Saltibus. The well pad is located on a steeply sloping hillside. Grading of the well pad and particularly, removal of vegetation and large trees with extensive root systems could destabilize the site and cause a landslide or mudflow. The access road leading to the well pad requires passage through steep mountainous terrain. The access road improvements in this area include addition of gravel but would not expand the access road or create an unstable condition. The improvements to the access road would generally make the road more stable.

Fond St. Jacques. The well pad at Fond St. Jacques is located in an area that contains saturated soils. Construction of the well pad will require drainage to reduce the saturation of the soil conditions on site and reduction in .

Well Drilling

The slopes surrounding the Saltibus well pad and south of Fond St Jacques well pad are prone to landslides and potential mudflows. Landslides could affect the drilling sites depending on the location and extent of slope failure. At the Saltibus site, erosion control measures and proper site drainage will be implemented to avoid slope failure at the well pad.

Reclamation

Saltibus. Reclamation activities would focus on providing vegetation with rooting structures that would provide slope stabilization. Successful revegetation of the site would reduce the risk of landslide or mudflow following project implementation.

Fond St. Jacques. Reclamation would return the sites to a gently sloping site with vegetation and would not increase the potential effects related to landslides, mudflows, and unstable soil conditions.

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.

Reclamation

Reclamation 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 5.2-4.

Table 5.2-4 Summary of Geology and Soil Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Erosion/ Topsoil	Erosion (Civil Works)	High	Moderate (FSJ and MS-1) High (S-5)	**Significant**	Water-1 Soils-1 (S-5) Soils-3 (FSJ)	Less than Significant
	Erosion (Well Drilling)	High	Moderate S-5) Low (FSJ)	**Significant (S-5)** Less than Significant (FSJ)	Soils-1 (S-5)	Less than Significant
Slope/Soil Stability	Destabilization Slopes/Soil (Civil Works)	High	High (S-5) Moderate (FSJ)	**Significant**	Water-1 Soils-1 (S-5)	Negligible to Less than Significant
	Destabilization Slopes/Soil (Well Drilling)	High	Moderate (S-5) Low (FSJ)	**Significant (S-5)** Less than Significant (FSJ)	Soils-1 (FSJ)	Less than Significant
	Induced Seismicity (Well Drilling)	Moderate	--	Negligible	--	--
	Reclamation	High	Moderate (S-5) Low (FSJ)	**Significant (S-5)** Less than Significant (FSJ)	Soils-2 (S-5)	Less than Significant

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 Saltibus or Fond St. Jacques well pads. Saltibus includes two residences within 100 meters and three additional residences within 200 meters. At Fond St. Jacques, a community with approximately 20 residences are located within 200 meters of 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 could involve drilling and testing activities at night.

Potential Risks/Impacts and Magnitude

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 5.2-5. Reference noise levels for typical noise sources are provided in Table 5.2-6 below to provide context for the noise that would be experienced.

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, the adjusted noise level would be 74 dBA at 20 meters and 86 dBA at 5 meters. Because civil works activities would be temporary and limited to daytime hours, daytime noise from civil works activities would not be excessive and would not interfere with normal daytime activities.

Table 5.2-5 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	66	60	54	48	42	--
Well Drilling (Mud Drilling)	80	74	68	60	54	48	42	--	--
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 5.2-6 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 300 meters (1,000 feet)		
	100 dBA	
Gas lawn mower at 1 meter (3 feet)		
	90 dBA	
Diesel truck at 15 meters (50 feet) at 50 mph		Food blender at 1 meter (3 feet)
	80 dBA	Garbage disposal at 1 meter (3 feet)
Noisy urban area, daytime		
Gas lawn mower, 30 meters (100 feet)	**70 dBA**	Vacuum cleaner at 3 meters (10 feet)
Commercial area		Normal speech at 1 meter (3 feet)
Heavy traffic at 90 meters (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

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 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 average nighttime noise level was measured at approximately 55 dB in both Saltibus and Fond St. Jacques; therefore, because ambient noise levels exceed the World Bank nighttime noise standard, a 3 dB increase over the ambient conditions (approximately 58 dB) represents a level at which noise levels from drilling could be a nuisance in the existing environment. The noise from drilling operations/equipment could exceed a nuisance level for a distance of approximately 60 meters from the well pad. One residential dwellings is located within 60 meters of the Fond St. Jacques well pad, and depending on the location of the stationary equipment the residents could be affected by nighttime noise and experience sleep interference. Mitigation Measure Noise-1 and Noise-2 define specific noise reduction measures for the drilling contractor to implement to ensure noise levels do not exceed 58 dB at he nearest residence during the drilling period.

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/venting would exceed the 45 dB threshold for a distance of nearly 1,700 meters not accounting for topography, which would reduce or block noise. Because nighttime noise levels average 55 dB and were measured at up to, residents within 200 meters would experience nighttime noise levels during testing that are 3 dBA greater than ambient nighttime noise conditions after accounting for noise reduction from the proposed 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.

Reclamation

Site recontouring and reclamation activities would produce temporary noise from use of large equipment, similar to the equipment that would be used for the civil works phase. Noise during reclamation would be very short in duration (a few days). Reclamation activities would take place during daytime hours. The noise impact would be similar to large truck 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 5.2-7.

Table 5.2-7 Summary of Noise Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Residences	Daytime Noise (Civil Works)	Moderate	Moderate	Less than Significant	Noise-1	Less than Significant
	Daytime Noise (Well Drilling)	Moderate	Moderate (FSJ) Low (S-5)	Less than Significant	Noise-1	Less than Significant
	Nighttime Noise (Well Drilling)	High	Moderate (FSJ) Low (S-5)	**Significant**	Noise-2	Less than Significant
	Well Testing	High	High	**Significant**	Noise-3	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 within 10 meters (30 feet) of construction activities could experience plater or stucco damage from vibration in excess of PPV 0.5 cm/sec (0.2 in/sec).

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 grading 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.

Reclamation
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 5.2-8 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 (FSJ) Moderate (S-5)	Low	**Significant (FSJ)** Less than Significant (S-5)	Noise-4 (FSJ)	Negligible

5.2.6 Natural Habitats and Biodiversity

Sensitive Resources
The Saltibus (S-5) well pad contains trees, shrubs and vines that provide habitat for priority bird species. Several priority birds including endemic and endangered bird species were observed on the S-5 well pad and in proximity to the well pad during project surveys. The MS-1 storage area and Fond St. Jacques well pad contain agricultural production areas. No natural habitats are present within the MS-1 or Fond St. Jacques well pad areas and those areas have low sensitivity for natural habitats and biodiversity. Priority bird species could occur in the forested areas adjacent to the Fond St. Jacques well pad.

Potential Risks/Impacts and Magnitude

Direct Impacts on Habitat and Species (Civil Works)
Saltibus (S-5). Construction of the Saltibus well pad would require removal of trees and vegetation which provide nesting and foraging habitat for priority birds. Birds and bird nests could be impacted by the act of vegetation clearing if the clearing activity occurred during the nesting season (May to August). In addition, vegetation clearing could result in reduced nesting and breeding habitat for birds and wildlife. If the activity were not properly timed or proper

avoidance protocols were not followed, the activity could result in mortality of individual birds or loss of a nest of a priority or endangered species. Due to the small size of the project and limited size of the well pad, the project would not affect regional populations of any species.

MS-1 and Fond St. Jacques. Access road grading and well pad construction in agricultural areas or disturbed habitats would not have an adverse impact on natural communities or biodiversity because no natural communities occur in the area. Wildlife would tend to avoid areas of noise and human activity.

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 introduction of invasive weeds could adversely impact native habitats surrounding the potential drilling areas.

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. Multiple priority bird species including endangered birds were documented in the forested areas within an surrounding the S-5 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 approximately 40 to 60 dB. Civil works noise would exceed 60 dB for a distance of approximately 100 meters from the well pad. Well drilling noise would exceed 60 dB for a distance of approximately 50 meters from the well pad. Well testing activities would exceed a 60 dB noise level for a distance of approximately 300 meters 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 or injury or mortality from heavy equipment or vehicles.

Reclamation

Reclamation activities would include regrading and revegetating the well pad sites. Reclamation 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 5.2-9.

Table 5.2-9 Summary of Natural Habitats and Biodiversity Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Wildlife Habitat	Habitat Loss	High (S-5) Low (FSJ)	Moderate (S-5)	**Significant (S-5)** Less than Significant (FSJ)	Soils-2 (S-5)	Negligible
	Introduction of Invasive Weeds	High	Low	**Potentially Significant**	Biodiversity-1	Negligible
Priority, Endemic, and Endangered Birds	Nest Destruction	High (S-5) Low (FSJ)	Moderate (S-5) Low (FSJ)	**Significant (S-5)** Less than Significant (FSJ)	Biodiversity-2	Negligible
	Nesting Disturbance	High	Moderate	**Significant**	Biodiversity-3	Negligible
Wildlife	Attracting Wildlife	Low	Moderate	**Potentially Significant**	Waste-1	Negligible

5.2.7 Archeological and Cultural Resources

Sensitive Resources

The MS-1 storage area contains historical and Amerindian resources. No archaeological resources or historical uses are known to occur within either the S-5 well pad or Fond St. Jacques well pad. The well pads have low sensitivity for archaeological and cultural resources.

Potential Risks/Impacts and Magnitude

Civil Works

The project would involve grading and ground disturbance at the S-5 and Fond St. Jacques well pads, which are not located in archaeologically sensitive areas. The existing access road in Fond St. Jacques would be widened and the access road to Saltibus would be improved. Due to the disturbed nature of the existing access roads 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 pads are located in areas that have 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.

The MS-1 material storage area contains archaeological resources. The storage of materials at the MS-1 site could damage artifacts or result in the removal of historic or Amerindian resources if the soils stored at the MS-1 site mix with the native soils containing archaeological materials or if excavation occurred within the MS-1 area. The mitigation specifies use of a geotextile fabric to secure the underlying soils and prevent loss of archaeological resources that could be important to history.

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.

Reclamation

Reclamation activities would occur in the areas disturbed by civil works activities. Reclamation 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 5.2-10.

Table 5.2-10 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	High (MS-1) Low (S-5 and FSJ)	Moderate Moderate (S-5 and FSJ)	**Significant (MS-1)** **Potentially Significant (S-5 and FSJ)**	Cultural-1 Cultural-2 Cultural-3	Negligible to Less than Significant

5.2.8 Landscape and Visual Character

Sensitive Resources

There are no scenic vistas within the Fond St. Jacques or Saltibus areas. Neither well pad is located within the PMA or buffer zone and neither project area is in the viewshed of a tourist destination. The Saltibus and Fond St. Jacques project areas have a low sensitivity for visual change.

Potential Risks/Impacts and Magnitude

Civil Works

The removal of vegetation from the well pads and the grading of well pads will have a temporary impact on the landscape and scenery in areas adjacent to each well pad. Substantial vegetation disturbance could have a minor but long-term impact on visual quality if the well pads were not revegetated following project activities.

Well Drilling

The presence of tall drill rigs and construction equipment would contrast with the natural landscape and temporarily degrade the visual quality near drilling areas. The drill rig would only be in place for up to 3 months during drilling and testing. Trees, dense vegetation, and topography in the S-5 area would partially screen the drilling activities from views, such as those from the primary access roads. The well pad construction and drilling activities at Fond St. Jacques would be visible from the access road and adjoining residential area.

Reclamation

Reclamation activities would be short-term and not have an adverse effect on the landscape or visual character of the area. Reclamation activities including site recontouring, revegetation, and trash removal would avoid any long-term impacts on the landscape.

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 5.2-11.

Table 5.2-11 Summary of Landscape and Visual Quality Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Views from Adjacent Roads and Residences	Vegetation Removal and Grading	Low (S-5) Moderate (FSJ)	Low	Less than Significant	--	--
	Visible Construction Equipment	Low (S-5) Moderate (FSJ)	Low	Less than Significant	--	--

5.2.9 Traffic Circulation and Safety

Sensitive Resources

The roads that would be used to access the well pads and material staging and storage area 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 Saltibus S-5, MS-1, and Fond St. Jacques is paved with the exception of the segments of access roads that would be improved as part of the project.

Potential Risks/Impacts and Magnitude

Road Expansion (Civil Works)

The existing paved road network from Vieux Fort to Saltibus and Fond St. Jacques is suitable for access and no paved road improvements are needed for the project. The project would improve an unpaved road segment from the paved road network to the well pad at S-5 in Saltibus. The unpaved access road at Saltibus provides access to a few residences and WASCO water supply intake. The road would need to be maintained open throughout civil works and drilling phases to allow for residential and WASCO access. The project would also expand an existing unpaved road from the paved road network to the well pad site at Fond St. Jacques. The unpaved access road improvements would occur within a road that provides access to several residences and the expanded access road would impact one residential structure and one power utility pole to provide sufficient turning radius and passing for trucks.

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.

Reclamation

Site reclamation would require temporary travel of large construction equipment on area roads during site recontouring and revegetation. Reclamation activities would be very short in duration (a few days) and would be conducted off area roadways within the well pad area. Reclamation 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 5.2-12.

Table 5.2-12 Summary of Traffic Circulation and Safety Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Traffic Circulation	Road Expansion	High (FSJ) Low (S-5)	Moderate Low (S-5)	**Significant (FSJ)** Negligible (S-5)	Utilities-2 Social-1	Negligible
	Lane and Road Closures	High	Moderate	**Significant**	Traffic-1	Negligible
	Transport of Large Equipment	Moderate	Moderate	**Significant**	Traffic-2	Negligible
	Traffic Safety	High	High	**Significant**	Traffic-2	Negligible

Community Members	Road Hazards	High	High	**Significant**	Traffic-2	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 well pads and staging area. Buried WASCO pipelines occur within the Fond St. Jacques well pad and cross the access road.

Potential Risks/Impacts and Magnitude

Civil Works, Well Drilling, and Reclamation

Saltibus and Fond St. Jacques. The project would involve operating large trucks and equipment on area roads to access the work area. Low-hanging utilities and communications systems could be damaged in areas where there is inadequate clearance for large equipment to pass. Damage to utilities and communication systems could result in service interruptions to communities that are served by the utility lines.

Fond St. Jacques. A power line pole is located within the limits of grading for the access road to the Fond St. Jacques well pad and within the well pad disturbance area. The project could affect power service if the power poles were not relocated prior to construction. The project will involve grading in an area that contains WASCO water supply pipelines. In addition, heavy vehicle and equipment travel on the access road has the potential to damage buried pipelines if sufficient protections for the pipeline were not in place.

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 5.2-13.

Table 5.2-13 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-2	Negligible
	Relocation of a Power Pole	High (FSJ) Low (S-5)	Moderate (FSJ) Low (S-5)	**Significant (FSJ)** Negligible (S-5)	Utilities-1	Negligible
	Damage to Buried Utility Pipelines	High (FSJ) Low (S-5)	Moderate (FSJ) Low (S-5)	**Significant (FSJ)** Negligible (S-5)	Utilities-2	Negligible

5.2.11 Hazards and Hazardous Materials

Sensitive Receptors

The communities living near the drilling areas are at risk of hazards from construction operations. Sensitive receptors include residents near the drilling sites and community members who may use the roads or recreational facilities near the drilling areas. No schools are located in proximity to the drilling areas.

Workers would also be exposed to hazards and hazardous materials (refer also to Section 5.3.5 for worker health and safety and community health and safety).

Potential Risks/Impacts and Magnitude

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.

Reclamation
Reclamation would use equipment similar to that used in construction. Site clean-up and reclamation 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 5.2-14.

Table 5.2-14 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 drilling areas have a low to moderate risk of wildfires during the dry season or periods of drought.

Potential Risks/Impacts and Magnitude

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.

The project would involve operating large trucks and equipment near low-hanging utility lines, including power lines. Live power lines could cause electrocution and fires.

Well Testing

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

Reclamation

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

Impact Significance and Mitigation

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

Table 5.2-15 Summary of Fire Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Community Members, and 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 at Fond St. Jacques is not located in an ecologically sensitive area. The well pad at Fond St. Jacques is located within land used for agricultural production and near a residential area. The presence of trash or waste in these areas could degrade the existing environment, attract wildlife, and affect existing land uses, such as agricultural land.

Potential Risks/Impacts and Magnitude

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.

Reclamation

Site reclamation would include site clean-up and reclamation. The wellhead, if no longer needed, would be removed and recycled. Trash would be hauled away. Limited quantities of waste would be produced during site reclamation.

Impact Significance and Mitigation

The significance of solid waste impacts and the mitigation measures that would be applied are summarized in Table 5.2-16.

Table 5.2-16 Summary of Solid Waste Impacts and Mitigation

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

5.3 Social Risks and Impacts

5.3.1 Livelihoods

Sensitive Receptors

The potential drilling area in Fond St. Jacques and the storage area at MS-1 are under agricultural production. The livelihoods of farm owners and workers could be impacted, if the project causes a reduction in agriculture production. The expansion of the access road in Fond St. Jacques would impact private lands.

Potential Risks/Impacts and Magnitude

Direct Impact on Livelihoods (Civil Works and Well Drilling)

The project would temporarily disrupt agricultural production within the well pad at Fond St. Jacques and staging and storage area at MS-1. The project would impact row crops at MS-1 and disrupt crop production during staging and storage activities. Construction of the well pad at Fond St. Jacques would remove the area from agricultural production for approximately 1 year during the project construction and testing phases. The agricultural activities would be able to resume following site reclamation; however, the 1 acre of land purchased for the Project at Fond St. Jacques would not be returned to agricultural production.

Short-term impacts would occur through well pad construction, material storage, drilling, testing, and reclamation 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. Similarly impact from material staging and storage could affect crop productivity if the staging and storage areas introduced any hazardous materials to the area (see Section 5.2.10) or compacted the soil conditions.

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 ARAP (Appendix E).

Water Supply and Topsoil Loss

The project could also deplete the water supply or degrade water supply systems used for agriculture (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.

Reclamation

Reclamation would restore the sites to agricultural production and would avoid long-term impacts from loss of productive use of the land. The reclamation 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 ARAP 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	Negligible
	Long-term Loss of Livelihood	High	Low	**Potentially Significant**	Social-1 Soils-1	Negligible
Community Members	Temporary Construction Jobs	--	--	Positive	--	--

5.3.2 Tourism

Sensitive Receptors/Resources

Tourism is the primary economic activity in the Soufrière 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 close proximity to the Saltibus or Fond St. Jacques well pads or staging and storage area MS-1. The closest tourist destination is located approximately 1 kilometer from the project as shown on

Figure 5.3-1. Intervening topography and dense vegetation would restrict views of the drilling areas and project activities.

Potential Risks/Impacts and Magnitude

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.

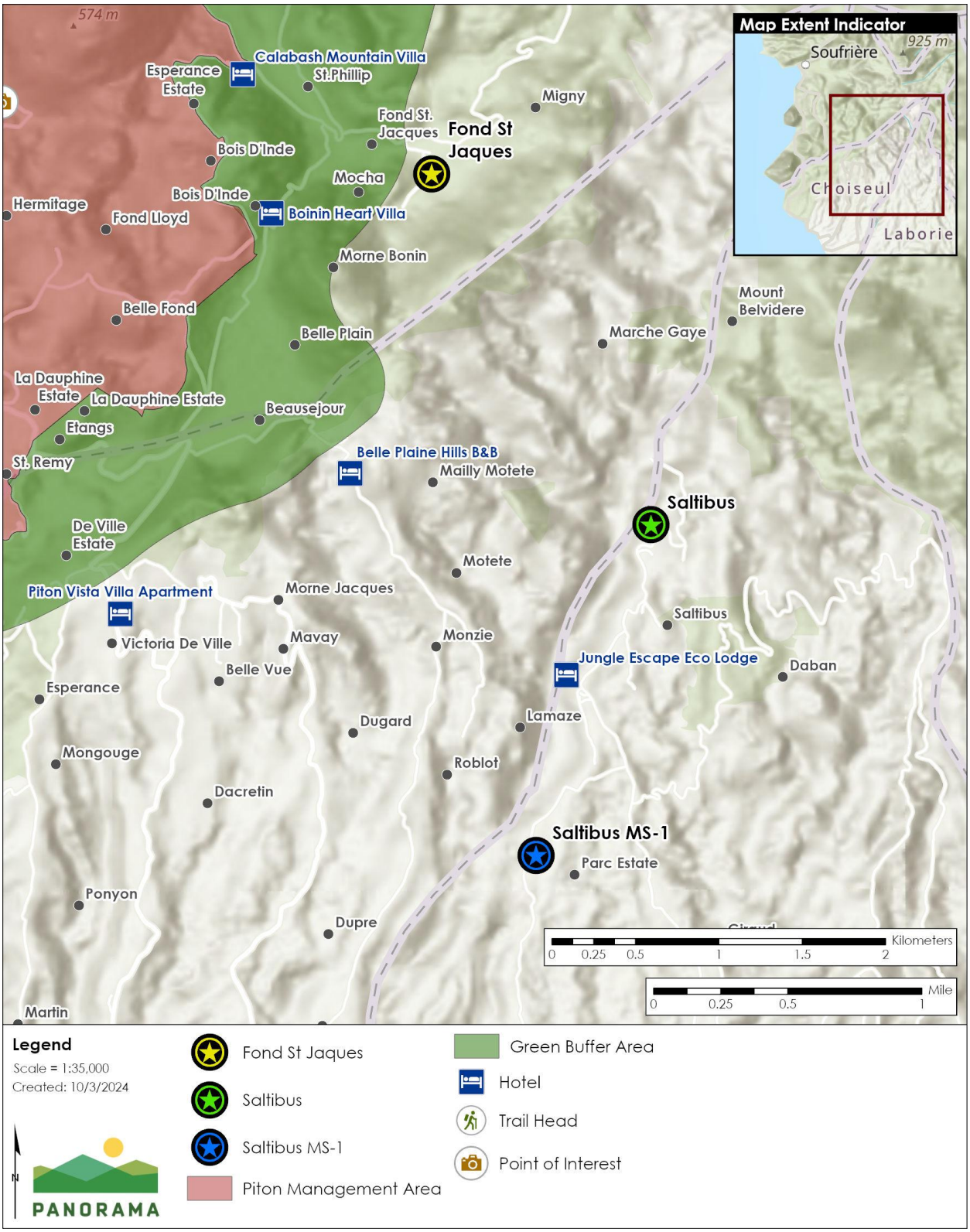
Impact Significance and Mitigation

The significance of impacts on tourism and the mitigation measures that would be applied are summarized in Table 5.3-2.

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

One residential dwelling unit is located within the area of stockpiling and storage at MS-1 and one dwelling unit would be impacted by the access road expansion at Fond St. Jacques. Both residences would need to be relocated. Agricultural land uses in the project area would be temporarily displaced during civil works and well drilling activities. In addition private lands would be impacted by the access road expansion.

Potential Risks/Impacts and Magnitude

Direct Impacts (Civil Works and Drilling)

Resettlement refers to the potential displacement of people or existing land uses. One residence would be displaced within the area of stockpiling and storage at MS-1 and one family would be displaced by the access road expansion at Fond St. Jacques. No residences would be displaced within either well pad. Agricultural products within the Fond St. Jacques well pad and MS-1 staging and storage area would also be impacted during well pad construction and material staging. Resettlement impact and loss of livelihood are addressed in detail in Appendix E. Agricultural use would be permanently displaced within the 1-acre portion of the Fond St. Jacques well pad that is being acquired permanently for the project.

Indirect Impacts

Emergency evacuation of residents in the event of a well blowout is not anticipated and would be very short in duration (a few hours) and would not cause resettlement. The project would temporarily impact agricultural land during construction and reclamation 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. An ARAP 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**	A-RAP	Negligible
Community	Displaced Residences	High	Moderate	**Significant**	A-RAP	Less than Significant
	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 project would comply with applicable laws and policies governing labor rights and working conditions. The project would also incorporate World Bank EHSGs and policies relevant to working conditions and equality to ensure and safe and equitable environment for all workers. The project would also comply with the Saint Lucia Labour Code, which defines conditions for workers including health and safety provisions as well as conditions for payment and worker leave. Mitigation Measure Social-2 also defines requirements for fair working conditions for individuals that would be vulnerable to discrimination.

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 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 at each location). 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 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. Working conditions for the project would need to comply with the Employees Occupational Health and Safety Act as well as Saint Lucia Labour Code, which define requirements for working conditions to protect employee health and safety.

Environmental hazards in Saint Lucia that may be encountered during construction include hurricanes and tropical storms, landslides, earthquakes, volcanic eruptions, and flooding. 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 dB) over a few weeks, or exposure to high noise levels (>100 dB) 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 dB (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**	Noise-1	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 who are living or using property adjacent to the well pads and access roads would be exposed to the greatest risk of hazards.

Potential Risks/Impacts and Magnitude

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, open holes and trenches, fires, potentially harmful geothermal gases, and hazards associated with a potential well blowout (all described previously).

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 construction, 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 Cumulative Impacts

A substantial number of cumulative projects including residential projects and commercial projects are proposed within 2 kilometers of the project. While there are a large number of projects proposed within 2 kilometers, the impacts of temporary well drilling and testing would not combine with the impacts of residential or commercial development because the nature of the project impacts would be different and the project would be temporary. As a result, the project would not result in cumulatively considerable impacts when considered with other projects in the region.

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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, or 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 that 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 will compensatory measures 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/Applicable Sites	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	Water Resources		
• Water Quality • Erosion and Topsoil Loss • Landslides and Mudflows • Applies to S-5, MS-1, and FSJ	**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 into 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 • Drilling Contractor	• During Construction • During Well Drilling • During Site Reclamation

Issues/Potential Impacts/Applicable Sites	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 • Hazardous Materials • Applies to S-5 and FSJ	**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 either reinjected to the geothermal well at the completion of drilling or shall be evaporated. Drilling fluid shall be reused to the extent feasible during drilling to conserve water.	• Drilling Contractor	• During Well Construction
• Water Quality • Hazards and Hazardous Materials • Applies to S-5 and FSJ	**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 to the extent feasible. If reinjection is not feasible, the brine shall be evaporated and any remaining materials shall be disposed of at a landfill and treated as hazardous waste. Forced evaporation using heat and fans may be used to increase the rate of evaporation during the wet season.	• Drilling Contractor	• During testing
• Water Quality • Geothermal Emissions • Hazards • Applies to S-5 and FSJ	**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.	• Drilling Contractor	• During Well Drilling

Issues/Potential Impacts/Applicable Sites	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	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 • 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		
• Sanitary Waste • Applies to S-5, MS-1, and FSJ	**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 • Applies to FSJ	**Water-6: Water Extraction Strategy for Fond St. Jacques** The drilling contractor, in conjunction with the PIU, 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 PIU 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	• PIU • Drilling Contractor	• Before Construction Define Strategy • During Construction

Issues/Potential Impacts/Applicable Sites	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	approach to supplemental water supply to the extent needed to supply supplemental water at Fond St. Jacques.		
• Water Supply • Applies to FSJ	**Water-7: Water Supply Monitoring** • Diversions from the creek for use at each well pad will be metered and recorded daily during drilling. • Flow in the creek upstream of the diversion shall be measured approximately every 2 weeks during the drilling activities under dry weather conditions. • Discharge from the WASCO spring box upslope of the well pad shall be measured and recorded at least every other day during drilling activities. • If discharge from the WASCO spring decreases to the point that WASCO cannot offset the decrease by increasing withdrawals from the other spring, water from the creek diversion or other more distant source should be offered to WASCO as a replacement supply.	• Drilling Contractor	• During Construction
• Water Quality • Applies to S-5 and FSJ	**Water-8: Water Quality Monitoring** Water quality shall be monitored at the following sites: • At one location on the stream that flows along the west side of the Fond St. Jacques well pad and one location on Soufriere River downstream of the confluence with the stream along the west side of the project site. Monitoring shall occur at an accessible location as close to the downstream end of the well pad as possible. • In the Doree River upstream and downstream of the well pad. Access to the channel from the footpath may influence the selection of exact locations. At each monitoring site, turbidity and electrical conductivity shall be measured in the field using a handheld meter during the first rain event that produces runoff from the site during civil works and during drilling. Sampling shall be repeated for up to three rain events. Water quality samples shall be collected and analyzed for oil and grease. If sampling indicates suspended sediment, oil or grease are entering the creek from the drill site, additional sediment retention measures should be installed at the site. These could include diverting runoff to settling basins, installing straw or geotextile sediment dams, or other standard practices.	• Civil Works Contractor • Drilling Contractor	• First rain event following civil works and drilling activities; three monitoring events during rain.

Issues/Potential Impacts/Applicable Sites	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	Air Quality		
• Air Quality • Applies to S-5, MS-1, and FSJ	**Air-1: Fugitive Dust Management** The following procedures shall be implemented where dry exposed soils are located in project areas: • 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.	• Civil Contractor	• During Civil Works • During Reclamation
• Air Quality • Applies to S-5, MS-1, and FSJ	**Air-2: Construction Emissions Controls** The construction contractors shall be responsible for ensuring all vehicles and equipment are properly operated and maintained according 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 • During Well Drilling
• Worker Health and Safety • Community Health and Safety • Applies to S-5 and FSJ	**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	• Drilling Contractor	• During Well Drilling and Testing

Issues/Potential Impacts/Applicable Sites	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	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. • 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 i 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 Landslide • Applies to S-5	**Soils-1: S-5 Slope Stabilization Measures** Trees greater than 45 centimeters diameter at breast height located along the outer perimeter of the Saltibus well pad (S-5) shall be retained where feasible. The project geotechnical engineer in coordination with a botanist shall identify trees that shall be retained to maintain slope stability. Special attention shall be given to retaining if possible, the rare *Turpinia occidentalis.* Trees within the well pad that are to be retained shall be marked on the plan set prior to vegetation removal. Any trees along	• Civil Works Contractor • EMC	• Before Construction Mark Trees for Preservation on Plan Set • During Construction

Issues/Potential Impacts/Applicable Sites	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	the perimeter of the well pad that cannot be maintained shall be cut at the base and their root structures maintained to provide stability to the slope. A subdrainage system shall be designed by a qualified engineer to alleviate pore pressure within the well pad and along the hillslope fill areas. The subdrainage system shall be included on the final plan set.		
• Erosion and Landslide • Applies to S-5	**Soils-2: S-5 Site Reclamation** A site reclamation plan shall be developed by a reclamation specialist. The reclamation specialist shall have at least 10 years of experience preparing reclamation plans or implementing site reclamation (e.g., revegetation) with knowledge of the vegetation communities and habitat conditions in Saint Lucia. The reclamation plan will identify: • Soil management and measures to improve soil conditions for revegetation (e.g., addition of removed and stockpiled topsoil, mycorrhizal inoculant, etc.) • Grading for permanent stabilization (e.g., stepping back the grade along the outer hill slope and removal of fill along the outer slope) • Tree species, including trees that will provide habitat for priority bird species in the area (e.g., fruiting trees) • Tree species shall be autocthonous; allocthonous species shall be forbidden in reclamation • Location and number of trees for planting • Other vegetation species for planting (shrubs or vines), if needed • Measures for control of invasive species including inspection of equipment and materials applied in the reclamation activity	• Civil Works Contractor/ Reclamation Specialist	• During Civil Works and Prior to Reclamation
• Erosion and Topsoil Loss • Applies to FSJ and MS-1	**Soils-3: Topsoil Preservation and Reclamation** 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 reclamation 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 and stabilized to	• Civil Works Contractor	• During Construction • During Reclamation

Issues/Potential Impacts/Applicable Sites	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	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.		
Noise			
• Noise • Applies to S-5 and FSJ	**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; • Locate access roads and well pads as far from sensitive receptors as feasible; • Limit civil work activities to daytime hours (7:00 to 18:00), to the extent feasible; • Avoid civil works during sensitive morning, evening, and nighttime periods, to the extent feasible; • 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; • Implement a Noise Complaint Program to record and respond to noise complaints during construction. • A sound barrier shall be properly constructed along the Fond St. Jacques well pad limits as specified in the design plans. • A sound barrier shall be installed along portions of the S-5 well pad between the noise producing devices and the nearest receptors to intercept the line of sight. If the line of sight is intercepted by a hill slope, the hill slope will provide noise attenuation.	• Civil Works Contractor • Drilling Contractor • PIU (notify residents and respond to noise complaints)	• Before Construction notify residents • During Construction

Issues/Potential Impacts/Applicable Sites	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	• Stationary noise sources shall be a minimum of 40 meters from the nearest occupied residential structure.		
• Noise • Applies to S-5 and FSJ	**Noise-2: Drilling Noise Control Monitoring and Mitigation** Prior to the start of well drilling, the contractor shall prepare a Noise Control and Mitigation Plan. The Noise Control and Mitigation Plan will specify: 1. The location of all stationary noise sources (per the requirements of Mitigation Measures Noise-1) 2. The noise level at each stationary noise source 3. The noise level at the nearest receptor during operation of the stationary noise source include attenuation with the sound wall (as defined in Mitigation Measure Noise-1) 4. For any stationary sources that will produce noise > 58 dB at the nearest receptor, proposed noise attenuation measures that would be used to reduce noise levels to < 58 dB. All noise attenuation measures identified in item 4 shall be maintained throughout the duration of drilling/noise. Prior to drilling activities, the contractor shall install a continuous noise meter at the edge of the well pad nearest residences and at a distance of approximately 100 meters from the well pad. The contractor shall review the noise monitoring data weekly or more frequent to verify that noise levels have not exceeded the predicted noise levels in the Noise Control and Mitigation Plan.	• Drilling Contractor	• Before Start of Well Drilling develop the Noise Control and Mitigation Plan • During Drilling implement noise controls
• Noise • Applies to S-5 and FSJ	**Noise-3: Well Testing Noise Mitigation** • A drum silencer shall be used during well testing; • Venting of the resource shall be conducted as far from sensitive receptors as possible; • Community members within 500 meters of the well pad shall be notified about the testing activities to avoid alarm; • At least 2 weeks prior to testing activities that involve venting of the resource, notify community members within 200 meters of the well pad of the timeframe for testing	• Drilling Contractor • PIU	• Prior to and Testing notify community • During Testing use a drum silencer

Issues/Potential Impacts/Applicable Sites	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	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.		
	Vibration		
• Vibration • Applies to FSJ	**Vibration-1: Vibration Monitoring** Structures within 10 meters of civil works activities and 30 meters of drilling activities will be documented with photographs prior to construction and after the completion of drilling to assess and record any pre-construction cracking and any post-drilling cracking. If any structural damage as evidenced by new cracking is documented during the photo survey that could have been caused by the civil works or drilling activity, homeowners will be compensated to repair the damage that was incurred as a result of the project.	• PIU	• Before Construction conduct survey of structures • After Construction conduct survey
	Natural Habitats and Biodiversity		
• Natural Habitats • Applies to S-5, MS-1, and FSJ	**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
• Natural Habitats • Applies to S-5	**Biodiversity-2: Vegetation Removal Timing** Vegetation clearing and removal activities within suitable habitat for priority bird species (S-5) shall be conducted outside of the nesting season (March to August).	• PIU	• During Construction
• Nesting Birds • Applies to S-5 and FSJ	**Biodiversity-3: Nesting Bird Avoidance and Impact Minimization** Project activities shall be scheduled outside of the prime bird nesting season (May to August) to the extent feasible. All vegetation removal at S-5 shall occur outside of the	• PIU	• Before vegetation removal

Issues/Potential Impacts/Applicable Sites	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	prime bird nesting season (March to August). 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 the nesting birds show signs of disturbance that could result in nest failure, all work activities that disturb the birds shall be temporarily halted and visual and acoustic barriers shall be erected between the nesting location and work areas. Installation of any visual and acoustic barriers shall be overseen and approved by the qualified biologist. Monitoring is not required for continuous construction activities/noise as any birds that nest in the area would be assumed to be adapted to the on-going noise level.		• Before Construction Commences During the Nesting Season
Archaeological and Cultural Resources			
• Archaeological and Cultural Resources • Applies to MS-1	**Cultural-1: Protection of Cultural Resources at MS-1** To the extent feasible, the contractor shall avoid activities within areas containing cultural resources within MS-1. Prior to staging and stockpiling of materials at MS-1, the contractor shall engage and archaeologist. The boundaries of the archaeological resource shall be delineated in the field under the direction of an archaeologist with knowledge of historic and Amerindian artifacts in the region. Areas containing archaeological resources shall either be protected with a fence to avoid activities in the area, or a geotechnical liner shall be placed upon the soil surface to protect the resources from any grading. Steel or wooden plates shall be placed above the geotechnical liner to protect the soil from rutting prior to heavy equipment travel in areas containing cultural resources. to protect any cultural resources at the MS-1 site. Soil materials shall be stored on top of the liner to prevent mixing of the soil with the native soil materials and any artifacts present in the area. No excavation shall be conducted in areas containing archaeological resources at MS-1. Any stockpiled soil materials in areas containing archaeological resources shall be removed carefully to avoid damaging the protective geotechnical liner and buried resources. All protective materials/barriers or fencing shall be removed at the completion of construction to restore use of the site.	• Civil works contractor	• Site Preparation • Site Restoration

Issues/Potential Impacts/Applicable Sites	Mitigation Measure	Responsible for Implementing	Timing of Requirements
• Archeological and Cultural Resources • Applies to S-5 and FSJ	**Cultural-2: Inadvertent Discovery of 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 i n 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 plan has been prepared and implemented to the satisfaction of the archaeologist. In consultation with PIU, the archaeologist will determine when construction can resume.	• Civil Works contractor to develop Chance Find Management Plan • Civil Works Contractor to halt work in the event of a chance find • PIU to contact archaeologist	• During Construction
• Archeological and Cultural Resources • Applies to S-5, MS-1, and FSJ	**Cultural-3 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	• Civil Works Contractor	• During Construction

Issues/Potential Impacts/Applicable Sites	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	proper record keeping and cataloging. A training log shall be kept on the job site as a record of all training provided.		
	Traffic Circulation and Safety		
• Traffic Circulation • Community Health and Safety • Applies to S-5, MS-1, and FSJ	**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 to the paved road network. Signs shall be posted to warn drivers of slow-moving vehicles entering and exiting during deliveries. Notice shall be posted a minimum of two weeks prior to construction activities with information on the timeframe of construction, potential traffic delays, and safety measures that will be implemented during construction. Local traffic laws and speed limits shall be followed at all times.	• PIU • Civil Works Contractor • Drilling Contractor	• Before Construction develop Traffic Management Plan if needed • During Construction implement traffic management
• Traffic Circulation and Safety • Livelihoods • Applies to S-5 and FSJ	**Traffic-2: Maintain Community Access** All occupants and property owners adjacent to and beyond the improved roadway segments shall be notified of the road construction schedule and duration at least 2 weeks prior to roadway construction activities. The notice shall provide a phone number to contact regarding access concerns. Access to community members and businesses occupying the parcels along and beyond the road work area shall be maintained throughout the duration of road construction activities. Flaggers will be position to notify work crews of the need for vehicle transport through the roadway construction zone. If roadway passage must be closed for a specific period of time, all occupants and businesses that would be affected must be notified of the closure schedule at least 72 hours prior to the closure.	• PIU • Civil Works Contractor	• Before Construction provide notification • During Road Construction maintain access
	Utilities and Communication Systems		
• Utilities	**Utilities-1: Locate and Protect Buried Pipelines**	• PIU	• Prior to Civil Works locate

Issues/Potential Impacts/Applicable Sites	Mitigation Measure	Responsible for Implementing	Timing of Requirements
• Applies to FSJ	Prior to grading and road construction at Fond St. Jacques, all utility pipelines within the work area shall be properly located. Any pipelines within the grading area shall be relocated prior to grading. Pipelines buried beneath the roadway shall be evaluated by a licensed engineer to ensure there is adequate protection for the pipeline during large material hauling. If additional cover or protection is required, the pipeline protection shall be identified on the final design plans.	• Civil Works	and protect pipelines
• Utilities and Communication Systems • Applies to S-5 and FSJ	**Utilities-2: Protect Overhead Utility Lines** The civil works contractor shall provide advance notice to LUCELEC prior to any road expansion or well pad grading activities that would affect power infrastructure in the Fond St. Jacques area. Any physical conflicts with the power line infrastructure shall be resolved and power poles relocated prior to road construction in the area. 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 construction contractors shall work with the applicable system providers to temporarily disconnect or reposition the lines for the duration of construction.	• Civil Works Contractor • Drilling Contractor	• Before Fond St. Jacque Road Work • Before and During Mobilization of Drilling Equipment
Hazards and Hazardous Materials			
• Water Quality • Hazardous Materials • Worker Health and Safety • Community Health and Safety • Applies to S-5, MS-1, and FSJ	**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 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 30 meters (100 feet) from any downgradient drainage or within secondary containment capable of containing its entire volume.	• Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction

Issues/Potential Impacts/Applicable Sites	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	• 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.		
• Hazardous Materials • Community Health and Safety • Applies to S-5 and MS-1	**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 the 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.	• Civil Works Contractor	• Prior to disposition of materials
Fires			
• Wildfire Ignition • Applies to S-5, MS-1, and FSJ	**Fires-1: Fire Prevention and Response** The risk of fires shall be evaluated for each project site based on the activities that would occur, environmental conditions, and presence of ignitable or combustible materials in the area. If the activities pose a risk of igniting a wildfire, appropriate fire prevention and response equipment shall be available at each active site, such as shovels, axes, fire extinguishers, and dedicated water tanks. All workers shall be trained in proper fire prevention and response procedures prior to working on the site.	• Civil Contractor • Drilling Contractor	• During Construction

Issues/Potential Impacts/Applicable Sites	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	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.		
	Solid Waste		
• Water Quality • Hazardous Materials • Waste • Applies to S-5, MS-1, and FSJ	**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 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 • Resettlement • Applies to MS-1 and FSJ	**Social-1: Resettlement and Livelihoods** Impacts on any dwelling units shall be avoided to the extent feasible. Where it is not feasible to avoid a dwelling unit, the owner shall be resettled in accordance with the Abbreviated Resettlement Action Plan (A-RAP). Resettlement shall occur in accordance with all World Bank and Government of Saint Lucia laws and standards. Impacts to active farmland should be avoided to the extent possible. The locations of access roads and well pads should be positioned away from active agricultural areas, as feasible. 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. If active farmland cannot be avoided, crops with long maturing periods (i.e., bananas, coconuts, cocoa, avocados, mangoes, and citrus) should be avoided to the greatest extent possible. Where farmland and crops are impacted by the project, farm owners and farmworkers should be compensated for the loss in pay and agriculture production for affected growing seasons in accordance with the A-RAP. Male and female farm owners and farmworkers shall be compensated for impacts to agriculture production equally. If any lands are impacted beyond the areas designated in the plan set and evaluated in the A-RAP, the lands shall be restored immediately, or landowners shall be properly compensated for such unplanned impacts.	• Civil Works Contractor mark limits of work areas • PIU responsible for compensation under the A-RAP	• Before Construction
• Working Conditions and Equality • Applies to S-5, MS-1, and FSJ	**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.	• 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
	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 • Clean drinking water at all times • Adequate training for their position Violence, sexual harassment, discrimination, and drug abuse shall not be tolerated. Workers engaging in such activities shall be suspended immediately while the incident is investigated. 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 • Applies to S-5, MS-1, and FS-J	**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	• PIU • Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	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 Stakeholder Engagement Plan, 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 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 • Applies to S-5, MS-1, and FSJ	**Safety-1: Health and Safety Plan** The construction 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);	• Civil Works Contractor • Drilling Contractor	• Before Construction prepare plans • During Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	• 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 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 • Applies to S-5, MS-1, and FSJ	**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	• Civil Works Contractor • Drilling Contractor	• During Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	• 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.		
• Worker Health and Safety • Applies to S-5, MS-1, and FSJ	**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 • Applies to S-5 and FSJ	**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

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
• 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. • 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.	• Drilling Contractor	• Before Construction prepare plan • During Construction implement plan as warranted

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 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 at S-5 was selected after further evaluation of the geothermal resource area and site investigations in 2024. While the S-5 site is constrained by topography, the site was determined to be feasible for slim hole drilling and is better located within the geothermal resource area than previously evaluated sites. The MS-1 site was retained for staging and storage of materials that could not fit at the S-5 site. The Fond St. Jacques east well pad was selected over the Fond

St. Jacques west area because the selected site is larger and has less community conflicts than the alternative Fond St. Jacques west well pad area that was previously considered.

7.2 Alternatives Considered but Rejected

7.2.1 Alternative 1: Alternate Drilling Areas

Rural and Mountainous Areas

An alternative to the proposed project location in Fond St. Jacques adjacent to residential areas would be to move the project drilling areas away from the flat and open areas, where residences and farmland are located, to more rural areas that have steeper slopes and would have much greater road and pad construction costs. The pros and cons of this alternative are summarized as follows:

Pros

- Avoids direct impacts to farmland and livelihoods
- Reduces impacts on adjacent residents (e.g., noise, air quality, livelihoods, and traffic circulation)
- Reduces some public safety concerns (e.g., geothermal gas emissions, hot fluids, heavy equipment, etc.) for nearby residences
- Reduces risk of impact on WASCO water supply infrastructure

Cons

- Greater impacts associated with grading, ground disturbance, and vegetation disturbance
- Greater risk of erosion and sediment transport
- Greater impacts on habitat for wildlife and nesting birds
- Potential for causing landslides and mudslides
- Potentially greater visual impacts
- Longer construction period
- Greater construction costs

This alternative would require similar mitigation to the proposed project; however, mitigation to compensate farm owners and farmworkers for a loss in livelihoods would not be needed. Additional mitigation would be needed to address the risks and impacts from working on slopes. The civil works costs would be substantially greater.

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 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 in the PMA
- 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

This alternative would require similar mitigation to the proposed project; however, mitigation to compensate farm owners and farmworkers for a loss in livelihoods might not be necessary. Additional mitigation would be needed to address impacts to visual resources, tourism, the PMA, and to preserve the World Heritage Site designation. The project conflicts with national policy to protect the PMA would also be unresolved.

7.2.2 Alternative 2: Reduced Drilling Sites

The drilling areas in Fond St. Jacques are in close proximity to residences. An alternative to the proposed project would be to avoid drilling in Fond St. Jacques, which is in very close proximity to residences, and only drill wells in the Saltibus area. The pros and cons of this alternative are summarized as follows:

Pros

- Reduces direct impacts on farmland and livelihoods
- Reduces impacts on adjacent residents (e.g., noise, air quality,

Cons

- Reduces exploration study area
- No subsurface data would be collected for the northern extent of the geothermal interest areas

livelihoods, and traffic circulation)
- Reduces some public safety concerns (e.g., geothermal gas emissions, hot fluids, heavy equipment, etc.) for nearby residences
- Reduces construction costs
- Reduces mitigation costs

- Fond St. Jacques is within the area that was defined as the resource target area resulting from geophysical assessment

This alternative would require similar mitigation to the proposed project; however, some mitigation procedures for construction noise, utilities, and community health and safety may not be needed.

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 impacts

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

No mitigation would be required under this alternative.

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
Community	Residents, landowners, and workers in proximity to the project.
Project Affected Persons	Residents, landowners and farmers/ farm workers, agricultural squatters at the well pad and along the access road within the area of project activities/direct impact.
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
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
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

Stakeholder Type	Individuals/Groups/Organization
Government/Institutional/ Authorities/supporting organization (Legal mandates)/facilitators	Government Departments/Ministry of: • Forestry Division • 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
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
Project Sponsor/Fiduciary Support/facilitator	RESDP; World Bank

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
Water Resource Management Agency	26 August 2024
Forestry Division	26 August 2024
Department of Physical Development and Urban Renewal	26 August 2024
PMA Office	27 August 2024
Forestry Division	28 August 2024
Water Resource Management Agency	28 August 2024

Stakeholder	Meeting Date
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 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. The PMA Office expressed concerns about any disturbance with the Green Buffer Zone that could affect the PMA. None of the PMA Office comments are applicable to the project areas covered under this ESIA, 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.

8.4.2 Roles and Responsibilities

The Grievances Redress Committee (GRC) will be responsible for receiving and resolving in a fair, objective, and constructive manner, all concerns or complaints raised by PAPs within the communities affected by the Project. The broad responsibilities of the GRC include:

- Developing and publicizing the grievance management procedures
- Receiving, reviewing, investigating and keeping track of grievances
- Adjudicating grievances
- Monitoring and evaluating fulfillment of agreements achieved through the grievance redress mechanism

8.4.3 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.

Appendix A List of ESIA Preparers and Contributors

Appendix A List of ESIA Preparers and Contributors

Topic Area/Role	Name
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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 Abbreviated Resettlement Action Plan