ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT - CONSTRUCTION AND OPERATION OF GEOTHERMAL REINJECTION WELL RV-I 2 AND OF PIPELINE

For Dominica Geothermal Development Company Ltd.

Eclipse Inc
November 2020

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List of Abbreviations

Acronym	Meaning
ASL	Above Sea Level
ARAP	Abbreviated Resettlement Action Plan
DGDC	Dominica Geothermal Development Company Limited
DOMLEC	Dominica Electricity Services Limited
DOWASCO	Dominica Water and Sewerage Company Limited
EHS	Environmental Health and Safety
EPC	Engineer, procure and Construct
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
GoCD	Government of the Commonwealth of Dominica
H_2S	Hydrogen Sulphide
IFC	International Finance Corporation
IUCN	International Union for Conservation of Nature
kV	Kilovolt
kW	Kilowatt
mm	Millimetres
MW	Megawatts
NO_x	Oxides of Nitrogen
NO_2	Nitrogen Dioxide
ORC	Organic Rankine Cycle
O_3	Ozone
PAP	Project Affected Persons
PM_{10}	Particulate Matter- with a diameter of 10 micrometres or less
PPE	Personal Protective Equipment
PS	Performance Standard
SEP	Stakeholder Engagement Plan
SO_2	Sulphur Dioxide
SOP	Standard Operating Procedures
ToR	Terms of Reference

U.S. EPA	United States Environmental Protection Agency
WBG	World Bank Group
WHO	World Health Organisation

PROJECT DATA SHEET

Dominica Geothermal Development Company Ltd. - Environmental and Social Impact Assessment

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EXECUTIVE SUMMARY

INTRODUCTION

The Dominica Geothermal Development Company Ltd. (DGDC) is developing a geothermal power plant in the community of Laudat in the Roseau Valley, utilising what is referred to as the "Wotten Waven" geothermal reservoir. The net capacity of the power plant is 10 MWe utilizing Organic Rankine Cycle technology which is an environmentally friendly, closed-loop system. This technology requires geothermal fluids pass heat to an organic working fluid which boils, and the organic vapour then drives a turbine connected to a generator. These are often also called 'Binary Cycle' plants because they use two fluids (the original steam and the organic secondary fluid).

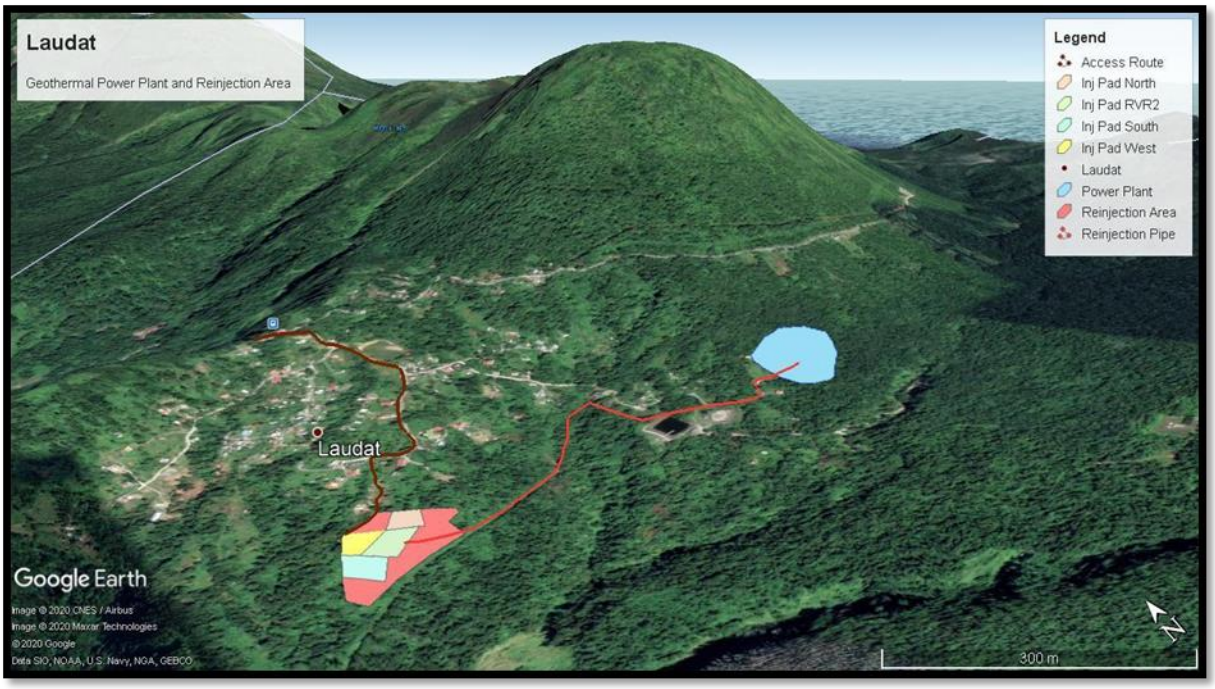
This component of the project involves the construction and operation of the well pad, the drilling of a geothermal reinjection well, and the construction and operation of a reinjection pipeline and road access. The ESIA addressed the impacts of these components on the social, economic and environmental aspects of the community of Laudat.

The proposed length of the pipeline is approximately 1.2 kilometres. It is located on the south-western periphery of the village of Laudat. The pipeline will follow the same route as the pipe from the hydro-balancing tank for the hydropower plant and then diverting from the route to the reinjection well pad.

The proposed site of the reinjection line and pad are on private land. Approximately 5 acres of land will be acquired from 12 landowners. Land will be acquired either through negotiated agreement or by Compulsory Acquisition under the Land Acquisition Act 1946.

The proposed facility is not in proximity to most homes in the community. The closest buildings to the site in question are an existing school building which is currently used as a community centre and a Roman Catholic Church.

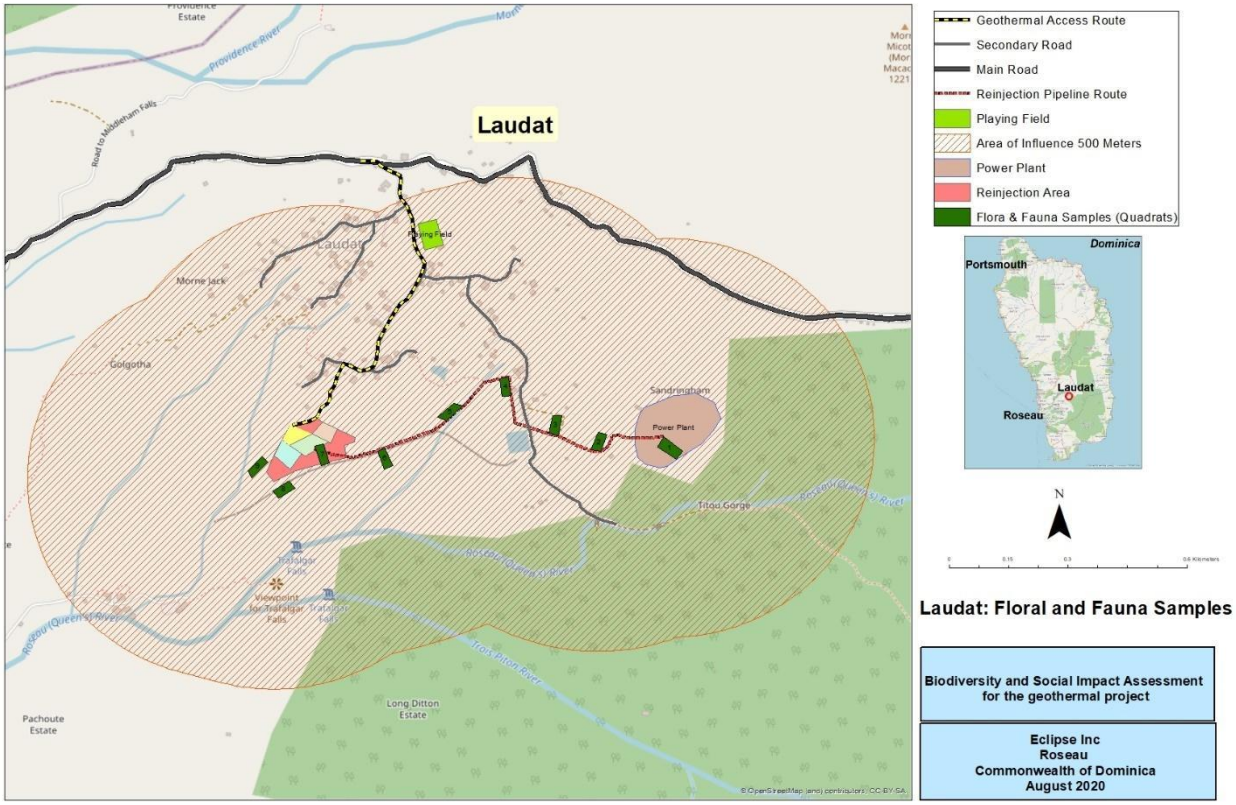
Figure 1: Geothermal Power Plant & Reinjection Area



The production of geothermal energy is of strategic importance to the Government of Dominica in terms of lowering the relatively high energy bills at the household level and improving the economy of Dominica on a long-term basis. This represents phase 1 on the geothermal project which will cater to domestic energy needs. The project construction phase is expected to start in 2021 and completed in 2022.

For the purposes of the study a designated geographical area was established as a “area of influence” to evaluate the impacts of the proposed project. The demarcated zone of influence consists of a 500m radius around major project infrastructure, viz., the proposed Geothermal Power Plant site and Reinjection Well site, respectively. It should be noted that generally the entire community is considered an area of influence

Figure 2: *Project Area of Influence*



PROJECT DESIGN AND TECHNOLOGY

Organic Rankine Cycle is the preferred technology -a binary system that denotes the use of two fluids, the geothermal fluid from the geothermal system and an organic fluid. This technology utilizes heat from the geothermal fluid to bring an organic fluid to the boiling point which produces vapour that drives generator turbines. The steam cools and condenses into water and is reinjected back into the ground to be used again.

This is a closed system where production influents will be reinjected into well and reduce the negative impacts associated with other systems.

The project is expected to comply with national standards as well as to IFC Environmental and Social Performance standards and the relevant health and safety guidelines.

Additionally, the proposed project design features and system proposed have contributed to reducing negative impacts while creating processes that support high energy efficiency.

IDENTIFICATION OF ALTERNATIVE SITES

Several alternative routes were proposed for construction of the pipeline which was expected to run from WW-P1 in Laudat to WW-01 and/or WW-R1 into the Trafalgar. These routes were evaluated on the basis of the constructability, topography, natural hazard exposure (i.e. landslides, rock falls, etc.), estimated capital costs, operational considerations and social and environmental constraints. They proved to be financially unfeasible and were abandoned in favour of the preferred location southwest of the village of Laudat.

Within this preferred site, two locations were considered for the location of the reinjection well. Factors considered in the site selection, included accessibility, preservation of the integrity of the reservoir, the level of road construction required, land requirements, complexity of land ownership and land acquisition and distance from the community. One site was located approximately 630 meters from the production well, at an elevation of 525m (1,722ft) above sea level. The alternative site is situated approximately 830 meters from the production well, at an elevation of 594 meters (1,948 ft.) above sea level. The site closer to the production well was selected as the preferred site for the following reasons:

- It will avoid major disruption of the village roads.
- It required an easier pipeline route.
- The pad is within reasonable distance from major waterways
- The existing access road can be improved to facilitate access to the drilling rig and for pipeline construction.
- Extensive clearing of forest vegetation will not be required
- In terms of soil characteristics, it shows better water holding capacity and therefore reduces the potential for groundwater contamination.
- The subsurface soil does not indicate any subsurface aquifer which could potentially be modified or contaminated from any

PHYSICAL, ECOLOGICAL AND SOCIO -ECONOMIC BASELINE CONDITIONS

Physical

The site lies within an altitude of 592 m or 1492 ft.ASL. The greater percentage of the land surface within the project area is gently sloping with a slope characteristic of <30º. The land surface is deeply incised by one (1) permanent and two (2) temporary natural watercourses that traverse the area. Several smaller watercourses radiate across the terrain.

The climate of the area, like most of Dominica, is classified as “humid tropical marine”, exhibiting little seasonal or diurnal variation. Relative humidity is usually in the region of 85%. The area lies within the precipitation zone that receives 5,080-6,350 millimetres (200-250 inches) of rainfall per year.

Like Dominica the area is prone to hurricanes. However, the project area of influence lies within areas with a low susceptibility to landslide and flooding and low to moderate risks from earthquakes.

Habitat and Ecosystem

Much of the original natural vegetation within the area has been altered due to the combined impacts of human induced activities and tropical weather systems. Consequently, due to extensive degradation and modification the forest formation within Laudat can best be described as modified secondary rainforest in various stages of succession.

This modified habitat does not have the typical form, structure, and species composition of the rainforest proper. Generally, it does not have a clearly defined closed canopy but rather a fragmented canopy 12-18m (40-60ft) tall and an understory stratum 4.5-9m (15-30ft) high. *The* ground cover is very spare except on the forest edge. No endemic or threatened species of plants were found in the area.

Several endemic, rare and threatened faunal species were identified within the project area. With respect to the avifauna, the Red-necked Parrot, *Amazona arausiaca,* and the Imperial Parrot, *Amazona imperialis,* were sighted in the area.

Socio-economic

The village of Laudat has a population of about 321 individuals comprising 174 male and 147 females living in 128 households (Government of Dominica, 2011).

Current land use of the community comprises of a mix of subsistence agriculture, livestock farming (sheep, rabbits, pigs), charcoal production, lumber production, harvesting of firewood, wildlife hunting, private residential homes, tourism facilities, watershed, river recreation and hydroelectric infrastructure (power plant,. hydroelectric pipeline corridor and balancing tank).

The socio-economic assessment indicated that the GoCD is the largest employer followed by agriculture and tourism. The agricultural sector is dominated by men. A small percentage of women are involved in agriculture (1.6 % of the population), specifically in vegetable farming and horticulture.

The majority of the community acknowledged that benefits would accrue to them in terms of employment and training as a result of the establishment of this project. However, they have expressed fears with respect to safety, the land acquisition process and the possibility of the project triggering volcanic activity, among others.

EVALUATION OF THE IMPACTS

The potential environmental impacts likely to arise from the drilling of the geothermal well and construction of the pipeline were assessed by harmonizing the project components with the environment and social processes likely to be impacted. Significance of the impact was assessed based on the magnitude of the impact and the sensitivity of the environmental or social receptors. There were no impacts of major significance on the environment and the community from the project.

The following outlines the potential impacts resulting from environmental observations, literature review and consultations held with stakeholders.

Impact on Income Generation and Employment

The project will have a positive impact on employment generation and income. The extent of direct employment is projected to be between 20 and 50 persons, with a likelihood for income generation from accommodation, transport, catering services sectors during the construction phase. The impact on tourism and agriculture will be negligible.

Impacts Associated with Air Quality and Noise

The project activities are expected to increase noise levels due to drilling, construction, and increased traffic flow through the community. Project activities will create sound level increases for community members who live closest to the reinjection site and site workers who undertake activities of drilling and construction.

Air quality is expected to be affected as a result of fumes from vehicles and machinery used on the project site. Emission from exhaust such as NOx, H_2S, CO and particulate matter are expected to increase as a result of fossil fuel combustion in vehicles and machinery and equipment. However, the significance for air quality and noise is considered minor and negligible, respectively, with respect to the community.

Impact on Surface Water and Groundwater Pollution

Construction at the project site could result in contamination of surface water. There may also be a risk of contamination from hazardous waste. Mitigation measures and project design will reduce the possibility of contamination and as such the significance of this is determined to be minor.

Impact on Biodiversity and Landscape

The impact on biodiversity is considered minor due to the modification of the primary ecological function and species composition of the forest habitats of the study area. Much of the original natural forest vegetation within the area has been altered due to the impacts of human induced activities and tropical weather systems. As such, the impact of the project on the biodiversity of the area is considered minor. Mitigation measures are recommended for minimizing the impacts.

The impact of the project on the landscape is moderate given the acreage of the facilities when compared to the larger landscape area. Mitigation measures are proposed to enhance the aesthetic amenity and reduce the magnitude of the impact through landscaping, camouflaging of the pipelines.

Risk to Health and Safety of workers

The site activities will result in alterations to the quality and structure of some components of the physical environment: air, soil and water. Alongside these impacts, the site activities that will be carried out during the entire construction phase will also create nuisances and risks for site workers. Workers' health and safety will be affected by noise, moving parts, cutting equipment, sharp edges, heat, emissions from combustion of fossil fuels and hazardous material. An Occupational Health and safety Manual OHM as well as an Environmental, Social & Health and Safety Policy has been developed by the DGDC that will guide the Construction and operational processes to safeguard the health and safety of the workforce

Risk to Community Health and Safety

Increased traffic flow through the community during the construction phase could place residents at risk to accidents. A traffic management plan has been recommended to include the construction of speed bumps, pedestrian crossings as well as sensitization programmes to reduce the impact

Other aspects like air quality, and noise is within international guidelines and will not harm or impair the health of the community.

Other Impacts

The significance of the impacts on soil and surface water and waste management has been assessed as minor with proposed mitigation measures to reduce the impacts.

SUMMARY OF IMPACT

Table 1: *Summary of Potential Impact*

Impact Description	*Potential Effect*	*Impact Significance*	*Residual impact*
Construction			
Income generation	Job creation and income generation for community	Positive Minor	
Negative Impact on Tourism	Major effects will be derived from increased traffic along major access road	Negligible	
Residents exposed to increased traffic accidents and pollution	Increased dust and particulate matter can negatively impact the health of the community & increase the risk of road accidents	Minor	Negligible
Land acquisition	Most landowners only do backyard farming with five having adequate land around their residence	Negligible	
Impact on community Health and safety	Reduced air quality from dust and increased exhaust emissions and external workforce	Minor	Negligible
Occupational Health & Safety	Workforce at risk of accidents, noise, exposure to hazardous material	Minor	Negligible
Negative impact on the status and biodiversity of the Morne Trois Pitons NPWHS	Any impacts from geothermal activities on the MTNP could affect its status as a World Heritage Site	Negligible	
Biodiversity- loss of habitat and reduction in ecological biodiversity	A reduction in volume of secondary forest and agricultural land. Minimal mortality of species. Reduction in trees for food, shelter and breeding. Negative impact on endemics	Minor	Negligible

	and threatened species. Area is not a critical habitat for these species.		
Loss of aesthetic amenity of the landscape	Trees will be clear-felled along pipeline and well pad and will be replaced by buildings of an industrial nature	Moderate	Minor
Disturbance of topsoil Soil contamination from leakage of oil and petroleum products	This involves removal of vegetation and topsoil, construction of drainage channels and risk of contamination of soil from leakage of oil and petroleum products and chemicals used in drilling	Minor	Negligible
Disturbance to wildlife, and the community from noise generation	Annoyance to the community and temporary behavioural changes to wildlife.	Negligible for the community Minor for wildlife	Negligible
Pollution of surface water	This involves vegetation removal and earthworks up to 1.2 km and a width of 20 m resulting in erosion and sedimentation and the risk of pollution from lubricants from vehicle and machinery	Minor	Minor
Risk of contamination of ground water resources through fissures or geothermal fluid leaks	During the drilling phase, the mud will be in contact with the penetrated geological formations in particular, through fissures, faults or via under-pressurised permeable formations.	Minor	Negligible
Reduced air quality from exhaust emissions and particulate	Could have an impact on community health	Minor	Negligible
Waste Generation	Mis-handling and uncontrolled disposal could impact the	Moderate	Negligible

	environment		
Operation			
Loss of employment to most of the workforce	There will be reduced employment since operations will not require that volume of employees and loss of income.	Minor	
Temporary impact of light on the flight path of the Black-capped Petrel and increased mortality resulting from poaching	Increased mortality of wildlife and impact on feeding pattern of the Black-capped petrel that may affect its viability	Minor	Negligible
Potential soil contamination from accidental leakage of brine from reinjection pipeline	Contamination of soil from hazardous substances which could get into surface water through run-off. Very low likelihood of this occurring because of project design	Minor	Negligible
Noise impact from reinjection	Equipment will render the noise limits much below the recommended db. (A)	Negligible	
Contamination of Surface water	From leaks and spills from reinjection, geothermal wastewater and geothermal fluids stored on-site	Minor	Negligible

CUMULATIVE IMPACTS

Cumulative impacts are defined as impacts accruing from other projects within the existing geographic space or projects located alongside other existing facilities with similar discharges. This project will be located in close proximity to the existing pipeline corridor for electricity generation. The development of geothermal energy is new and there are not many developments of this type within this area except for the DOMLEC electricity generation plan. As such, the cumulative effect of the power plan will not result in significant environmental or social impacts.

LAND ACQUISITION

The project is expected to acquire approximately 5.77 acres of land. There are 12 landowners whose land will be acquired for the reinjection pipeline route and the reinjection well. All of the properties are undeveloped and unused except for one landowner who was at the time, undertaking subsistence agriculture – predominantly citrus fruit trees and animal husbandry. Acquisition will be undertaken by the Government of Dominica under the Land Acquisition Act Chapter 53:02. This may be accomplished through negotiation or compulsorily as allowed under the Act. To date, discussions have been held with some affected landowners and an in-depth evaluation and assessment of all properties has been undertaken to ascertain the exact location and acreage of land required. Negotiations with landowners are on-going.

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

An environmental and social management plan has been developed which lists all the mitigation measures and indicates the critical locations for monitoring adverse effects of the project, the reporting protocol, the agencies and institutions responsible for implementation.

The DGDC has had experience in social and safeguards management and monitoring. A Social Safeguard and Monitoring Officer has been in place and is familiar with IFC standards and guidelines. A monitoring plan has been developed. It is expected that monitoring will be undertaken by independent technical persons in collaboration with the relevant government department to ensure compliance with relevant laws and policies and mitigation recommendations.

1.0 INTRODUCTION

1.1 Background

The Government of Dominica obtained assistance from the European Union and the *Agence Francaise de Developpement* (AFD) for the drilling of three geothermal slim-hole exploration wells in Wotten Waven (WW-01) and Laudat (WW-02, WW-03) in 2011 and 2012, in a bid to determine the quantity and quality of the geothermal reservoir in what is referred to as the Wotten Waven geothermal field. Subsequently, in 2013 and 2014, drilling of one reinjection well in Trafalgar (WW-R1) and one production well in Laudat (WW-P1) were undertaken.

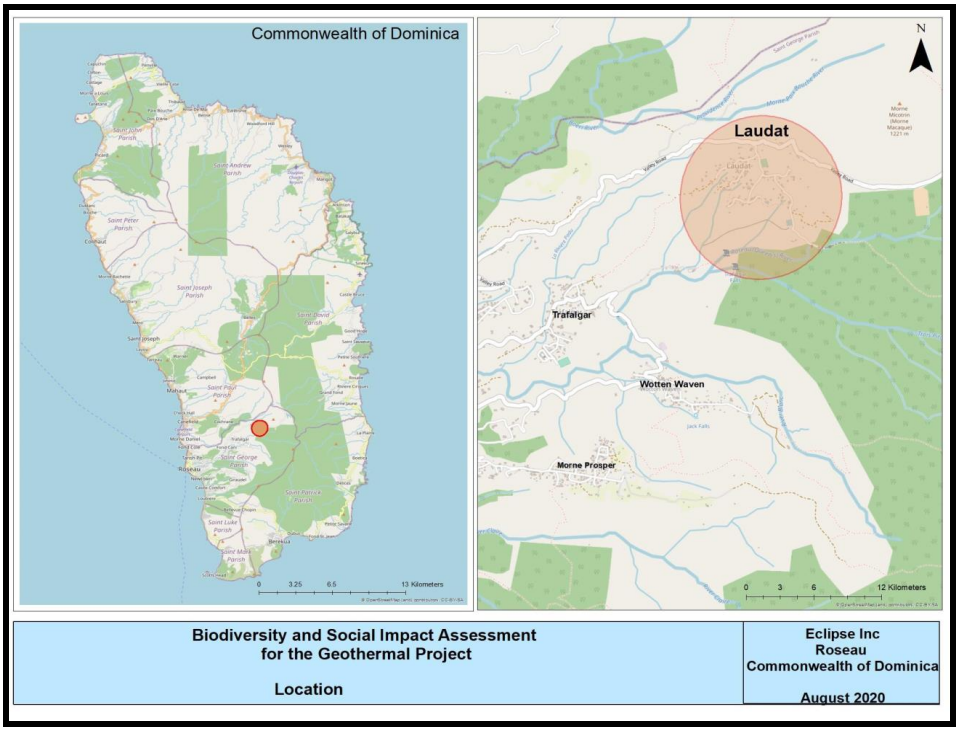
In 2016, the Government of Dominica sought financing from the World Bank for the funding of a Geothermal Risk Mitigation Project for the construction of a 7MW power plant for domestic use, with the Dominica Geothermal Development Company Ltd., DGDC, being the executing agency. The design included the use of the production well (WW-P1) and power plant site in Laudat and reinjection wells in Wotten Waven (WW-01) and Trafalgar (WW-R1). Following a failed procurement in November 2019, that approach was abandoned.

In 2019, The DGDC commissioned two independent consulting firms to undertake reinjection studies. Both firms recommended the location of a reinjection area in Laudat (refer to map below) thus eliminating the construction of a pipeline from Laudat to Wotten Waven and Trafalgar while maintaining the integrity of the reservoir.

One of the firms, Iceland Geosurvey (ISOR), was retained to advise on an appropriate re-injection site in the Laudat area. The report stated that “a prerequisite was to gather and compile available information on the geothermal reservoir in the Laudat region into a 3-dimensional model”. ISOR was contracted to build the 3D model, utilizing data submitted by the DGDC (including a Lidar-survey) and data gathered during drilling of the existing wells in Laudat, so as to lay the foundation for a well-supported site selection. The software “Leapfrog” was used for rendering the geological units, expected to be drilled through, with known aquifers and loss-zones, and calculated formation-temperature values were used, derived from temperature logs from the existing wells.

Geographical constraints are considerable in the region and in order to confine the reinjection to an area that is readily reachable with a pipeline, ISOR suggested the site southwest of the Laudat village (as shown below).

Figure 3: *Project Location*



DGDC undertook and onsite evaluation to determine the level of accessibility of the selected area, land requirement and the complexity of land ownership, and two sites, #A and #B, were proposed and considered. The report provided information on the coordinates of the sites and the distance to production well WW-P1 (see Table below).

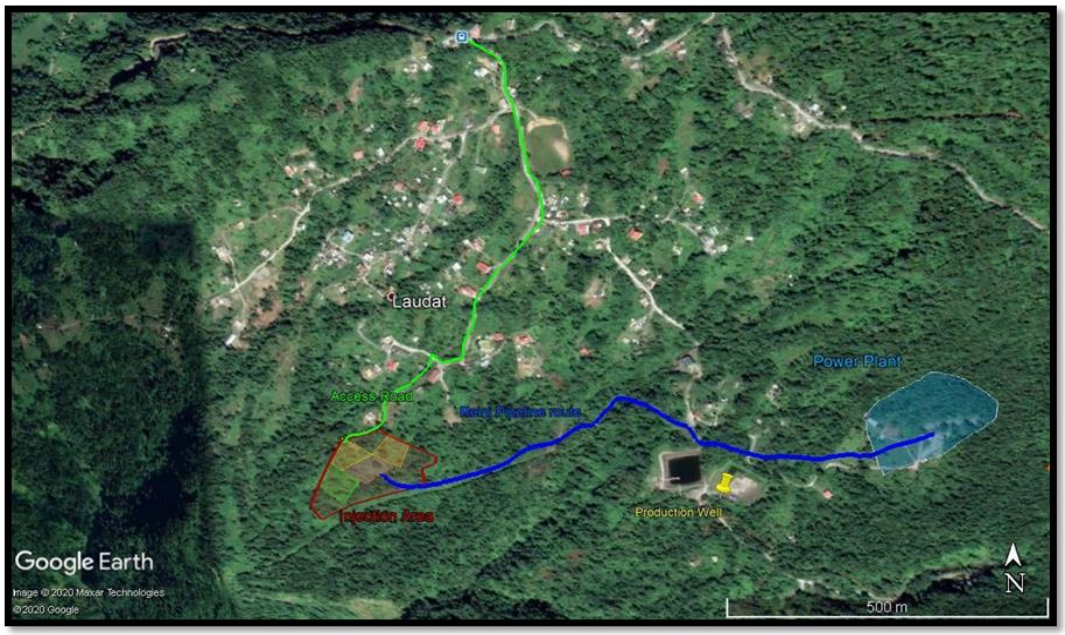
Table 2: *Coordinates of Proposed Sites*

Sites	Latitude	Longitude	Distance to WW-P1	Actual distance
A	15°19´51.50°N	61°19´59.93°W	550 (on map)	630m
B	15°19´47.26°N	61°20´04.42°W	700 m (on map)	830 m

Reference - ISOR, Iceland Geosurvey - Dominica Geothermal Development - Impact of re-injection in Laudat - Draft - Gunnar Þorgilsson Sigurður Sveinn Jónsson - Prepared for Dominica Geothermal Development Company (DGDC) Report number: June 2020

The preferred site as indicated by the DGDC is Site A located 630 m from the production well WW-P1. It is located on gently sloping land. The site is under secondary forest vegetation and residual agricultural crops. The area can be accessed via an abandoned farm access road on its north side. The site is fringed by a dry ravine on its northern side and the hydro pipeline corridor to the south. The Roseau River is also located some distance away on its southern side.

Figure 4: *Location of Proposed Geothermal Plant, Reinjection Pipeline, Well & Access Road*



A re-test of the production well WW-P1 in Laudat in October 2019 confirmed the viability of the resource and its ability to produce 10MW of power. In 2020 the DGDC and a French consortium agreed to the construction of a 10MW Domestic power plant in the same power plant location in Laudat.

1.2 Objectives

The objective of this study is to undertake an Environmental and Social Impact Assessment, (ESIA), of the construction and operation of a new reinjection well, and its associated well pad, pipelines and access road in order to determine the environmental and social impacts and provide recommendations for the prevention or mitigation of any negative impacts.

1.3 Scope of the ESIA

The proposed project entails the construction and operation of the well pad, the drilling of a geothermal reinjection well, and the construction and operation of a reinjection pipeline as well as the partial rehabilitation of the access road. The ESIA will address the impacts of these components on the social, economic and environmental aspects of the community of Laudat.

This ESIA is being undertaken in compliance with the laws and regulations of Dominica for construction and in keeping with the national requirements of the Physical Planning Division of the Government of Dominica.
The applicable international Standards such as the World Bank Environmental and Social Operational Policies, the IFC Performance Standards on Environmental and Social Sustainability, and the World Bank Environmental, Health and Safety Guidelines were also used as best practice guidance

1.4 Structure of the Report

Abbreviations
Executive Summary
Chapter 1 – Introduction
Chapter 2 – Approach and Methodology
Chapter 3 – Project Description
Chapter 4 – Policy, Legal and Administrative Framework
Chapter 5 – Evaluation of Baseline Data (Environmental)
Chapter 6 – Evaluation of Baseline Data (Socio-economic)
Chapter 7 – Assessment of Alternatives
Chapter 8 – Assessment of impacts- Methodology
Chapter 9 - Social Impact Assessment
Chapter 10 – Assessment of Environmental Impacts
Chapter 11 – Environmental and Social Management Plan
Chapter 12 – Summary of Stakeholder Consultations
Appendices
References

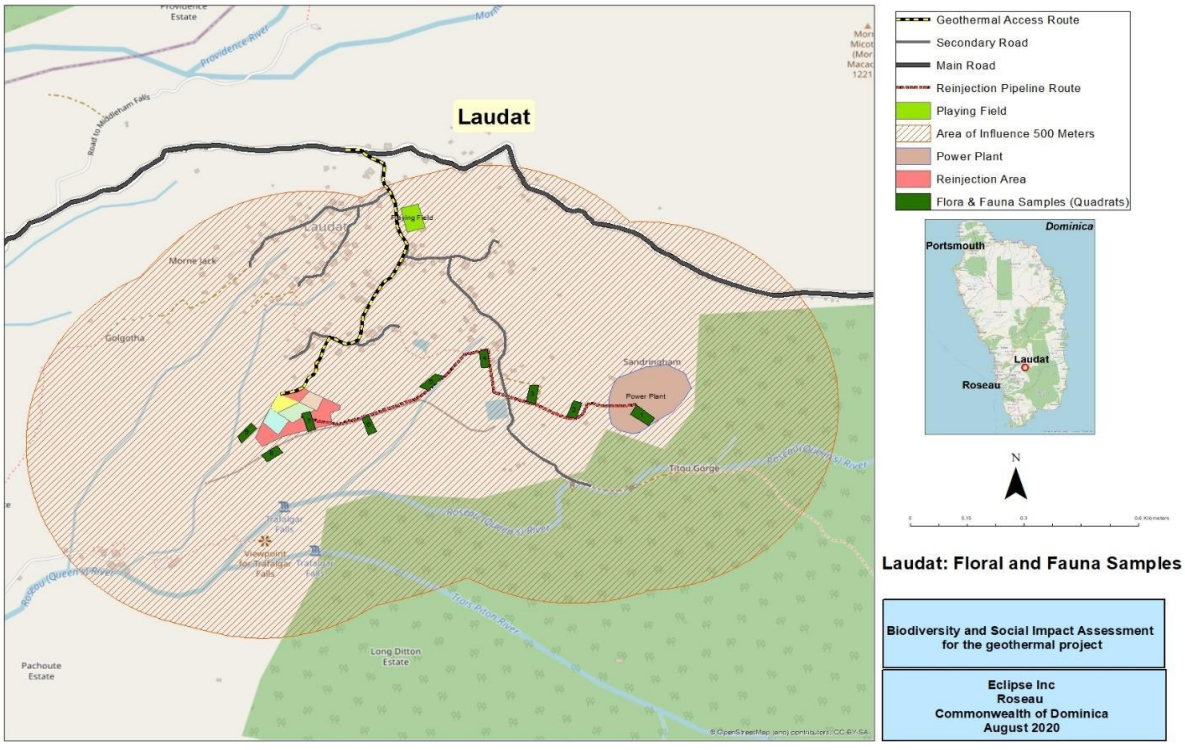
2.0 METHODOLOGY

2.1 Introduction

The methodology for impact assessment of the potential social and environmental impacts that will arise from the project is based on good industry practices. Identified potential impacts are confined to the project's area of influence and in accordance with World Bank Performance Standard 1 "Assessment and Management of Environmental and Social Risks and Impacts".

The study area of the report is generally limited to the Area of Influence (AoI) a designated geographical area within which project activities and potential impacts are evaluated. The AoI is comprised of a 500m radius around other major project infrastructures.

Figure 5: *Project Area of Influence (AoI)*



Overall, this area is limited to the Laudat community but may vary slightly based on the evaluation of each environmental and social aspects.

2.3 Evaluation of Baseline Data

This entails collation of environmental and social data relevant to the community. World Bank (1999) guidance on identification of baseline data states that it '…describes relevant physical, biological, and socioeconomic conditions, including any changes anticipated before the project commences. Also takes into account current and proposed development activities within the project area but not directly connected to the project. Data should be relevant to decisions about project location, design, operation, or mitigatory measures. The section indicates the accuracy, reliability, and sources of the data.'

Key environmental and socio-economic issues relevant to the well pad and reinjection sites as well as the community were evaluated based on the following research methods:

- General site visits to the project area and community
- Desk review on the physical and socio-economic conditions
- Review of policy, legal and institutional framework
- Literature review and field surveys to assess the existing ecology

Interviews were conducted with a cross section of stakeholders - residents in the AoI, relevant Ministries, utility companies, and landowners.

2.4 Previous Studies

A review of previous documents was undertaken to assess gaps in information. This included past Environmental & Social Impact Assessments (ESIAs) conducted prior to drilling of three (3) exploration wells and the addendum for the production and re-injection wells between 2011 and 2013.

The most recent ESIA studies conducted by JACOBS INC. in 2018, covering the power plant site and former re-injection route were reviewed with a view to understand project design, location, operations and proposed mitigation measures, to assess the quality of data, gaps and associated predictions relevant to the proposed assignment.

The following are some of the reports commissioned with respect to geothermal development in Dominica.

- STEAM- DOMINICA GEOTHERMAL DEVELOPMENT COMPANY – Review of the development and construction of a 2x3.5 M geothermal power plant and development of concepts of master plan for further geothermal development- Draft Review 2020-02-24
- JACOBS - Dominica Geothermal Development - Environmental and Social Impact Assessment - NZ Ministry of Foreign Affairs & Trade - ESIA Volume 1: Introduction - RZ020300-002-NP-RPT-0004 | 21 - July 2018
- JACOBS -Dominica Geothermal Development - Environmental and Social Impact Assessment - NZ Ministry of Foreign Affairs & Trade - ESIA Volume 2: Environmental Impact Assessment - RZ020300-002-NP-RPT-0005 | V2, July 2018
- JACOBS - Dominica Geothermal Development - Environmental and Social Impact Assessment NZ Ministry of Foreign Affairs & Trade - ESIA Volume 3: Social Impact Assessment -RZ020300-0002-NP-RPT-0006 | V4 - October 2018
- JACOBS - Dominica Geothermal Development – Environmental and Social Impact Assessment - NZ Ministry of Foreign Affairs & Trade - ESIA Volume 5: Technical Appendices - RZ020300-0002-NP-RPT-0008 | V2 - July 2018
- ISOR, Iceland Geosurvey - Dominica Geothermal Development - Impact of re-injection in Laudat - Draft - Gunnar Þorgilsson Sigurður Sveinn Jónsson - Prepared for Dominica Geothermal Development Company (DGDC) Report number: June 2020
- ADEME - ADEME CENTRE DE SOFIA ANTIPOLIS 500 ROUTE DES LUCIOLES 06560 VALBONNE FRANCE - Roseau Valley Geothermal Project Phase 1: Exploratory Drilling Environmental Impact Study - Township of Roseau, Dominica – Caraibe Environnement- Report No. 4064- RO517/11/Of/MI/HG of 30 September 2011(VF1)
- Caraïbes Environnement Développement & Coll (2009) Regulatory Impact Assessment on the Initial Environment - Environmental Feasibility Study.
- Caraïbes Environnement Développement & Coll (2011) Stage 1: Exploration Drilling Process – Environmental Impact Assessment.
- Caraïbes Environnement Développement & Coll (2013) Stage 2: Preliminary Environmental Impact Assessment of Geothermal Production and Re-Injection Drilling Wells in Dominica – Environmental Impact Assessment. To support the preparation of an ESIA for the Project, baseline surveys of the social, physical and biological environment within the Roseau Valley were completed between October 2013 and April 2015.

- Caraïbes Environnement Développement & Coll (2015a) - Initial environmental status of the Roseau Valley in Dominica, planned for development of geothermal electricity production. Final report, May 2015.

Additional information/documents were requested and collated from relevant Ministries - Forestry Division, the Ministry of Health and the Environment, the Statistical Division, Ministry of Finance, and the Ministry of Gender Affairs.

2.4.1 Gaps and limitations on available information

The following represent the gap analysis with respect to the environment and social aspects of the project. Evaluation of past ESIA's and documents listed did not have site specific information on areas of flooding, landslide, seismicity, geology and landscape as outlined below.

- **Flood:** Flash flood hazard extents were derived from the CHARIM project (Caribbean Handbook for Risk Information Management) which was produced in 2015. The flood hazard assessment was based on flash flood modelling of the entire island (all watersheds in one simulation). This map was created from analysis of the long-term records of daily rainfall data for Dominica to determine the rainfall depth for 5, 20 and 50 years. These records are often measured at the national airports or capitals of the islands. The daily maxima are combined in a Gumbel probability density analysis for the return periods. Through the analysis of data from this map, the flood risk of the project area (including the power plant, pipeline route and reinjection area) was derived.
- **Landslide:** Landslide susceptibility map was derived from the CHARIM project. Through the analysis of data from this map, the landslide susceptibility of the project area (to include the power plant, pipeline route and reinjection area) was derived.
- **Seismic/ Earthquake and Volcanic:** The layers used to prepare these maps were derived from the USAID multi-hazard project (2007). The analysis of these maps facilitated the analysis of the level of exposure of the project area to seismic and volcanic events.
- **Geology:** Geological data was derived from the Dominica Geology map (J. Roobol and A. Smith, 2015). This map provided information on the lithology of the project area. This map is precise and detailed and gives a description of the volcanic deposits found in the project area and surroundings.

- **Landscape, Visual:** The baseline study for visual amenity captured the location of viewpoints over the valley from high points as well as the view up the valley from Roseau, providing descriptions of landscape and architectural characteristics of the territory. It was felt that information on visual amenity should highlight the landscape of the community of Laudat. The data will be used to establish the baseline in the ESIA.
- **Aquatic Ecology and Water Quality:** The baseline studies in 2015 recorded the current condition of the aquatic habitats, water quality and biological values of the waterways in the study area (Caraibes Environment Development, 2015a/b). The baseline data is considered comprehensive in the documentation of current water quality and the condition of the biota present, including all relevant biological groups (diatoms, macroinvertebrates, microcrustaceans and fish). It is noted that systems for classifying the health of aquatic communities in the study region were limited; however, appropriate attempts were made to develop relevant biological indices that can be used as the basis for assessment of potential impacts associated with the proposed development. Species vulnerability to disturbance was assessed using the International Union for Conservation of Nature (IUCN) Red Lists.
- **Socio-economic:** The socio-economic data provided information on the Roseau valley and was not specific to Laudat which is now directly within the project's extended area of influence. Additionally, the original Social Impact Assessment study did not make provisions for the construction of the reinjection well, and its reinjection pipeline, in Laudat. Therefore, the possible impact of this reinjection well on the community and the concerns of residents were not previously evaluated. It was also felt that the long-term impact of Hurricane Maria and Covid-19 would have had some profound changes on the socio- economic landscape of the community.
- **Terrestrial Biodiversity:** The reinjection site is new so there was no information in past ESIA reports on the biodiversity of the site in question for establishment and future monitoring of baseline data.
- **Soil testing:** There is no available information in past reports on the soil of the site in question since it is a new site, hence the need to do soil tests of the project site.
- **Water quality:** Previous water quality studies have been done along the rivers located in the immediate area of the proposed geothermal plant and previously proposed reinjection sites. Baseline surveys conducted for ESIA Volume 2, lists water quality parameters and guideline values for three points on the Roseau (Queens) River at points upstream and downstream of the proposed site. The Queens River flows through

the city of Roseau. It is supplied by rivers flowing through Laudat and Trafalgar and could be impacted by the proposed geothermal wastewater reinjection. (Water Quality analyzed for the ESIA Volume 2 is hereby referred with permission from the Dominica Geothermal Development Company).

- **Air Quality:** Baseline monitoring has been undertaken previously to determine the existing levels of contaminants in air, including H2S but also NO2, SO2, ozone, and particulate matter as PM10 and PM2.5 (Caraïbes Environnement Développement & Coll, 2015a/b). As such this was used as baseline information.
- **Noise:** Noise levels surveys were required to establish a baseline for the community and to compare with baseline established in past reports to assess whether any changes had taken place since these were done a few years prior to this report.
- **Groundwater and hydrology:** Baseline information on surface and ground water hydrology for the site under review was not available in past reports.

2.5 Aspects Identification

The key environmental aspects have been detailed by the "TOR prepared by the DGDC as follows:

- **Environmental aspects**
    - Geology
    - Hydrology
    - Soils
    - Climate
    - Air and noise pollution
    - Terrestrial and aquatic biodiversity
    - Water quality
    - Morne Trois Pitons National Park World Heritage Site
    - Historical / archaeological features
    - Aesthetic amenity
    - Land use
    - Hazardous substances and waste
    - Traffic and access

- **Socio-economic**
    - Demographic overview
    - Religion
    - Ethnicity and culture
    - Gender Relations
    - Educational Profile
    - Land/ home ownership
    - Economic Profile
    - Social and Physical Infrastructure and Community Services
    - Ecosystem Services
    - Climate Change and environmental Impact on the community
    - Socio-economic Assessment of Landowners

Other Issues assessed were the community's perception of the proposed project and associated concerns, what safeguards they would like to see implemented, general comments and recommendations of the community with respect to the proposed project.

2.6 Impact Assessment

Based on WB requirements the environmental and social risks and impacts of the project have been assessed in accordance with World Bank Performance Standard 1 and good industry practices. The assessment will be proportionate to the potential risks and impacts of the project, and will assess, in an integrated way, all relevant direct, indirect, and cumulative environmental and social risks and impacts throughout the project life cycle, including those specifically identified through stakeholder consultation

The impact assessment predicts and assesses the Project's likely positive and negative impacts, in quantitative terms to the extent possible. For each of the environmental and social aspects listed above, the assessment determines the sensitivity of the receiving environment and identifies impacts and evaluates their magnitude and overall significance. An ESIA will always contain a degree of subjectivity, as it is based on the value judgment of various specialists and ESIA practitioners. The evaluation of significance is thus contingent upon

values, professional judgement, and dependent upon the context. Ultimately, impact significance involves a process of determining the acceptability of a predicted impact.

More details on the impact assessment scoring will be provided under section entitled “Assessment of Impacts”.

2.7 Methodology for Assessing Biodiversity

Following the literature review and gap analysis of the available information, a rapid biodiversity assessment of the proposed project site was undertaken. The rapid biodiversity assessment comprised baseline surveys of the habitats and species within the Area of influence of the proposed project, providing additional raw data, necessary to complement and update the previous biodiversity assessments. Detailed methodology for assessing the socio economic and environmental aspects will be detailed under pertinent sections.

2.8 Interviews with Professional Experts

Interviews were sought with professionals of the DGDC to request and verify technical information with respect to the proposed project, with the Forestry Division to inform them of the project and to get their views on potential biodiversity impacts and proposed programs with respect to the MTNPWHS and the Dominica Water and Sewerage Company Ltd, (DOWASCO) to seek information on the existing flow measurements of the rivers within the water catchment, fears of any impact as well as access to data on ground water resources.

2.9 Public Consultations / Focus Group Discussions

One-on-one interaction with potential affected people was undertaken during social surveys, including interviews with landowners, meetings with women and community residents to inform them of the project and the ESIA being undertaken for the project. Overall project features, social safeguards, issues related to women’s safety and security, environmental safeguards

were discussed. Discussions were also held with landowners on land acquisition, and the impact of Hurricane Maria and of COVID-19 on livelihoods.

Focus group discussions and interviews were held over a period of 2 weeks in August 2020 with a cross section of members of the community as well as targeted special interest groups – women and youth - to provide information on the project, the process and elements of undertaking the environmental and social impact assessment, to obtain baseline information and to get their perspectives on the positive and negative impacts of the project.

Formal Community consultations/meetings were held with stakeholders to sensitize and inform the directly affected stakeholders about the project and generate feedback on the key issues of environmental and socio-economic concerns and mitigation measures.

Table 3: Team Composition

Name	Area of Expertise	Assigned Position
Marie-José Edwards	Environment and Natural Resource Management Specialist	Team Leader
Sylvester St. Ville	Public Health and Safety Specialist	Environmental Health and Safety Specialist
David Williams	Forest Ecologist	Assessment of Fauna and Flora
Stephen Durand	Wildlife and Bird Specialist	Assessment of wildlife
Lyn Baron	GIS Mapping Specialist and Geologist specialist	Mapping
Lennox St. Aimie	Social Planner/Statistician	Social Planner
Garry Shillingford		Field Officer

3.0 PROJECT DESCRIPTION

3.1 Project Owner

The Project is being developed by the Dominica Geothermal Development Company (DGDC), which was established mid-2017. The Government of Dominica is the sole shareholder. The company is governed by a Board of Directors appointed by the GoCD. The DGDC operates with guidance of commercial, financial and technical advisors.

3.2 Project site

The proposed project is located on the southwestern periphery of the village of Laudat, west of Morne Micotrin, north of the Roseau River/La Riviere Mywal and east of the steep cliffs in the vicinity of the Trafalgar Falls. The site lies on the shoulder of Morne Micotrin, at an altitude range of 592m (1,492ft) ASL.

The reinjection pipeline runs from the eastern (power plant) to southern boundary (re-injection area) of the community and traverses mostly through patches of secondary forest and crosses the Ravine Fordy near the DOMLEC (Dominica Electricity Services) Power Plant. The Reinjection area/ well pad is located to the south of the community and is within closer proximity to the residential area than the other infrastructure (approximately 120-150 meters).

3.3 Technical Description

The proposed length of the re-injection pipeline from the power plant to the reinjection site is approximately 1.2 kilometers. The diameter has not yet been determined but will be in the range of DN250 – DN450. It is to be located on the south-western periphery of the village of Laudat.

Injection pipeline operates at temperatures around 110-120°C in normal operation. This temperature can go up to around 170°C for abnormal operation. The maximum pressure is around 10 bars at the reinjection well pad. If above ground piping will be used, then it must be

carefully designed with suitable supports and guides which safely allow for thermal expansion of the pipe between its hot and cold states. This will require vertical or horizontal u-bends every 100m.

The reinjection pipeline will be insulated to reduce heat loss, which is necessary to avoid deposition of silica and to protect people and wildlife from burns if it is above ground. It will be clad in aluminum or other appropriate material and may be coloured or camouflaged to reduce visual impacts if above ground. No danger from burning and no visual impacts will be if the pipe is underground.

The well pad will be constructed on land acquired by the government from the respective landowners. The closest buildings to the site in question are a former school building and a residential building. The infrastructures associated with this project are the upgrade of an access road, the creation of a service road along the reinjection pipeline, and the creation of a well pad for the drilling of the reinjection well.

Figure 6: *Location of Reinjection Well, Pipeline Corridor and Access Road for Drill Rig*

(Source R. Bruney DGDC)

3.4 Project Schedule

The project construction phase is expected to commence in the first quarter of 2021 to the second quarter of 2022.

3.5 Description of Construction Activities

General construction activities will include site improvement and slope stabilization where necessary. This will entail vegetation clearance.

Reinjection Pipeline Construction

The pipeline will first follow the same route as the pipe from DOMLEC's hydro-balancing tank for the hydropower plant and then divert from the route to the reinjection well pad.

Information gleaned from the ESIA report Volume 3 - Jacobs 2019 provides information on the proposed construction of a pipeline which is adopted here for the purposes of this study.

The pipeline will be constructed, followed by the set up and welding of steel pipes. If the pipe is underground, it will be laid down in a sand bed and then covered.

The equipment required for the injection pipeline construction works will include small drilling rigs for creating foundations, mobile cranes, trucks to transport materials and equipment, generators for pipe welding as well as excavators and trucks for foundation excavations.

The volume of water required for foundations for above ground piping is minimal and will be sourced from local water sources.

Construction of the Well – RV I 2

RV I2 will be a deviated well which will reach a vertical depth of approximately 1500 m.

<u>Access road:</u>

Rehabilitation of the access track to the well pad: Several road edge failures will need to be repaired in order to safely move heavy equipment to Laudat. There is a rough/unsurfaced portion to the reinjection area (from the former Laudat School) which will need to be upgraded.

Site preparation:

Site preparation for installing the platforms requires earthworks, forest clearing and evacuation of cut plants and trees, the use of earthmoving equipment such as a bulldozer or a grader and a compactor.

Well pad specifications:

Information from DGDC indicates that the platform will have a slope of 1% allowing the collection and reprocessing of all platform water. The surface area of the well pad is 6000 m² with a resistance of 50 MPa minimum (100 MPa under the machine and substructure). A waterproof coating (coated type) will be installed under the machine, the sludge area, the product storage areas (sludge, lubricant, etc.), the diesel tanks and the effluent collection area (surface around 2000/2500 m²).

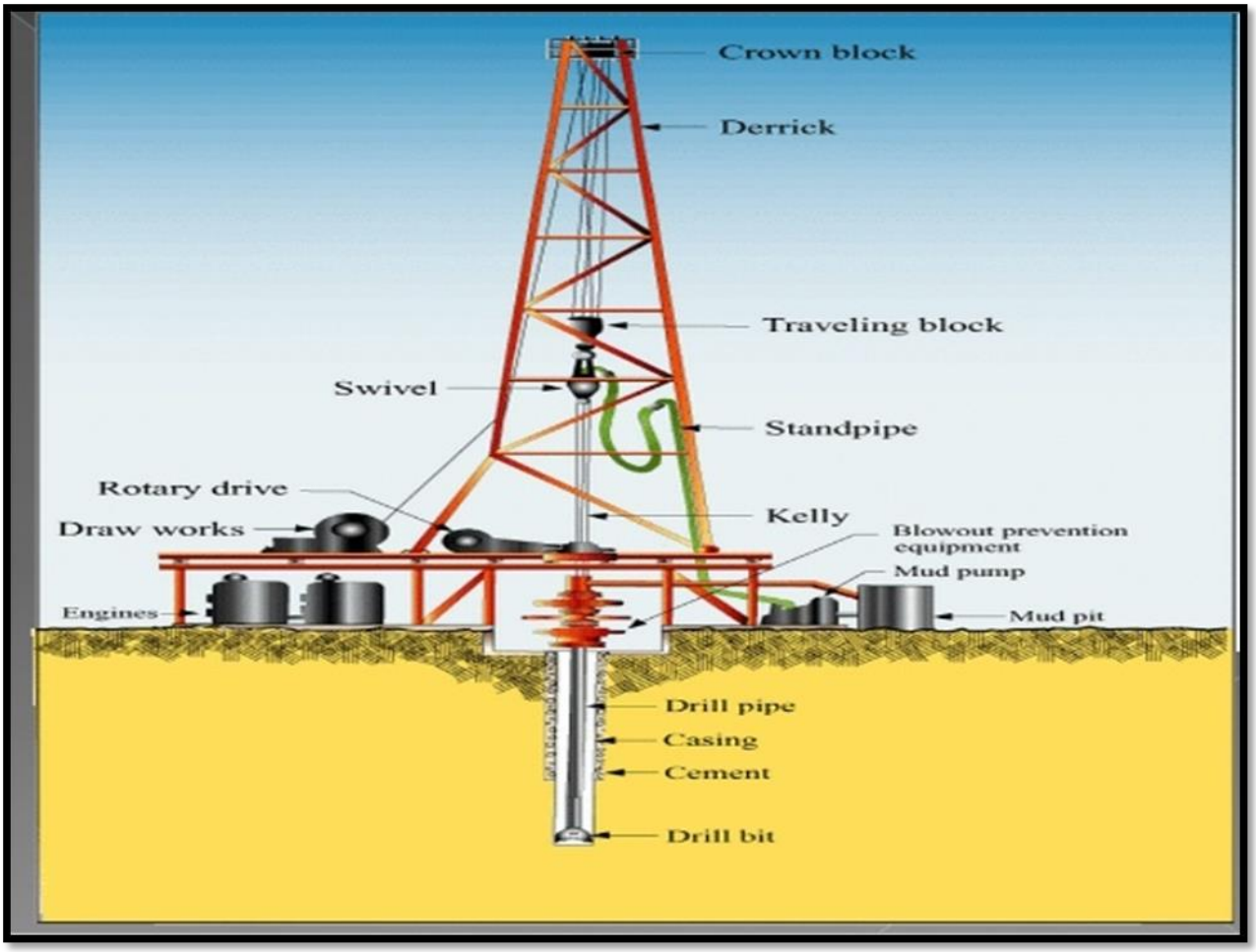
The infrastructure for the well pad consists of:

- A network of gutters arranged around the manufacturing and circulation basins for the drilling mud.
- Watertight basins or sludge tanks intended for the recovery of solid and liquid cuttings produced by drilling as well as geothermal water during the well test phase.
- A cuttings corral under the vibrators of the drilling rig. This structure is intended to be destroyed at the end of the drilling work.
- A reinforced concrete slab 0.30 m thick intended to accommodate the substructure of the drilling machine; this slab is 20 m long and 9 m wide for the construction of a well.
- For each well, a reinforced concrete cellar where the wellhead is located in its centre with its stack of safety valves and adapters.

Drilling:

The equipment required will include a derrick, the drilling tool or drill bit, the engines providing primary electrical power to the hydraulic rig and operating the pumps to circulate the drilling mud through the drill bit and up the casing annulus for cooling and removing cuttings while the well is drilled. Blow-out preventer equipment will be installed on the drill rig (during drilling) and on well head (temporary during drilling and permanent during operation).

Figure 7: *Schematic of a Drill Rig*



(Source: http://directionaldrilling.blogspot.com/2011/06/directional-drilling-and-its_28.html

During the drilling phase, two mud pumps will be used on the rig. These pumps will be fitted with noise reduction devices to limit the impact on the ambient noise level. The reservoir will be drilled from 750 to 1500 m vertical and a slotted liner will be installed.

Three different casings will be installed to protect the resources used for drinking water.

- The first one till 110 m vertical
- The second one till 430 m vertical depth
- The third one till 750 m

All this casing will be cemented.

In order to minimize the amount of product to be treated the equipment provided by the drilling contractor for installation will include

- Shale shakers (3 units) to recover the bulk of the cuttings from the wells and deliver them to the mud pit
- One or 2 centrifuges to optimize the maintain SG of drilling mud
- One flocculation unit to minimize the amount of mud to be treated

Sand traps will be placed beneath the shale shakers to receive coarse particles not transferred by the shale shakers to the mud pit.

The drilling fluids will be water base mud (WBM). The contents of the fluid are mainly:

- natural clay
- caustic soda
- polymers
- heat protector for polymers
- lubricant
- bacide

The drilling cuttings will be collected in a dedicated lined sump of approximately 1200m3 (5m L x 15m W x 3m D) as illustrated in the photo below.

Figure 8: *Lined Sump for Drill Cuttings*

Water

Water abstraction will be from a stream adjacent to the site. An authorisation request must be made to the relevant Ministry before abstraction.

Power supply

Information for DGDC indicated that on-site power generation will be provided either from generators supplied by the EPC contractor through DOMLEC.

Duration for drilling

The duration of drilling works will be six weeks.

Human resources

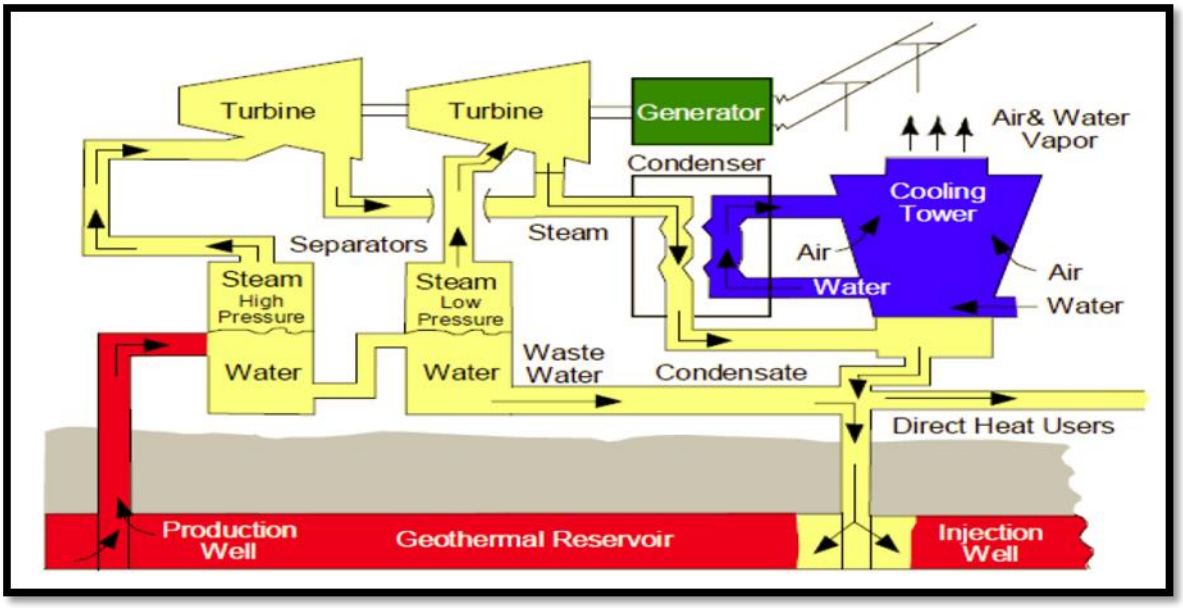
The drilling work team will consist of 6/8 persons working 12- hour shifts. Two teams will take turns to provide staffing around the clock. Other site workers include drilling supervision and testing service providers, and security.

3.6 Process Description

Organic Rankine Cycle is the preferred technology which utilizes heat from the geothermal fluid to bring an organic fluid to the boiling point which produces vapour that drives a turbine that is connected to a generator. The name binary denotes the use of two fluids, the geothermal fluid from the geothermal system and an organic fluid.

The two-phase geothermal fluid will be sent to a separator where it is divided into steam and brine phases. Steam and brine will be transported to the power plant to heat up the organic fluid. The steam will condense to condensate in the power plant and will be transported along with other brine to the injection pipeline for reinjection back into the ground through a well.

Figure 9: Typical Binary Power Plant Schematic



(Source: Al-Dabbas, 2009)

Brine Collection and Disposal

The brine from the power plant is transported to the injection pipeline that will feed the brine injection wells. The current preferred disposal option is via gravity. Other options that may be considered, in case of low injection capacity of the well with respect to well head pressure and the volume of brine produced, is using a pumping station installed at RVI2 prior to operation.

Proposed Condensate Collection and Disposal System

Condensate production is associated with the steam pipes because of temperature difference between the walls of the pipelines and other equipment and the surrounding atmosphere.

Condensate produced in steam pipelines is generally collected via a condensate collection drain pot (CDP), found at local low points on the route. This condensate will be discharged to a piped network and is then combined with the brine and transported via the injection line to the injection well for disposal. This decreases the silica concentration in the injection pipeline and is favorable for the operation of the power plant.

Figure 10: Condensate Collection Drain Pot

Storage Sump

The storage sump used for the collection of drilling cuttings during construction will be converted to store brine before injection during the operation phase.

Figure 11: Storage Sump

3.7 OPERATIONAL ACTIVITIES

After construction the pipeline will be flushed before use and the effluent discharged into a sump for subsequent discharge into the reinjection well. During operation the used geothermal fluid (brine and the steam condensate) produced from production well WW-P1 and WW-03 will be disposed of into reinjection well RVI2 via the pipeline.

Commissioning Activities

The injection pipeline will be flushed after construction and as part of a hydro-test. Location of a suitable discharge point will depend on the site piping layout and geometry but is expected to be into one of the sumps at the injection well pad.

Well Testing

Tests will be carried out for injection in the well. The duration of this operation will be around 48 hours, the duration will be adapted according to the flowrate available.

Water

The main requirements for water are for construction, potable for staff and commissioning of the well.

Maintenance

Reinjection pipeline: Unit maintenance would be undertaken to meet manufacturers, inspection agency and unit specific requirements. Inspection generally occurs twelve months after commissioning.

Scaling/Corrosion Control for the pipeline - No scaling control system will be installed – the reinjection temperature will be kept high enough to avoid this issue.

4.0 POLICY AND LEGAL AND REGULATORY FRAMEWORK

4.1 Introduction

The proposed project is guided by numerous pieces of legislation, policies, strategies, and institutions to protect the environment, many of which date back to 1967. Some have been recently upgraded and recently approved, providing guidance on ways in which the environment can be protected. This has become particularly important since Dominica has been faced with the negative consequences of climate variability and change resulting in extreme weather events causing devastation to the country.

4.2 Natural Resource Management and Environmental Protection

4.2.1 Physical Planning Act (2002)

This is an act to make provision for the orderly and progressive development of land in both urban and rural areas and to preserve and improve the amenities thereof; for the grant of permission to develop land and for other powers of control over the use of land. This act also makes provision for the regulation of the construction of buildings and related matters. It also provides for the protection of the environment and is administered by the Physical Planning Authority established by the act.

The EIA process in Dominica with respect to legal guidelines is as follows:
Section 2.1 of the Physical Planning Act 2002 No.6, defines environmental impact assessment as “the process of collection, analysis, evaluation and review of information on the likely effects of a proposed development on the environment and the means to overcome adverse effects which enables the Authority to determine whether development permission should be granted and with what conditions, the procedure for which is prescribed in regulations made under this Act”.

This is the principal act that makes provision for orderly and progressive development, use of land and provides for the regulation of construction of buildings and related matters. This act provides the Physical Planning Division with the legal mandate to grant permission to develop land and determine whether an environmental impact assessment is required for development deemed as having significant environmental harm.

Section 17 and 18 of the Act outlines the requirement of landowners to develop land under and in accordance with the terms of a development permission, granted prior to the commencement of such development including operations in, on, or under any land, and the making of a material change in the use of any building or land or the subdivision of land.

According to the Section 23 of the above-mentioned, Act 23:
(1) Subject to the provisions of this section, an environmental impact assessment shall be carried out in respect of an application for a development permit for any development set out in the Third Schedule of which road rehabilitation is not identified.
(2) Notwithstanding the provisions of subsection (1) the Authority may, after consultation with the Chief Environment Officer, require an environmental impact assessment in respect of an application for permission for any development (other than development set out in the Third Schedule) where the proposed development would be likely to have significant effects on the environment having regard to:

- **(a)** The nature of the proposed development.
- **(b)** The geographical scale and location of the proposed development.
- **(c)** The extent of the changes to the environment likely to be caused by the proposed development.
- **(d)** The degree of scientific certainty about the nature of the proposed development and its likely impact on the environment.
- **(e)** Any development plan for the area.
- **(f)** Any other matter as may be prescribed in the regulations.

Section 22 of the Physical Planning Act also outlines the necessity in having public and stakeholder participation for development proposals for which environmental impact assessment, EIA, is required.

Schedule 1 Section 9 (4)(d) - Part 1 outlines matters for which provisions may be made in the development plan with respect to roads as follows:

1. Reservation of land for roads and establishment of public rights of way including public rights of way to beaches.
2. Closing or diversion of existing roads and public and private rights of way.
3. Construction of new roads and alteration of existing roads.

4. The line, width, level, construction, access to and egress from and the general dimensions and character of roads, whether new or existing.
5. Providing for and generally regulating the construction or execution of works, incidental to the making or improvement of any road, including the erection of bridges, culverts, gullies, fencing, banners, shelters, the provision of artificial lighting, and seats and the planting or protecting of grass, trees and shrubs on or adjoining such road.

   The Physical Planning Act governing the process for EIA does not require an EIA with respect to road rehabilitation.

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4.2.2 Geothermal Resources Development Act 2016

In 2016, the government of Dominica in the Caribbean passed a new piece of geothermal legislation. The Geothermal Resources Development Act 2016 defines a regulatory framework surrounding “the development, exploration and use of geothermal resources.” The Geothermal Resources Development Act 2016 does not replace or repeal the Physical Planning Act 2002,

and development permission must usually be obtained in accordance with the procedure of Part IV of that Act.

The key content elements are: 1) Geothermal resources advisory committee; 2) Geothermal resources; 3) Management of geothermal resource development; 4) Geothermal resource allocation; 5) Procedure for obtaining a geothermal resource development agreement; 6) Fees, bonds and royalties; 7) Record keeping and publicity; and 8) Compliance and enforcement.

The Geothermal Resources Development Act of 2016 provides the legal basis for the development, exploration and use of geothermal resources. It replaces the Geothermal Energy Act of 1976. The Act's objectives are to: 1) enable the sustainable use of geothermal energy according to Dominica's population needs; 2) safeguard the life-supporting capacity of air, water, soil and ecosystems; and 3) avoid remedying or mitigating to any material with adverse effects on the environment. Additionally, the bill declares that all geothermal resources will always be vested in the state and subject to the control of the state, which is consistent with part one, section two of the Mines and Minerals Act of 1996.

The Act establishes the Geothermal Resources Advisory Committee (made up of the permanent secretary of the Ministry responsible for energy, the Executive Director of the IRC, the Chief Physical Planner of the Physical Planning Division, a senior state attorney and other public officers, and private professionals as appointed by the Minister) and details its duties and attributions. It determines the rules relating to geothermal activities including the creation, acquisition, transfer, exercise, and termination of rights. Activities must only be developed in special geothermal zones set out by the Minister in accordance with the Committee. (Jacobs ESIA Vol. 1)

4.2.3 Forest Act 1990

The Forests Act provides legal mechanisms for the conservation and control of forests. Consequently, it outlines the provision to declare any private land as protected forest if it is required for, among other factors, the protection against storms, landslides, soil erosion and the deposition of mud, stones and sand upon agricultural land in addition to the maintenance of water supplies in springs, rivers, canals and reservoirs.

4.2.4 Forestry and Wildlife Act 1992

This Act provides protection and mechanisms for the conservation and management of wild mammals, freshwater fish, amphibians, crustaceans and reptiles.

4.2.5 National Parks and Protected Areas Act, 1975

An act for establishing national parks, forest reserves and protected areas including marine parks for Dominica. The Act also gave legal status to the Morne Trois Pitons National Park (1975), the first unit of the proposed National Park System. It protects the fauna and flora of the Park, outlines the purpose and uses of the Park and sets the boundaries of the park under the relevant Schedule.

4.2.6 Environmental Health Services Act (No. 8 of 1997)

The Environmental Health Services Act makes provision for the conservation and maintenance of the environment in the interest of health generally and relation to places visited by the public. The act provides the Environmental Health Division with the authority to carry out the functions of the Minister of Health including investigation and providing advice on environmental pollution management, including waste disposal and air quality assessments. The act also makes provisions for granting permission for discharge into the environment of any pollutant or contaminant upon satisfaction that appropriate measures are taken to minimize these pollutants or contaminants.

4.2.7 Solid Waste Management Act

The act makes provision for the establishment of the Solid Waste Management Corporation with the responsibility of making provision for the collection, transport, storage, treatment and disposal of solid waste in Dominica. The act details the functions of the corporation including making provision for the management of medical and hazardous wastes, the management of sanitary landfills and for developing and introducing alternative and non-traditional measures of waste disposal.

4.2.8 Dominica Water & Sewerage Act, Chapter 43:40, 1989

The objective of the legislation is “to see to the orderly and coordinated development and use of Dominica’s water resources, to conserve and protect such resources for the benefit of present and future generations of Dominicans and to provide the Dominican public with a safe, adequate and reliable supply of water and with dependable sewerage services”.

The authority for water management including water conservation and preservation to include protection of water catchment areas has been bestowed on the Dominica Water and Sewerage Company, DOWASCO. The Company is also legally responsible for controlling pollution of freshwater resources. There is some overlap with the Forestry Division with respect to protection of water catchment areas.

4.2.9 Central Water Authority Regulations, No. 1 (1973)

The objective of the legislation is “to see to the orderly and coordinated development and use of Dominica’s water resources, to conserve and protect such resources for the benefit of present and future generations of Dominicans and to provide the Dominican public with a safe, adequate and reliable supply of water and with dependable sewerage services”.

4.2.10 The Geothermal Resources Development Act 2016

It defines the regulatory framework surrounding “the development, exploration and use of geothermal resources”. This Act does not replace or repeal the Physical Planning Act (2002) but replaces the Geothermal Act of 1976.

4.3 Socio-Economic Legislation

Employment Safety Act

Dominica’s Employment Safety Act, 3 of 1983, provides for the safeguard of safety and health at work and for the establishment of consultative and advisory committees and the appointment of safety officers. It makes provision for inspections to be conducted at each workplace by safety officers appointed by the Minister of Labour to ascertain whether there are breaches of the act and whether the safety of employees is protected.

Noise Abatement Act

The Noise Abatement Act No. 10 of 1993 makes provisions for the control of noise with a view to abatement. It provides for approval for noise generation in the operations of a business; however, approval must be granted by the Planning Authority.

Labour standards Act No 2 of 1977

This act makes provision for the fixing of the minimum wage and for the determination of working hours, leave and general matters relating to the welfare of workers in Dominica. It establishes the eight-hour workday and the 40-hour work week. Workers exceeding these hours are to be paid overtime.

Land Acquisition Act, Chapter 53:02

Outlines the procedures required for land acquisition and covers the following areas:

- Acquisition of land and abandonment of acquisition
- Appointment and powers of Board of Assessment
- Determination of small claims for Compensation
- Provisions Governing Assessment of Compensation
- Miscellaneous:
- Absentee owners
- Compensation to persons interested in adjacent land
- Specific provisions as to leases
- Persons in possession to be deemed owners
- Fees and expenses of Board
- Conveyancing etc.
- Payment of compensation
- Exemption from stamp duty and fees
- Limitation of time for making claim
- Assaulting or obstructing officer
- Saving

The Social Security Act (No. 38 of 1975): Especially as it relates to Part 2 (Insured Persons and Contributions) and Part 3 (Benefits).

4.4 Policies and Strategies

National Land Use Policy & Action Plan, 2015

Dominica's Land Use Policy was adopted in 2015 and is authorized under the Physical Planning Act (2002). It provides direction for issues related to land use planning in the Commonwealth of Dominica. The National Land Use Policy sets the foundation for all land use decisions and describes how best to manage development to improve quality of life for Dominicans, through economic and social development, protecting human health and safety, and conserving the natural environment.

The National Land use policy is based on 3 pillars.

1. Modernization and Social and Economic Development through
    - Modernization of infrastructure in recognition the physical infrastructure is critical for sustained economic development and social well-being
    - Supporting economic development through agriculture, fisheries, manufacturing, tourism, resource development, well-planned human settlements, recognition of the importance of Dominic's culture and Heritage, support of good quality housing, recognizing the Kalinago Territory as an area of special significance.
2. Enhanced Forest, Natural Environment and Agricultural Vitality through
    - Protection and Enhancement of the vitality of the forest and natural environment systems.
    - Integrate Planning at the level of the watershed and Dicoastal zones
    - Protection and enhancement of agricultural vitality
    - Protection of the National Parks, Waitukubuli National Trail and buffer zones
    - Protect and strengthen public access to rivers, beaches and parks from development projects.
3. Increasing Hazard Resilience

The Dominica Forest Policy (2010)

The Draft Dominica Forestry Policy was formulated in 2010. As stated in the policy document the "The purpose of this National Forest Policy is to guide the sustainable management of the forest resources of the Commonwealth of Dominica, while maintaining or improving the present area of forest cover.

The Policy covers all of Dominica's forested areas which includes forest reserves, national parks, unallocated state lands, the Kalinago Territory and privately - owned land. The Policy also concerns natural as well as plantation forests, including forested land that has been deforested or degraded and agro-forests.

The goal of the policy is to guide the conservation, protection, management and use of the nation's forest resources while ensuring that the productive capacity of the forests for goods, products and services is maintained or enhanced for present and future generations.
The main objectives of the policy are to:

a. Maintain or enhance the biodiversity and ecological functioning of forests.
b. Maintain or increase the area of land covered by forest; and
c. Optimize the contribution of forest resources to livelihoods and to the economy.

Dominica Low Carbon Climate Resilient Development Strategy 2012-2020 one of the objectives is to reduce total gross greenhouse gas (GHG) emissions through transition to sustainable energy technologies including harnessing of geothermal resources.

National Resilience Development Strategy—Dominica 2030 (NRDS), which elevates disaster risk management and climate change adaptation to national priorities. The vision of this strategy is to build the first climate-resilient country in the world. It plans to incorporate hazard and risk mitigation into infrastructure design and planning, social sectors, and all aspects of national development.

National Integrated Water Resources Policy, (IWRM) 2011

Some of the Guiding principles underlying the policy relevant to Forestry include the need to undertake watershed management in an integrated manner taking into consideration the LBS Protocol to ensure that measures are implemented to avert and minimize risks to human health and the ecosystems as well as the need to undertake water resources planning and management on a participatory approach involving all key stakeholders.

The National Policy and Action Plan for Gender Equity and Equality (2006)

The main objective is to create additional support, opportunities and services for men and women alike to maximize their potential as human beings and as valuable citizens of the

Commonwealth of Dominica. It identifies a range of issues, systems and institutions that must take on board gender differences and how they make use of services if all citizens are to enjoy lives free from fear and discrimination.

National Biodiversity Strategy and Action Plan 2002

The major objectives of this relevant to the project are as follows:

- To conserve and manage Dominica's terrestrial and marine biodiversity to ensure intra- and inter- generational equity
- Promote sound and sustainable environmental practices and technology so as to minimize the loss of agro-biodiversity, and reduce vulnerability to desertification, soil loss and contamination of water resources

National Agricultural Policy and Action Plan 2016–2025

Dominica's National Agricultural Policy and Action Plan 2016–2025. The policy framework is based on three pillars of environmental sustainability, competitive business and food and nutrition security.

While the policy does not address forestry activities and programmes one of the policy areas Objective 5, emphasizes the need for the preservation of the natural resource base. This is especially important because in some areas there is encroachment into areas demarcated as forest reserves. To this end, it aims to ensure sustainable use and management of agricultural resources, recognizing that the successful implementation of the policy relies on the extent to which the environment and natural resources, particularly soils and water, which are necessary for agricultural production, are sustainably managed and utilized.

Low Carbon Climate- Resilient Development Strategy 2012-2020

To facilitate Dominica's transformation to a low-carbon, climate-resilient economy while addressing pressing development, livelihood, and poverty issues. Enhancing the resilience of natural ecosystems and protecting carbon sinks are important aspects of the strategy.

4.5 Environmental and Social Management Capacities

Ministry of Environment, Urban renewal, Forestry, Wildlife and Parks Division (FWPD)
Conservation, management, and sustainable resource use of all forest reserves, national parks, nature sites, and the WNT, as well as soil and water conservation, enforcement of forestry, wildlife and national parks legislation, research and monitoring, public relations, and environmental education

Ministry of Health Wellness and New Health Investment, MHW NHI
The responsibility for environmental monitoring is administered by the Environmental Health Department (EHD) of the Ministry of Health, Wellness & New Health Investment. Its functions are described in the Environmental Health Services Act, # 8, of 1997. The department's mandate is to investigate problems and institute remedial measures in respect to environmental pollution, the management and disposal of solid and liquid waste, food safety and vector control activities. The department also has the mandate for reviewing building plans and monitoring workplace safety to reduce the impact of the environment on public health. Additionally, there is also the responsibility for conducting research in public health; however, this is done on a limited scale due to institutional capacity limitations.

While the EHD's primary function is environmental monitoring, the Division works along with other divisions of the MHW&NHI for organization and implementation of health services in Dominica. Care is provided using the Primary Care Strategy, where services are delivered to communities via a health team located in health districts around the country. An Environmental Health Officer works along this team to provide services through inspections and other health promoting strategies for the prevention of communicable and environmentally related non-communicable diseases.

The MHW&NHI, EHD also conducts environmental assessments to ascertain whether conditions exist in the environment which contribute or have the potential to contribute to adverse human health conditions and, if necessary, requests abatement or mitigation to reduce negative health impacts

Physical Planning Division

Physical Planning guides and regulates Dominica's physical development with authority granted by the Physical Planning Act 5 (2002). The division is responsible for monitoring of building, engineering, mining or other operations in Dominica. The division is concerned with safeguarding the health, safety and interest of the public as opposed to private interest. The Physical Planning division evaluates building proposals to ascertain structural integrity, land use and environmental assessments, if required, and manages development control. All building applications and development plans are reviewed by the division. Land-use planning is another important function of the division. It is the policy carried out by the Planning Division that guides how land is used. It is the systematic assessment of land potential balanced with environmental impacts and current and future demands. The primary goal of land-use planning is to balance the needs of the resident population with the needs of the environment.

In the interest of preservation and cultural heritage the physical planning division is also charged with the responsibility of protection of the architectural and cultural heritage of Dominica. They may by authority restrict the demolition, renovation or extension of any building which needs to be preserved. The division also carries out the function of environmental protection. Where any part of the country is considered as environmentally vulnerable, the division has the function of advising the government to declare such an area a protected area.

Energy Unit (Ministry Blue & Green Economy, Agriculture and National Food Security)

- Articulate/document the National Energy Policy.
- Develop a Sustainable Energy Plan.
    - Improve the legislative and regulatory framework for the energy and electricity sector.
    - Increase the capacity for Dominica to produce electricity from renewable sources such as hydro power, solar, and wind.

Solid Waste Management Authority

The Dominica Solid Waste Management Authority was established for the management of solid waste in Dominica. Their primary function is the collection and disposal of household waste; however, they are also mandated to collect and dispose of medical waste. The corporation also

manages the country's only landfill in the community of Fond Cole, where waste is buried in lined trenches.

National Emergency Management Office

The Office of Disaster Management (ODM) is part of the Ministry of Environment, Climate Resilience, Disaster Management and Urban Renewal structure. It manages the country's emergency operations and is committed to taking proactive and timely measures to prevent or reduce the impact of disasters on the Dominican people and economy. ODM works closely with the National Emergency Planning Organization (NEPO), a governmental organization with responsibility for the planning and organization of counter-disaster measures at central level.

One of NEPO's key functions is to develop, operate, and maintain a National Emergency Operations Centre in accordance with requirements specified in the National Disaster Plan. The National Emergency Planning Organization (NEPO) Advisory Committee is the senior Dominican disaster management body. The general direction and control of the Organization resides with the Honourable Prime Minister through this committee. The functions include:

- Management of the National Disaster Plan
- Assign responsibilities to NEPO members
- Ensure adequate manpower, training, and physical resources for emergency operations before, during, and after a national disaster
- Ensure adequate public awareness programmes on disaster preparedness
- Ensure that vulnerable areas are properly mapped and that a database exists for effective management action
- Monitor the activities of the annual disaster work program
- Advise on the coordination of emergency activities by voluntary organizations, locally and internationally
- Advise on the coordination and planning of disaster related activities.

Labour Relations and Occupational Health and Safety Department

Labour relations are managed by the Labour division of the Ministry of National Security. Their functions include the resolution of disputes between employee and employer and also are responsible for occupational Safety and Health including Employee safety at work sites. The

department collaborates with the MHW&NHI EHD to implement the requirements of the Occupational Health and Safety Guidelines by conducting safety inspections of worksites and investigation of injuries and conditions arising out of work-related conditions. Employees are bound by the Occupational Disease Notification regulations, which mandate the reporting of work-related injuries and conditions to the Labour Division, after which investigations are carried out.

4.6 World Bank Group Policies and Standards

4.6.1 Environmental and Social Safeguard Policies

The current environmental and social policies of the Bank are known as the "Safeguard Policies," the mechanism for addressing environmental and social issues in project - design, implementation and operation, and they provide a framework for consultation with communities and for public disclosure.

The World Bank's current environmental and social policies consist of 11 Operational Policies:

- OP 4.00 - Piloting the Use of Borrower Systems to Address Environmental and Social Safeguard Issues in Bank-Supported Projects
- OP 4.01 - Environmental Assessment.
- OP 4.03 - Performance Standards for Private Sector Activities
- OP 4.04 - Natural Habitats.
- OP 4.09 - Pest Management.
- OP 4.10 - Indigenous Peoples.
- OP 4.11 - Physical Cultural Resources.
- OP 4.12 - Involuntary Resettlement.
- OP 4.36 - Forests.
- OP 4.37 - Safety of Dams.
- OP 7.50 - Projects on International Waterways; and
- OP 7.60 - Projects in Disputed Areas.

4.6.1 Project Categorisation

In accordance with the WBG's OP 4.03, the WBG undertakes environmental screening of each proposed project to determine the appropriate extent and type of Environmental Assessment (EA) needed. The WBG classifies the proposed project into one of three key categories, depending on the type, location, sensitivity, and scale of the project, as well as the nature and magnitude of its potential environmental impacts.

- Category A: A Category A project is likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented. These impacts may affect an area broader than the sites or facilities subject to physical works. The EA for a Category A project examines the project's potential negative and positive environmental impacts, compares them with those of feasible alternatives (including the "without project" scenario), and recommends any measures needed to prevent, minimise, mitigate, or compensate for adverse impacts and improve environmental performance. For a Category A project, the borrower is responsible for preparing a report, normally an Environmental Impact Assessment (or a suitably comprehensive regional or sectoral EA).

- Category B: A Category B project has potential adverse environmental impacts on human populations or environmentally important areas - including wetlands, forests, grasslands, and other natural habitats - which are less adverse than those of Category A projects. These impacts are site-specific; few if any of them are irreversible; and in most cases mitigatory measures can be designed more readily than for Category A projects.

  The scope of EA for a Category B project may vary from project to project, but it is narrower than that of Category A assessment. Like Category A, a Category B environmental assessment examines the project's potential negative and positive environmental impacts and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance.

- Category C: A Category C project is likely to have minimal or no adverse environmental impacts. Beyond screening, no further EA action is required.

All Category A and Category B Projects require an assessment process to address the relevant environmental and social risks and impacts of the proposed project in accordance with the applicable standards (i.e. WBG Performance Standards and/or the WBG Environmental and Social Framework and the WBG EHS Guidelines). The assessment documentation should propose measures to minimise, mitigate, and offset adverse impacts in a manner relevant and appropriate to the nature and scale of the proposed project.

For Category A, and as appropriate, Category B Projects, the assessment documentation includes an Environmental and Social Impact Assessment (ESIA), Environmental and Social Management Plan (ESMP) with an Environmental and Social Management System (ESMS) usually prepared and implemented prior to construction commencing.

The assessment process should, in the first instance, address compliance with relevant host country (Dominica) laws, regulations and permits that pertain to environmental and social issues and with the WBG Performance Standards and EHS Guidelines.

A review of previous studies classified the project as a Category A by Caraïbes Environnement Développement & Coll (2015a/b) and more recently by Jacobs New Zealand Limited (Jacobs) as a Category A.

The World Bank recently confirmed that “the Project risk category is Category A on the basis of the screening criteria defined under the OP 4.03. Key risk includes locations of the reinjection lines as well as that of the power plant, which are on the periphery of the Morne Trois Pitons National Park (MTPNP), a UNESCO World Heritage Site. In addition, the Project’s direct area of influence could expand to high value biodiversity areas.”

4.6.2 Environmental and Social Framework

In August 2016, the World Bank adopted a new set of environment and social policies called the Environmental and Social Framework (ESF). As of October 1, 2018, the ESF applies to all new World Bank investment project financing. With existing projects continuing to apply the Safeguard Policies, the two systems will run in parallel for an estimated seven years.

The ESF consists of:

- the World Bank's Vision for Sustainable Development
- the World Bank's Environmental and Social Policy for Investment Project Financing (IPF), which sets out the requirements that apply to the Bank
- the 10 Environmental and Social Standards (ESS), which set out the requirements that apply to Borrowers
- Bank Directive: Environmental and Social Directive for Investment Project Financing
- Bank Directive on Addressing Risks and Impacts on Disadvantaged or Vulnerable Individuals or Groups

The Environmental and Social Standards (ESS) comprises:

- Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts
- Performance Standard 2: Labour and Working Conditions
- Performance Standard 3: Resource Efficiency and Pollution Prevention
- Performance Standard 4: Community Health, Safety, and Security
- Performance Standard 5: Land Acquisition, Restrictions on Land Use and Involuntary Settlement
- Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources
- Performance Standard 7: Indigenous Peoples; and
- Performance Standard 8: Cultural Heritage.
- Performance Standard 10: Stakeholder Engagement and Information Disclosure

4.6.3 General and Industry Specific EHS Guidelines

In addition to the performance standards, the WBG has developed EHS Guidelines covering both general and industry specific issues. The EHS Guidelines contain the performance levels and measures that are normally acceptable to WBG and are generally considered to be achievable in new facilities at reasonable costs by existing technology. The environmental assessment process may recommend alternative (higher or lower) levels or measures, which, if acceptable to the financiers, become project or site-specific requirements.

In general, when host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment.

The General industry specific (Electric Power Transmission and Distribution) EHS Guidelines became available for use in April 2007 and will be used in the preparation of the ESIA Report and supporting technical analysis.

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4.6.4. Environmental, Health and Safety Guidelines for Geothermal Power Plants (April 2007)

These guidelines provide a summary of EHS issues associated with geothermal power generation and recommendations for their management. These include:

Environmental

Environmental issues that may occur during geothermal power generation projects, include the following:

- Effluents
- Air emissions
- Solid waste
- Well blowouts and pipeline failures
- Water consumption and extraction.

Occupational Health and Safety

Occupational health and safety issues during the construction and decommissioning of geothermal power generation projects are common to those of other industrial facilities and their prevention and control are discussed in the General EHS Guidelines.

Specific health and safety issues in geothermal power projects include the potential for exposure to:

- Geothermal gases.

- Confined spaces.
- Heat.
- Noise.

Community Health and Safety

Community health and safety issues during the construction and decommissioning of geothermal power generation plants are common to those of large industrial facilities and are discussed in the General EHS Guidelines. Community health and safety issues during the operation of geothermal power generation plants include:

- Exposure to hydrogen sulphide gas.
- Infrastructure safety.
- Impacts on water resources.

Performance indicators and monitoring for each of the issues listed above follows the advice provided in the General EHS Guidelines.

4.6.5 International Labour Organisation (ILO) and United Nations Conventions

It is anticipated that a large portion of personnel working on the site through the construction phase will be employed through the EPC Contractors and Subcontractors providing specific services to the Project. It will be a contractual requirement for all providers to the Project that they comply fully with the laws and regulations of the GoCD concerning employment of labour and working conditions. The Project policy for its own employees will also follow the laws and regulations of the GoCD and an employment policy framework will be developed which will comply with (at a minimum):

- ILO Convention 87 on Freedom of Association and Protection of the Right to Organise.
- ILO Convention 98 on the Right to Organise and Collective Bargaining.
- ILO Convention 29 on Forced Labour.
- ILO Convention 105 on the Abolition of Forced Labour.
- ILO Convention 138 on Minimum Age (of Employment).
- ILO Convention 182 on the Worst Forms of Child Labour.
- ILO Convention 100 on Equal Remuneration.
- ILO Convention 111 on Discrimination (Employment and Occupation).

- UN Convention on the Rights of the Child, Article 32.1; and UN Convention on the Protection of the Rights of all Migrant Workers and Members of their Families.

4.6.6 International Conventions

Dominica is also signatory to the Convention on Biological Diversity (CBD), (1994) which is an international legal binding treaty aimed at developing national strategies for the sustainable use of biological diversity.

Dominica ratified the United Nations Framework Convention on Climate Change on 21 June 1993- one of the objectives is to enable Green growth through transition to sustainable energy technologies and reduce reliance on imported fossil fuels

Other International Conventions:

- International Plant Protection Convention-Ratified April 1979
- Kyoto Protocol on Climate Change - Ratified 5th January 2005
- Nagoya Protocol on Access and Benefit-Sharing (ABS)
- Stockholm Convention on Persistent Organic Pollutants (POPs) - Acceded 3rd August 2003
- UN Convention to Combat Desertification (UNCCD) - Ratified 28th November 1997
- UNFCCC National Communications (1st, 2nd, 3rd)
    - Vienna Convention for the Protection of the Ozone Layer - Ratified March 1993
    - Montreal Protocol on Substances that Deplete the Ozone Layer - Ratified June 1993
    - London Amendment - Ratified March 1993
    - Montreal, Copenhagen & the Beijing Amendments - Ratified March 2006
- UNCCD National Action Programmes (NAP) -draft 2015
- UN Framework Convention on Climate Change (UNFCCC) - Ratified 21st March 1994

5.0 EVALUATION OF BASELINE DATA

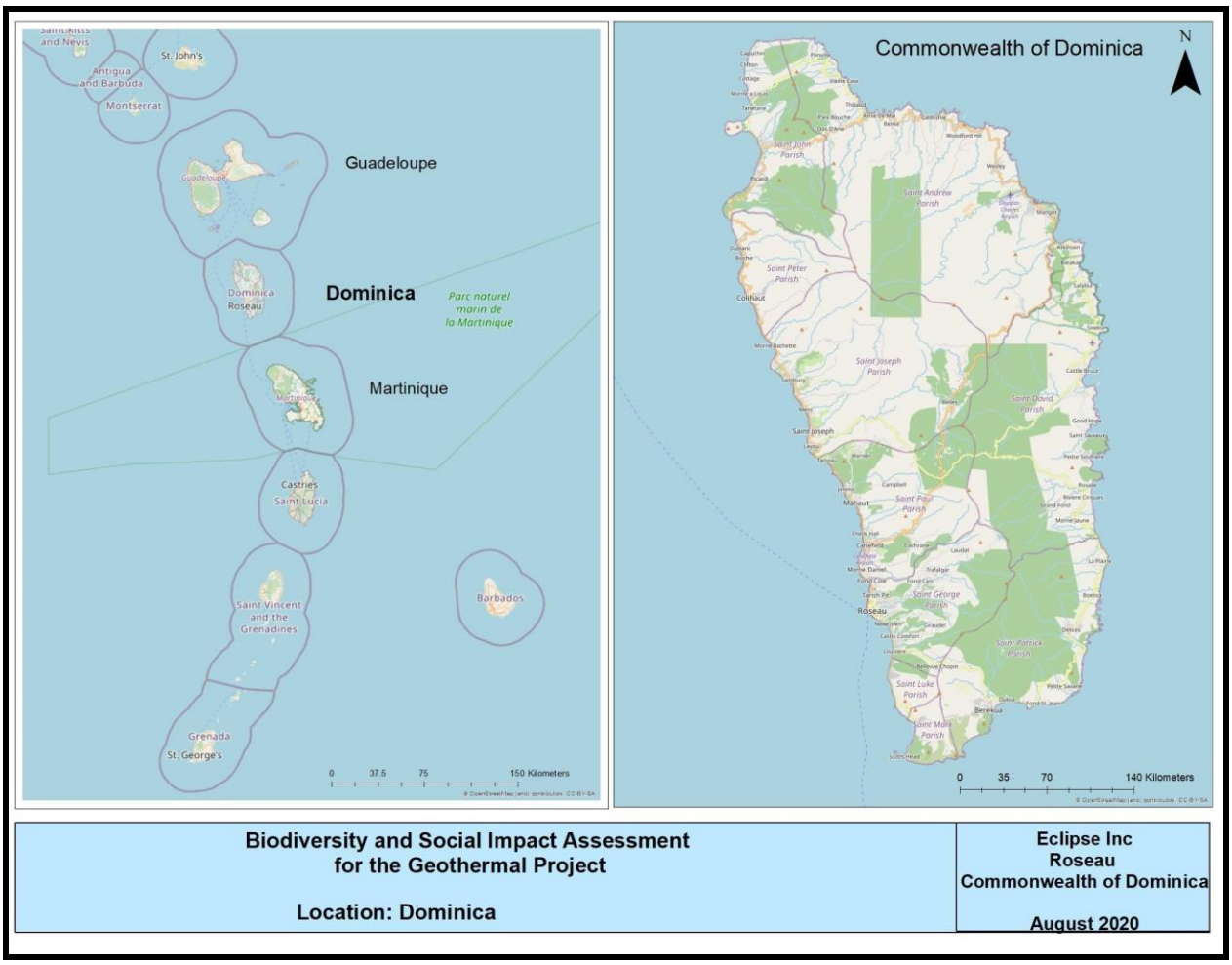
5.1 Environmental Setting

The island of Dominica, situated between the French Island territories of Guadeloupe to the north and Martinique to the south, is located at latitude 15 degrees 25 north of the Equator and longitude 61 degrees 20 West of Greenwich. With an area of 289.5 square miles and an abundance of rivers, waterfalls and springs, Dominica promotes itself as the nature island of the Caribbean. Its volcanic nature accounts for the black sandy beaches, the second largest boiling lake in the world and numerous sulphur springs. Almost 60% of the island is covered with dense forest and woodland and most beaches are black due to the volcanic nature of the island. The country enjoys subtropical conditions year-round and the months from June-December are known as the rainy season.

Dominica was first inhabited by the Carib Indians who named her Waitukubuli due to her length (46km) and then discovered by European explorer Christopher Columbus who renamed her Dominica since she was discovered on a Sunday. Dominica was colonized by the Europeans, mostly the French and by Britain who took over in 1805 until Dominica gained independence on 3rd November 1978. With a parliamentary democracy style of government mirrored after the British system, elections occur every five years where a dominant party forms the government. The prime minister is the head of the government and the President is the head of state, but his role is largely ceremonial.

Dominica's economy has been described as vulnerable by commonwealth.org. This is due to its terrain and its location. It is largely mountainous which results in less than 25% of the island being cultivated. In addition, Dominica is very susceptible to hurricanes and tropical storms which in the past have destroyed and crippled the agriculture sector and destroyed key crops which make up most of the island economic base. For many years the island had depended on agricultural crops such as bananas, sugar and lime for much needed revenue but given its vulnerability, there has been an increased effort by the government to diversify to tourism which is seen as more financially secure.

***Figure 12**: Dominica's Location in the Caribbean Region*



Laudat is a small village in the interior of Dominica, located between 3 mountains: Morne Watt, Morne Micotrin (Morne Macak), and Morne Trois Pitons. With a population of just above 300 persons, Laudat is referred to as a "gateway" because it is the sole entry point to many of the island's sites, including the Boiling Lake, Fresh Water Lake, and Titou Gorge. Perched about 1492 feet above sea level Laudat has a cool climate and views of the Caribbean Sea. It is located approximately 20 minutes from the capital, Roseau.

Area of Influence

For the purposes of the study a designated geographical area was established as a "area of influence" to evaluate the impacts of the proposed projects. The demarcated area of influence consists of a 500m radius around other major project infrastructure, viz., the proposed Geothermal Power Plant site and Reinjection Well site, respectively. This covers the entire

community of Laudat and surroundings. The north eastern portion of this zone intersects with the Morne Trois Pitons National Park buffer and extends into the park itself. The Dubique River, Trois Pitons River and Roseau river fall within this zone.

It should be noted that generally the entire community is considered an area of influence.

Figure 13: *Project Area of Influence*

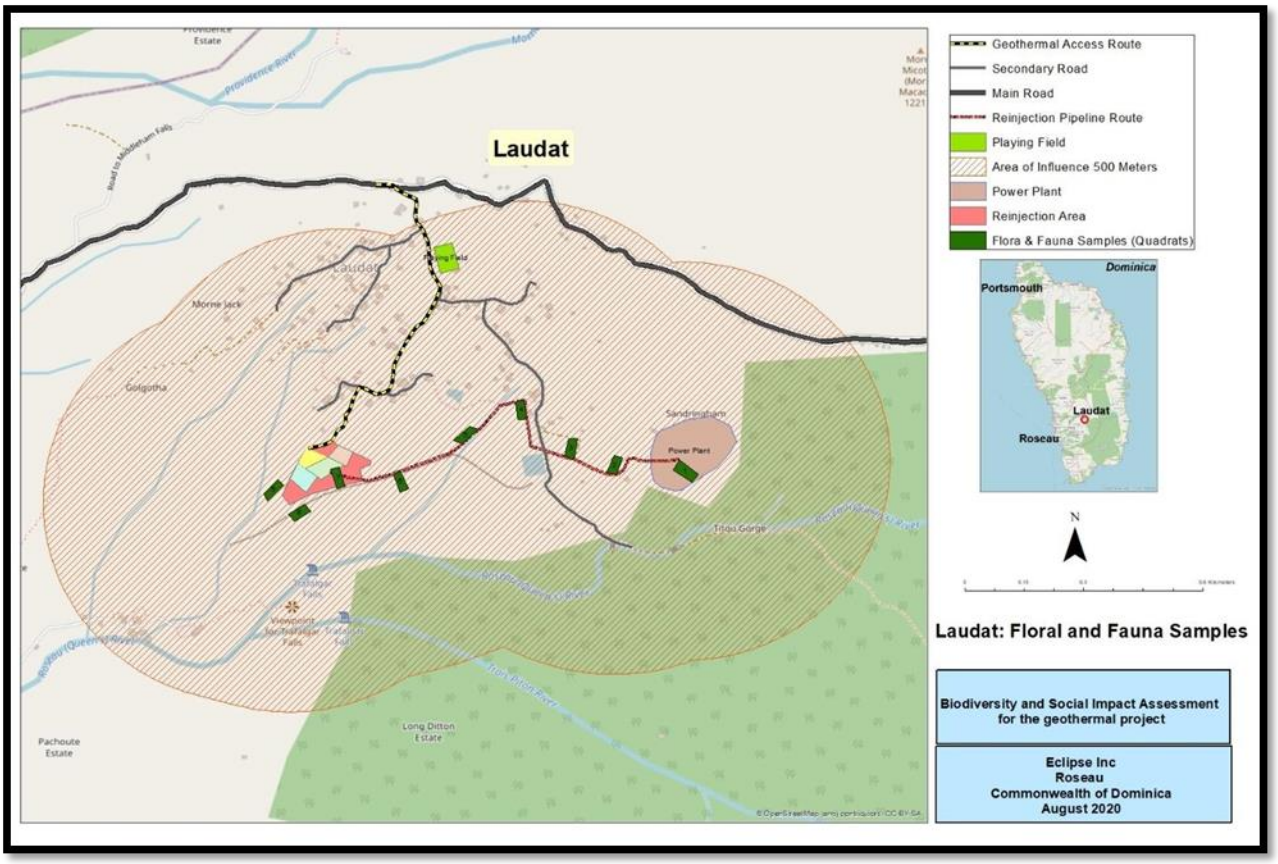
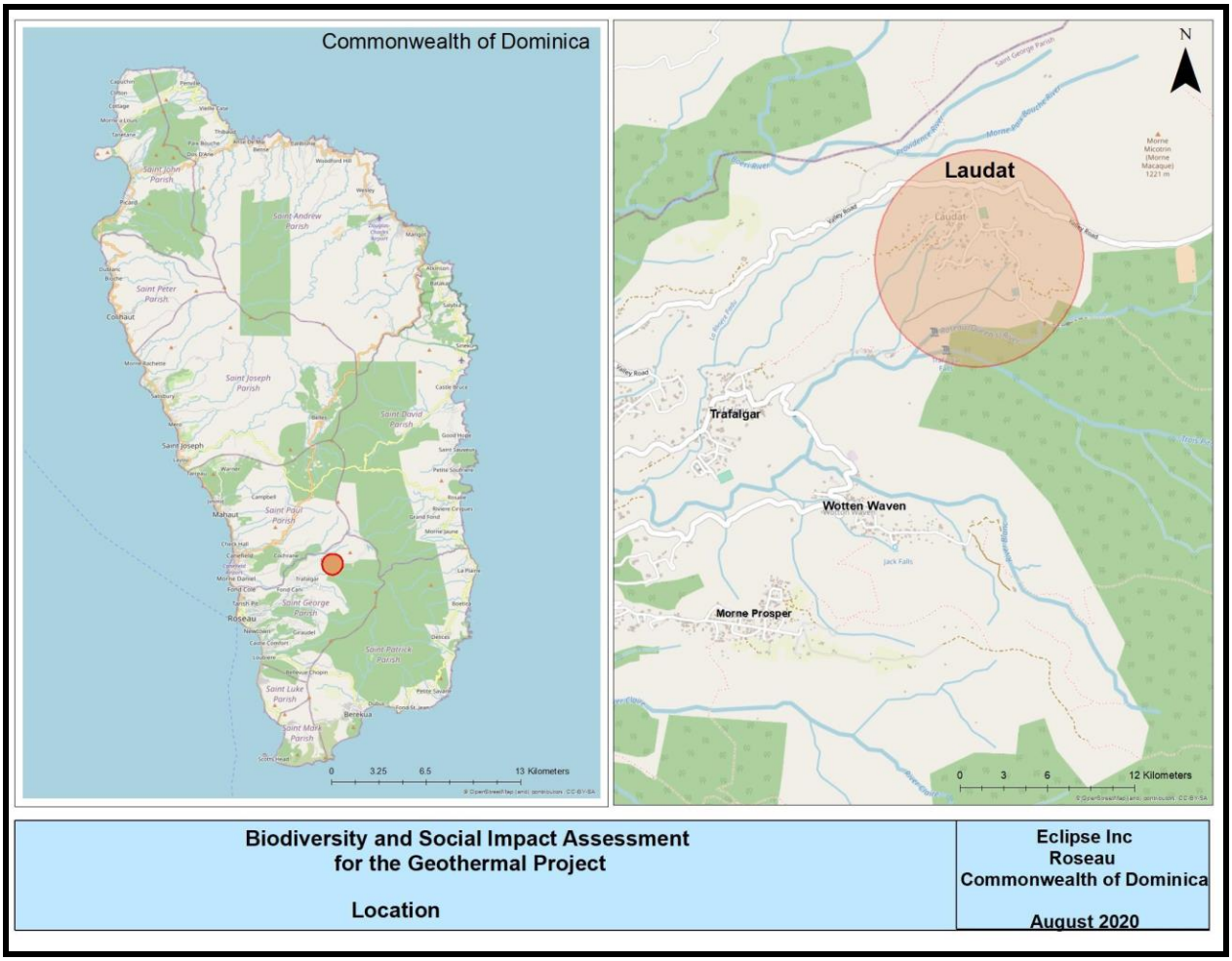


***Figure 14**: Location of Laudat*



5.2 Topography

The proposed project is situated on the southwestern periphery of the village of Laudat, west of Morne Micotrin, north of the Roseau River/La Riviere Mywal and east of the steep cliffs in the vicinity of the Trafalgar Falls. The site lies on a shoulder of Morne Micotrin, within an altitude of 592m (1,492ft) ASL. The greater percentage of the land surface within the project area is gently sloping with a slope characteristic of <30º. The land surface is deeply incised by one (1) permanent and two (2) temporary natural watercourses that traverse the area. Several smaller watercourses radiate across the terrain.

5.3 Geology

5.3.1 Overview of Dominica's Geology

Dominica lies at the centre of the Lesser Antilles Island Arc. Like its other Windward neighbours, it is relatively large and complex with at least nine active coalesced stratovolcanoes. Morne Aux Diables and Morne Diablotin are within 3- 12 km from the study region. For the last 500 years, Dominica has not experienced a major eruption which gives it one of the best and most extensively preserved tropical rainforests in the region. The youngest dated volcanic deposits on the island are associated with the Morne Patates dome on the flanks of the large active Plat Pays Volcano that comprise the southwestern end of the island. This was characteristic of a Pelean eruption (similar to the eruptions of Mt. Pélé in Martinique in 1902 and 1929) although radiocarbon analyses of the block and ash deposits suggest it occurred about 500 year ago. In addition, there have been two steam explosions (phreatic activity) in the Valley of Desolation in 1880 and 1997.

Frequent seismic swarms and vigorous and widespread geothermal activity on the island indicates that it is geologically active. This makes it the most worrying of all the Caribbean volcanic areas because statistically, a major eruption is long overdue.

Bedrock formations in Dominica are predominantly of volcanic origin composed mainly of Andesitic to Dacitic material from the Pleistocene era (Reading, 1991). The mineral composition of the bedrock is mainly plagioclase and biotite with some hornblende, quartz and pyroxene depending on location (See figure 18). On a north-south trend through the central part of the island, young lava domes of Morne Diablotin, Trois Pitons, Micotrin and Patates are aligned indicating similar geologic origin. Ignimbrite rocks deposited by hot ash fall and Nuee Ardantes are found at the outside surface of plugged vents.

Nearly all vertical cliffs of fine grains and hard rock that have resulted from these deposits can be seen in other parts of the island. Two sedimentary bedrock units, consolidated limestone consisting of coral, shells, mud and unconsolidated alluvium, are the only significantly different bedrock formations in Dominica.

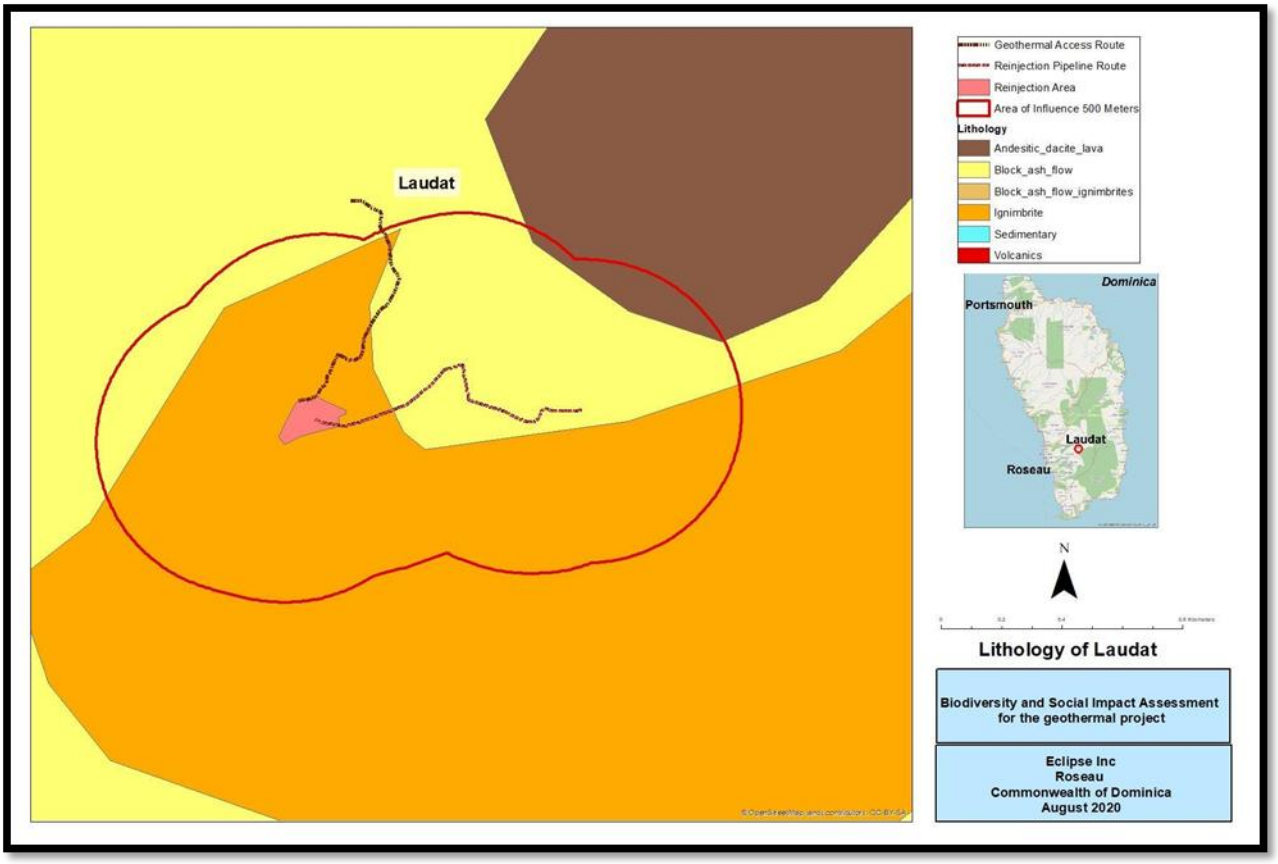
5.3.2 Geology of the Study Area

The reinjection site lies to the south of the Laudat Community and the reinjection pipeline passes through two main geological formations: Pleistocene Ignimbrites and the Pleistocene apron of block and ash flow deposits. Ignimbrites are pumice-dominated pyroclastic flow deposits with subordinate ash. Ignimbrite is primarily composed of a matrix of volcanic ash which is composed of shards and fragments of volcanic glass, pumice fragments, and crystals. The crystal fragments are commonly blown apart by the explosive eruption.

Two large lava-domes complexes, Morne Trois Pitons and Micotrin, rise NE of the capital city of Roseau in central Dominica. Micotrin (Morne Macaque) dome lies immediately south of the larger 1387-m-high Morne Trois Pitons; small lakes are located in the saddle between the two domes and on the eastern flank of Micotrin. The domes are located along the margin of a large semi-circular depression on the western coast of central Dominica, whose origin has been variously attributed to caldera collapse, gravity sliding, or the juxtaposition of several independent volcanic centers.

The area is the source of the voluminous, mostly submarine Roseau Tuff, a thick sequence of pyroclastic flows erupted between about 40,000 and 25,000 years ago. It is considered to have originated from calderas at Morne Trois Piton and Wotten Waven, the latter an elliptical NE-SW-trending caldera containing Micotrin at its NE end. Explosive eruptions at the Trois Piton-Micotrin complex producing pyroclastic flows continued into the late Pleistocene and Holocene. The youngest dated eruption took place about 800 AD, but other smaller eruptions may have occurred since.

***Figure 15**: Laudat Geology/ Lithology*



The reinjection pipeline passes through two main geological formations:

- **Pleistocene apron of block and ash flow:** Pyroclastic apron of block and ash flow from the younger Pleistocene to recent. A block and ash flow or block-and-ash flow is a flowing mixture of volcanic ash and large (>26 cm) angular blocks commonly formed as a result of a gravitational collapse of a lava dome or lava flow. Block and ash flows are a type of pyroclastic flow and as such they form during volcanic eruptions. In contrast to other types of pyroclastic flows, block and ash flows do not contain pumice and the volume of block and ash flow deposits is usually small. Block and ash flow deposits have densities in the range of 1600 to 2000 kg/m^3, two to five times greater than ash fall deposits. Some blocks in block and ash flow deposits may have thin and shiny coatings of carbon derived from charcoal formed from vegetation trapped by the flow.

- **Pleistocene Ignimbrites:** The most notable volcanic activity in Dominica is the large Roseau ignimbrite eruption, which resulted in formation of a submarine pyroclastic flow that extended over 250 km distance into the back-arc Grenada Basin, and produced co-ignimbrite ash fall throughout the North Atlantic to the east of the arc. It is the most recent large-scale explosive eruption in the Lesser Antilles arc and occurred about 28,000 years ago from the Trois Pitons - Micotrin center *(Sigurdsson 1972; Carey and Sigurdsson 1980).*

5.4 Aesthetic Amenity/Landscape

Laudat is a small rural community located in the upland interior of Dominica. It is situated between three of the island's tallest mountains, viz., Morne Micotrin, Morne Trois Pitons and Morne Watt. The village lies just outside the boundary of the Morne Trois Pitons National Park, a UNESCO World Heritage Site and is a relatively small village consisting of dispersed houses laid down along village roads, with open areas of subsistence gardens. The ambiance is generally rural, traditional, and peaceful. Given its strategic location, it is considered the gateway to the park and it is the jumping-off point for many tours and attractions in and around the park, including Boiling Lake, Valley of Desolation, Freshwater Lake, Boeri Lake, Middleham Falls, Titou Gorge and the Waitukubuli National Trail. Perched at about 592meters (1,492 ft.) above sea level, the locality has a cool climate and provides clear views of the surrounding rugged topography of mountains, dense rainforest, and the Caribbean Sea.

The proposed reinjection site and reinjection pipeline corridor are within an area where the natural forest landscape meets a rural village ambiance. In general, the reinjection drilling platform and reinjection pipeline, together with the necessary drilling installations, will by their industrial nature, contrast with the forest and rural landscape, particularly during the construction and exploratory phase.

The lower south-western part of the village where the reinjection site is planned, is on a peripheral area accessible by a farm access road. The site is not clearly visible from the core area of the village of Laudat. However, the site can be seen from viewing points in the upper part of the village and along the road above the village, leading to the Freshwater Lake. Although located at roughly one (1) kilometer distance from the Freshwater Lake Road, the site

and installations can be seen from high up by residents in the elevated area of the village, by persons traversing the Freshwater Lake Road and by visitors to the Morne Trois Pitons National Park. Conversely, when viewed from a distance (e.g. Morne Nichols, Morne Prosper), the visibility of the installations will be limited. However, the site's open visual aspect, the flatness of the drilling platform, the drilling equipment and machinery, etc., has the potential to affect, alter and even destroy the primary natural components of the south-western landscape in this sector.

Figure 16: View of Morne Micotrin

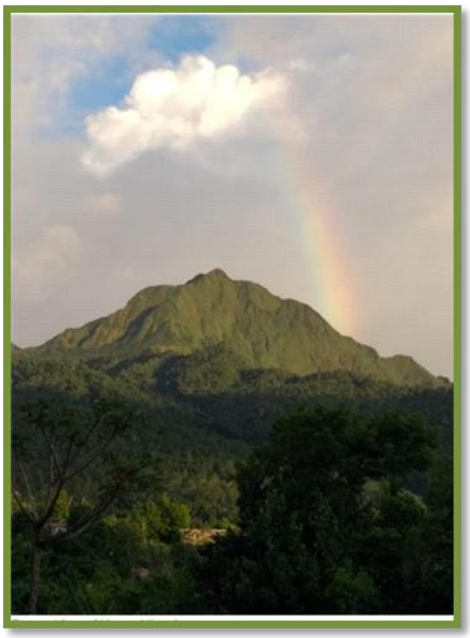


Figure 17: Seasonal Water Source

Figure 18: Titou Gorge

***Figure 19**: Hotel Construction Site*

Figure 20: *View of the Valley from Laudat*

Figure 21*: Landscape Feature: View of Hillside from Laudat*

5.5 Land Use

Most the lands within the area of influence are privately owned, except for lands allocated for public use, namely public roads, a primary school, playing field and health centre. Historically, the greater part of the lands in the study area was parcelled into two large estates namely, the Muedon Estate and Sandringham Estate.

Land Use within the Area of Influence

Based on the national land use database information, the current land use within the area of influence comprises of a mix of subsistence agriculture, livestock farming (sheep, rabbits, pigs), charcoal production, lumber production, harvesting of firewood, wildlife hunting, private residential homes, tourism facilities, watershed, river recreation and hydroelectric infrastructure (power plant, hydroelectric pipeline corridor and balancing tank).

Figure 22: Land use/ Land Cover for Laudat

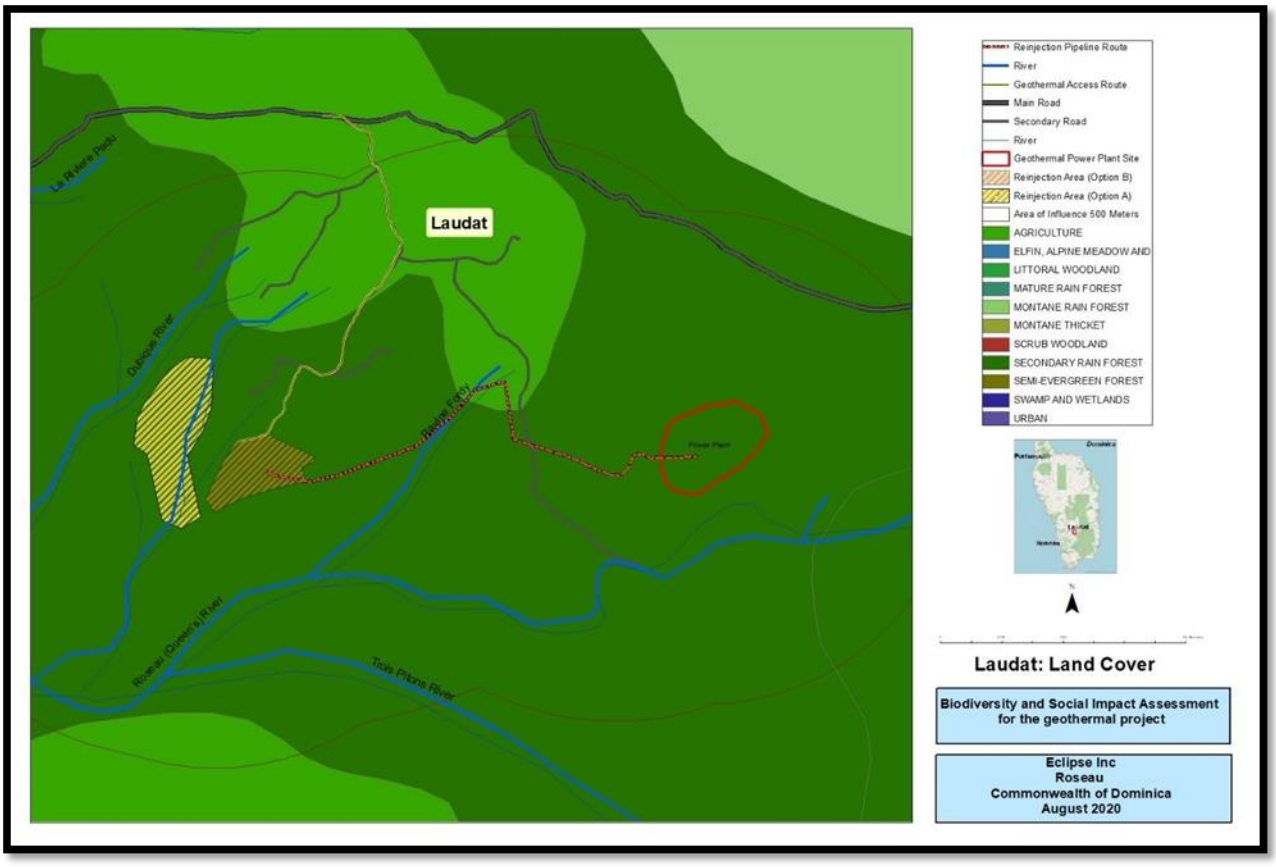


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Figure 23: DOMLEC's Pipeline

5.6 Soils

5.6.1 The Soil types within the Laudat area

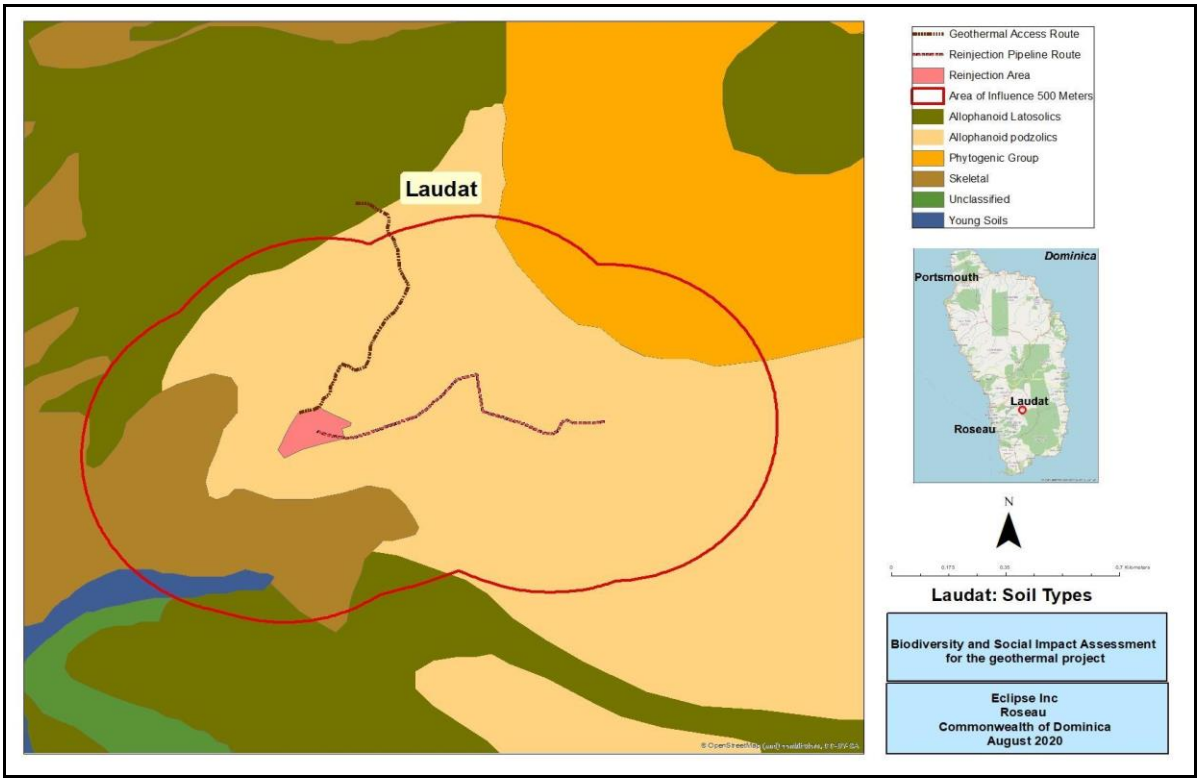
Young Soils: This is not a dominant soil type to the Laudat area. They are unstable and shallow with compact parent material at their base. As a result, drainage is moderately rapid and lateral. They are most highly prone to erosion as is evident in the watershed where most of the landslides and slippage occurred.

The Skeletals: Occur at the highest elevations in the watershed where the parent material is subjected to continuous weathering. Skeletals contain 35% or more rock fragments by volume, they are very shallow and highly prone to erosion. They are low in fertility and are otherwise common in the foothills, slopes and high elevations in the mountainous interior

Allophane latosolics (allophane-rich): in areas with high annual rainfall greater than 3750 mm and no dry season, where leaching is intense and constant, allophane soils predominate. With continued leaching even the silica may be removed to form gibbsite, but because of the youthfulness of the relief and the effectiveness of the slope erosion, allophane latosolic soils tend to persist and indeed cover large parts of the island interior. Generally, these soils have very low subsoil dry unit weights and extremely low topsoil dry unit weights, 5.5 - 10 kN/m3 and 1.9 - 4.1 kN/m3 respectively. As a result, their subsoil porosities are very high (0.66 -0.81) and topsoil porosities even higher (0.86-0.93).

Allophane podzolics (allophane-rich): this is the dominant soil type in Laudat. It occurs in the wettest areas with annual rainfall greater than 7000 mm, where leaching is extremely high, a peculiar variant of allophane is found. The allophane podzolics are characterized by deep litter and organic humic Ah horizons, a bleached highly leached subsoil, and a subsoil pan formed by accumulation of a complex of organic matter and amorphous sesquioxides. Their dry unit weights and porosities are higher than for allophane latosolics.

Figure 24: *Soil Map of Laudat*



5.6.2 Soils of Project Area

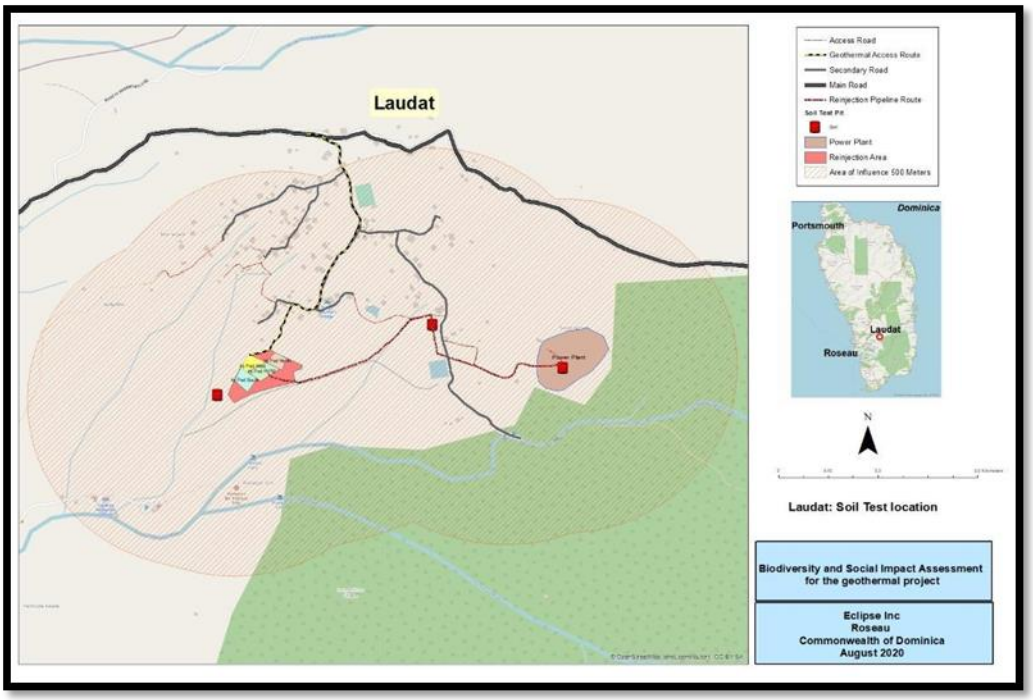
Soils within the area of influence are described as belonging to the Allophanoid podzolics soil group, developed from andesitic material (Lang 1967). Allophanic clay soils are often bouldery and relatively susceptible to erosion.

The soil in the project area is very deep and moderately well drained. They have grayish brown, loamy-sand surface underlain by dark yellowish brown to very pale brown loamy subsoils. A sandy base resides at a depth of 3ft 6 inches indicative of a shallow aquifer flowing beneath the surface. Water permeates through the soil at a rate of 0.3 minutes per inch indicative of a sandy underlying layer and the lack of resistance in the soil.

Figure 25: Soil Sample Sites

Soil samples were taken at three sites to include the proposed power plant where the pipeline begins, one along the proposed pipeline and one near the point of reinjection, to establish a baseline of the contaminant levels at the points of sampling. Samples were analyzed for the following parameters: arsenic, mercury, lead and salinity.

Figure 26: Test Pit Location Maps



The proposed reinjection site is located at the west of the community. The soil was assessed to identify soil type and sub-surface water absorption capacity at 4ft at the proposed site identified for reinjection of the geothermal wastewater. Two holes were dug at a depth of about four feet and filled with water up to a level of one foot to identify the speed at which water is absorbed to determine subsurface characteristics.

Figure 27: *Test Pit Hole 1 Location In 15. 329638° W 061.33463°*

Figure 28: *Test Pit Location Hole 2 Location N 15.331042° W 061.334033°*

The two holes were filled with water up to one foot and allowed to percolate over a period of ninety minutes. Water in hole 1 (one) dropped about three inches and hole two dropped about five inches over that period.

Table 4: *Water Absorption rates of Test Pits*

Date	Hole	Water Absorption Rate
27/8/20	1	30 min/inch
27/8/20	2	18min/inch

The top soil in that area consists of a layer of organic matter made up of rotten leaves and foliage of about 4 inches indicative of the colour and texture followed by a layer of loose soil and small gravel at about one foot deep with clay forming the layer atop a hard pan beneath that clay layer at about four feet deep.

The soil characteristics allow it to retain water which permeates slowly through at an average rate of about 25 Min/inch. This consistency reduces the rapid leaching of soil constituents over time therefore increasing the capacity of the soil to hold impurities. (Kaufman, D; Franz C 1993) There is no water flow beneath the soil surface.

5.7 Overview of Climate and Weather in Dominica

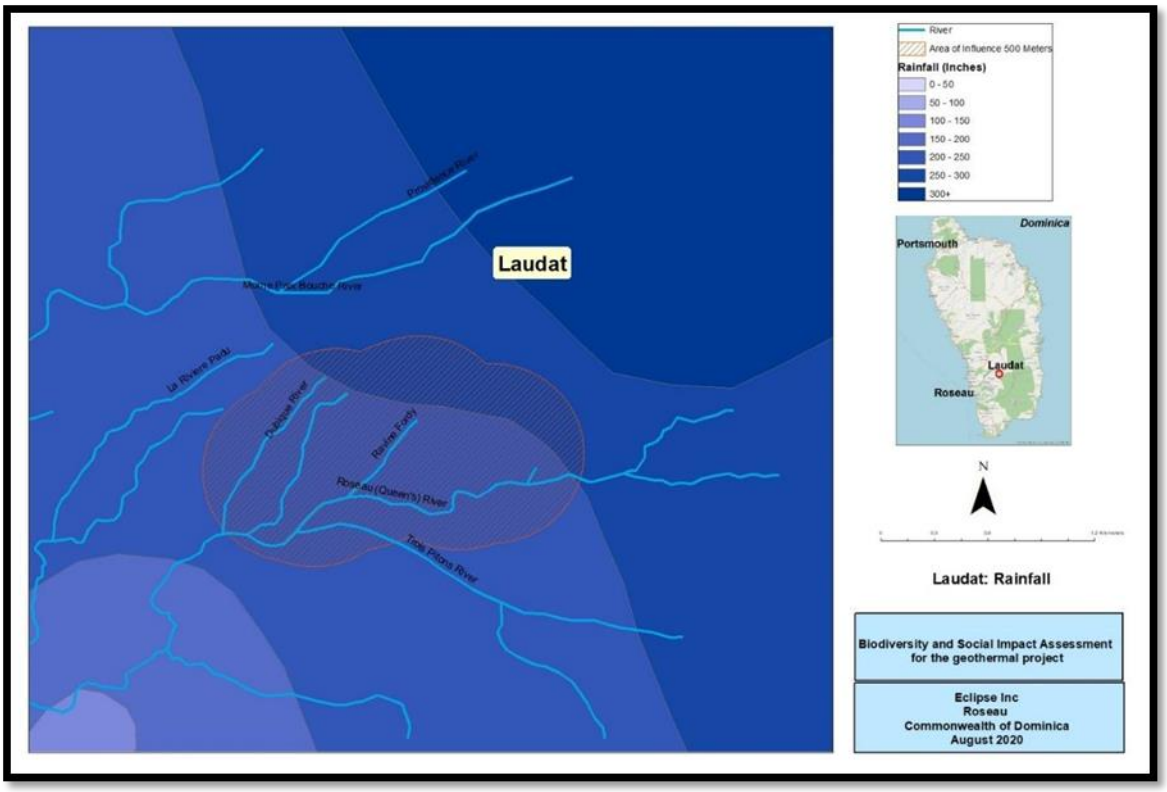
Dominica has a typical humid tropical climate with high temperatures and heavy rainfall. The island's rugged topography contributes strongly to micro-climatic variability. Average daily temperature ranges from 27ºC (81ºF) in coastal areas to approximately 21ºC (70ºF) at higher elevations. The heat and humidity are tempered by the north-easterly trade winds. The trade winds gusting from the Atlantic Ocean blow across the island in a general westward direction. Wind speeds are generally moderate, averaging 4 miles (6.4 km) per hour at sea level and about 14.4 km (9 miles) at elevations of 442m (1,450 ft.) above sea level.

5.7.1 Climate in Laudat

The climate of the Laudat area, like most of Dominica, is classified as "humid tropical marine", exhibiting little seasonal or diurnal variation. Relative humidity is usually in the region of 85%. The area lies within the precipitation zone that receives 5,080-6,350 millimeters (200-250 inches) of rainfall per year. Rainfall within the locality has been described as high. Most of the rainfall is due to orographic precipitation produced when the moisture laden trade winds are uplifted by the steep central mountain range. Rainfall generally occurs throughout the year while intensity varies.

Tropical storms and occasional hurricanes tend to occur from June to November, during the period considered the wettest. There is a dry season from January to May, but this seasonal distinction is much less pronounced in the upland interior of the island.

***Figure 29**: Rainfall Map of Laudat*



5.7.2 Natural Hazards

Dominica is prone to many natural hazards such as seismicity, volcanicity, hurricanes, landslides and floods. Many areas are highly susceptible to one or more of these natural hazards.

Hurricanes:

In at least every decade since the 1970s, Dominica has been affected by major Tropical storms and hurricanes. Since 1978, the island has suffered the damaging effects of seven hurricanes.

Three of them being category 4 storms (Benson and Clay, 2004). In 2015, Dominica was severely affected by Tropical Storm Erika. Tropical Storm Erika resulted in total damage and loss of EC$1.3 billion (Commonwealth of Dominica, 2016). Some hurricanes such as David in 1979 and Maria in 2017 proved to be particularly devastating to the island.

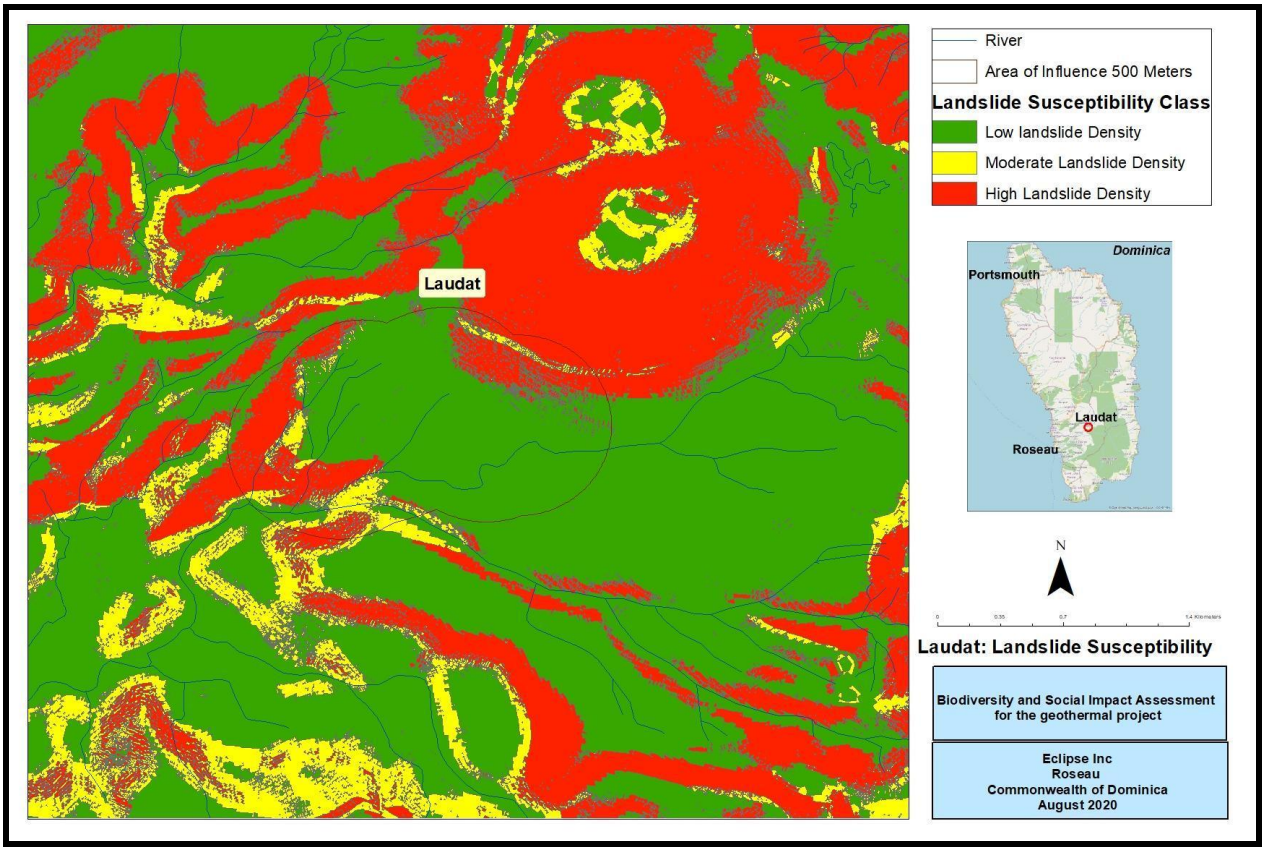
Landslides, inland flooding and sea surge are hazards which are closely related to tropical cyclones and rainfall events in Dominica and the rest of the Lesser Antilles. Dangerous sea surges can also be triggered during a tropical cyclone. These events have become even more frequent in the past decade with an increase in periods of intense rainfall even outside of the hurricane season. The population and infrastructure such as roads, electricity transmission lines are usually affected. The islands of the Caribbean share a common set of features that include small size, steep inland topography restricting the land space available for development, and a heavy socio-economic dependency on the coastline and limited resources. These features enhance sensitivity to climate variability so that extreme events such as droughts and floods and hurricanes pose a very real threat to regional development.

Recent Impact- Hurricane Maria

Hurricane Maria was Dominica's most powerful and destructive storm in recent memory with total damage surpassing XCD 2.5 billion (Van Western and Zhang 2017). The island housing stock was significantly impacted as well as businesses, farmland, and infrastructures. It was estimated that at least 60% of the tropical forest was damaged. In addition, 60 percent of the population was left homeless and 39 deaths were reported. Highly intensive precipitation triggered widespread floods as well as a tremendous number of landslides. Nearly 10,000 landslides were recorded throughout the island with extensive topsoil loss (Van Western and Zhang 2017). According to the report, Dominica will face some new problems from mountain hazards in the coming years, as many of the fresh scarps could produce more debris. Debris could also come from tree trunks still on the slopes or in the river channels. With so many fresh landslides in the upper catchments in nearly every watershed, it is likely that debris flows will be triggered with rainfall thresholds that are substantially lower than before the hurricane.

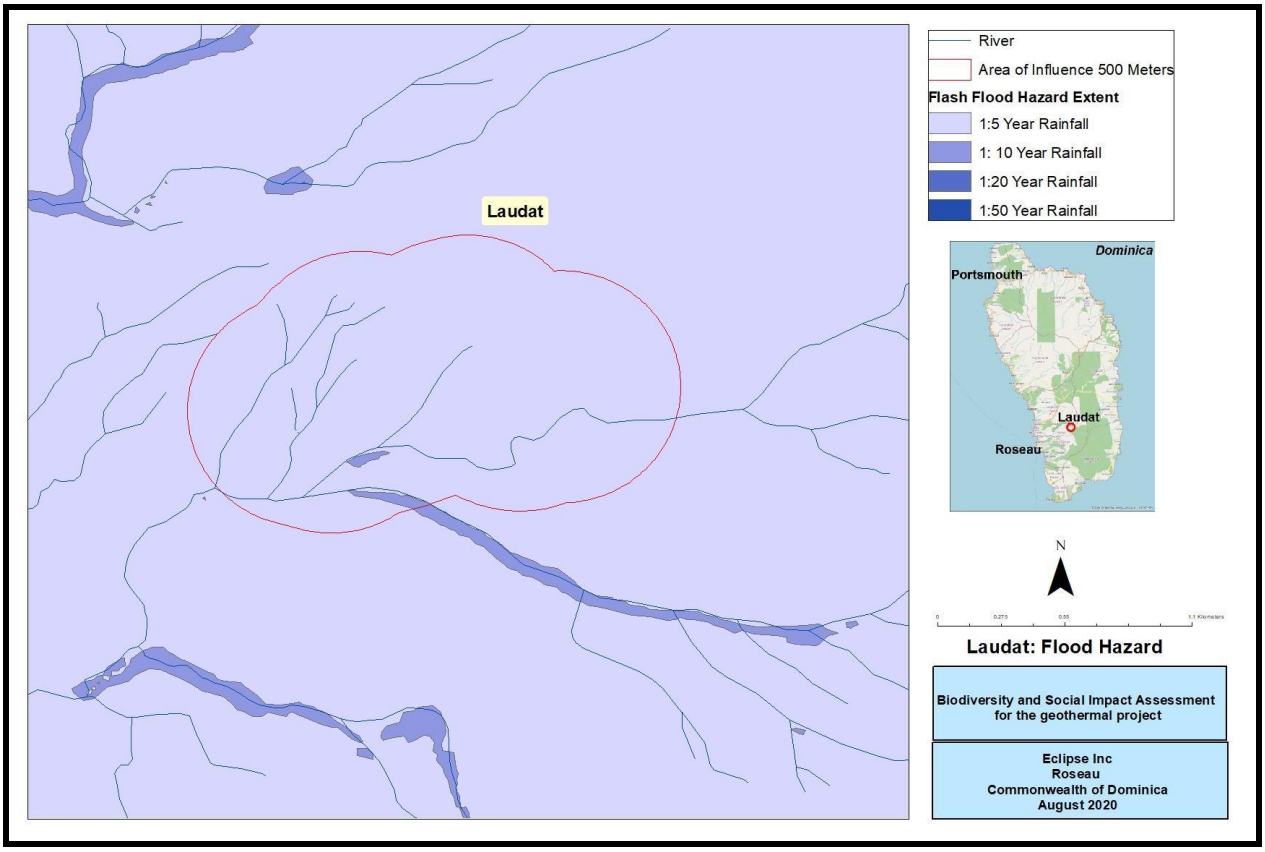
Landslide: The many areas in Dominica are highly susceptible to landslides due to the mountainous nature of the island, high rainfall, soil type, geology, and anthropogenic activities. Based on the landslide susceptibility map, the project area of influence, reinjection area and reinjection pipes are all within areas with a low susceptibility to land sliding.

Figure 30: Laudat Landslide Susceptibility



Flooding: Many communities in Dominica are highly susceptible to inland flooding due to the presence of many rivers, streams and dry ravines. High rainfall, soil type, geology and anthropogenic activities all influence inland flooding in Dominica. Based on the flood susceptibility map, the project area of influence, reinjection area and reinjection pipes are all within areas with a low susceptibility to Flooding.

Figure 31: *Laudat Flood Hazard Extent*



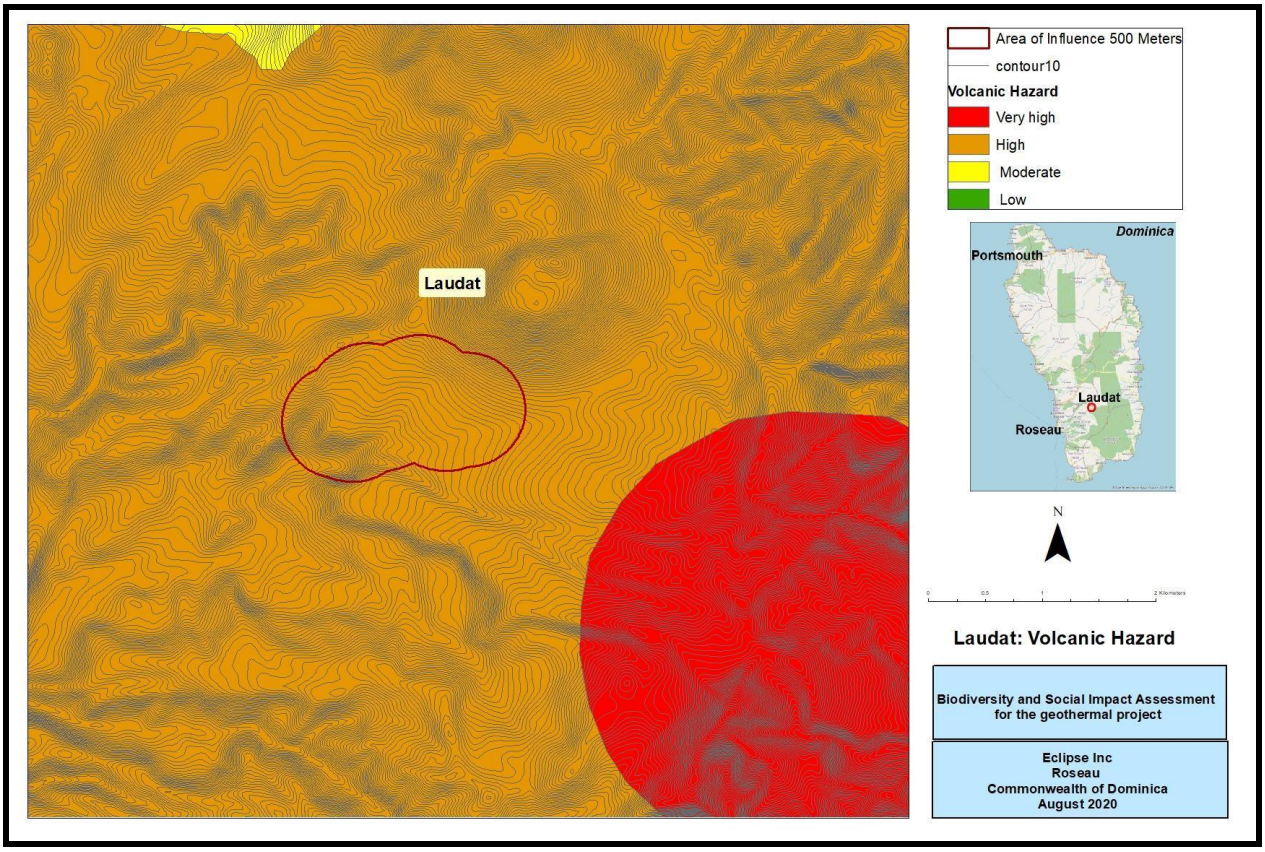
Volcanism

Dominica lies at the centre of the Lesser Antilles Island arc, where the islands of the Active Arc are large and complex comprising many coalesced stratovolcanoes. Whereas all the other volcanic islands of the Lesser Antilles have only one active volcano, Dominica has nine and yet there has been no major magmatic eruption since Columbus visited the island and as a result it has today the best and most extensively preserved tropical rainforests.

The youngest dated volcanic deposits on the island are associated with the Morne Patates dome on the flanks of the large active Plat Pays Volcano that comprises the southwestern end of the island. This was a Pelean eruption (similar to the eruptions of Mt. Pelee in Martinique in 1902 and 1929) and radiocarbon ages from the block and ash deposits suggest it occurred about 500 years ago. In addition, there have been two steam explosions (phreatic activity) in the Valley of Desolation in 1880 and 1997. Frequent seismic swarms and vigorous and widespread

geothermal activity today characterize the island. In fact, it is the most worrying of all the Caribbean volcanic areas and there is a general feeling that it (like Montserrat pre-1995) is long overdue for an eruption.

Figure 32: *Laudat Volcanic Hazard*



Seismicity

The geological history of the Lesser Antilles is complicated as reflected in the structure and rock composition of various islands (Figure 10). North of Dominica, the arc is divided into two island chains, sitting on top of a Cretaceous ocean island arc. The eastern chain is an older extinct arc, largely covered by thick carbonate platforms. The western chain is the site of active volcanism since ~20 million years ago. South of Dominica, the older and recent arcs are superimposed, forming one chain of islands bordered to the west by the 2900-meter-deep back arc Grenada Basin (Greely, 2012).

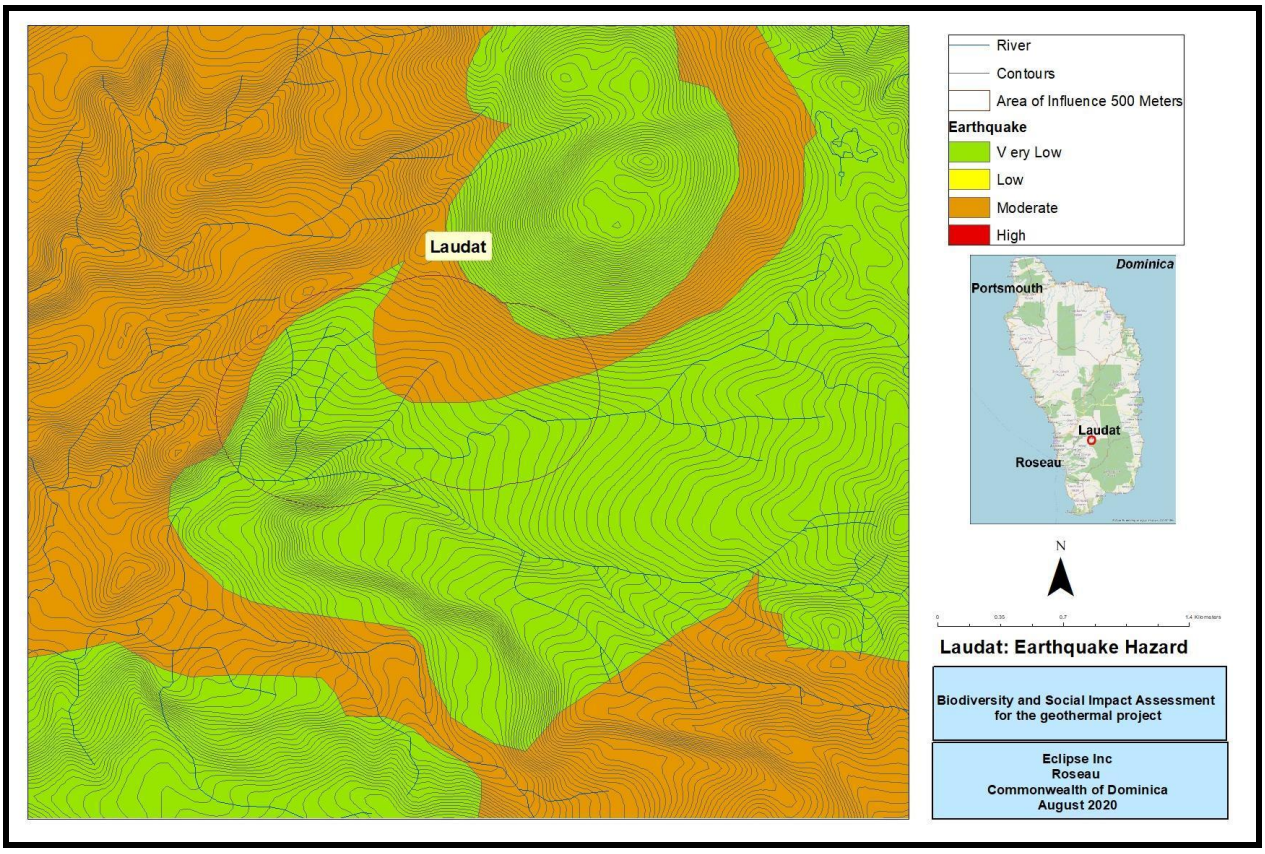
It is estimated that over 90% of the population live within 5 kilometers of active seismic zones. In November 2004, Dominica recorded a major earthquake with a 6.3 magnitude which caused

major disruptions to homes and public buildings particularly in the north of the island. Historically, the most common area of seismic activity has been in the south eastern sector of Dominica. However, in the north, there have been spurts in activity in 1841, 1893, 2000 & a particularly intense week-long burst of >500 earthquakes in 2003.

Following 6 years of low activity, a near-continuous series of earthquake events has been recorded beneath the central area of Morne Aux Diables since June 2009. Since June 2009, periods of elevated seismic activity have been experienced around the flanks of Morne Aux Diables Volcano in northern Dominica on the Lesser Antilles arc. This long dormant volcano is a complex of five intact andesitic lava domes with a central depression (or pseudo crater) within which a cold Soufriere is evident (Lindsay et al., 2005).

Prior to this activity, seismicity was very quiet except for a short period in 2000 and an intense short-lived swarm in April 2003. The most recent earthquake activity has been regularly felt by residents in villages on all flanks of the volcano.

Figure 33: *Laudat Earthquake Hazard*

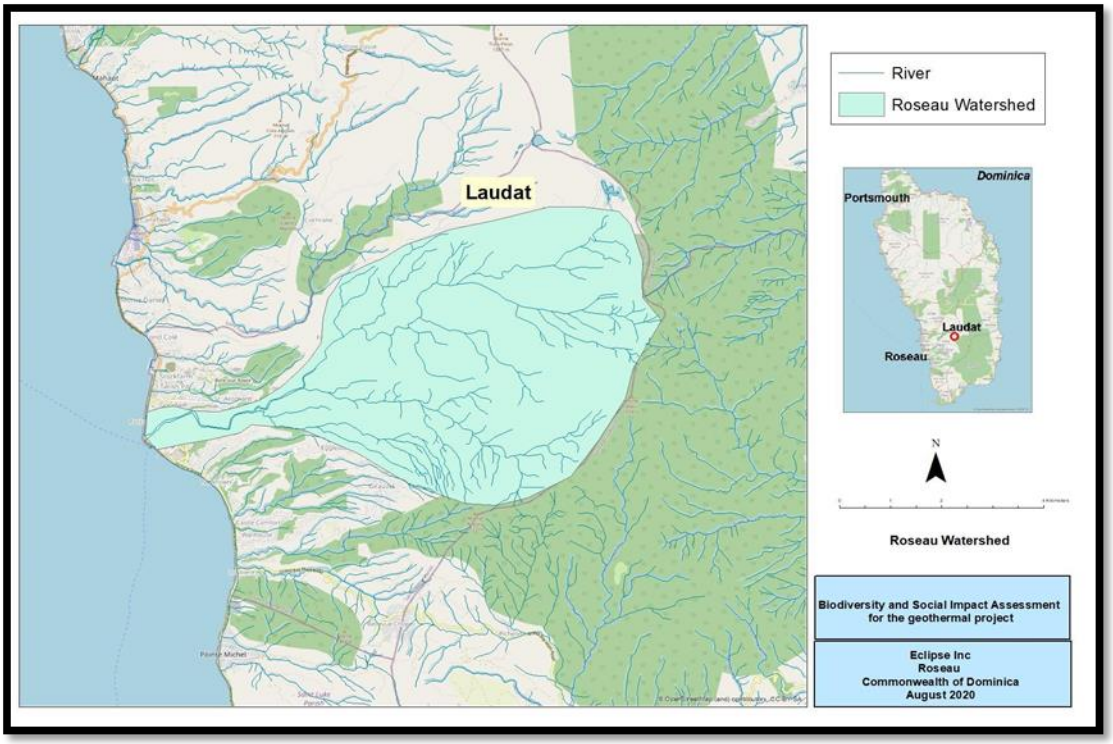


The risk of earthquake is classified as moderate to very low in the Roseau Valley (Refer to earthquake risk map). The proposed power plant and reinjection site is located within an area with moderate to very low earthquake risk. The reinjection pipeline is located within a very low risk seismic area. The nearest area classified as having a high risk of earthquakes is located over 1 km from the reinjection pipeline.

5.8 Hydrology of the Study Area

The project area falls within the Roseau River watershed. This is one of the largest watersheds in Dominica and extends southwards from Fort Young Hotel, Morne Bruce, Reigate, Champs Fleur Estate, Eggleston, Giraudel up to Morne Anglais and on the north from Roseau, Federation Drive to Goodwill, St Aroment along Bath Estate, Louisville, Copthall, Shawford Estate, and Trafalgar, Laudat to Morne Micotrin. The following rivers are included in this major watershed: La Riviere Pardu, Roseau (Queen's River), Riviere Blanc, Riviere Claire, Trois Pitons River, Riviere Douce.

Figure 34: *Roseau Watershed*



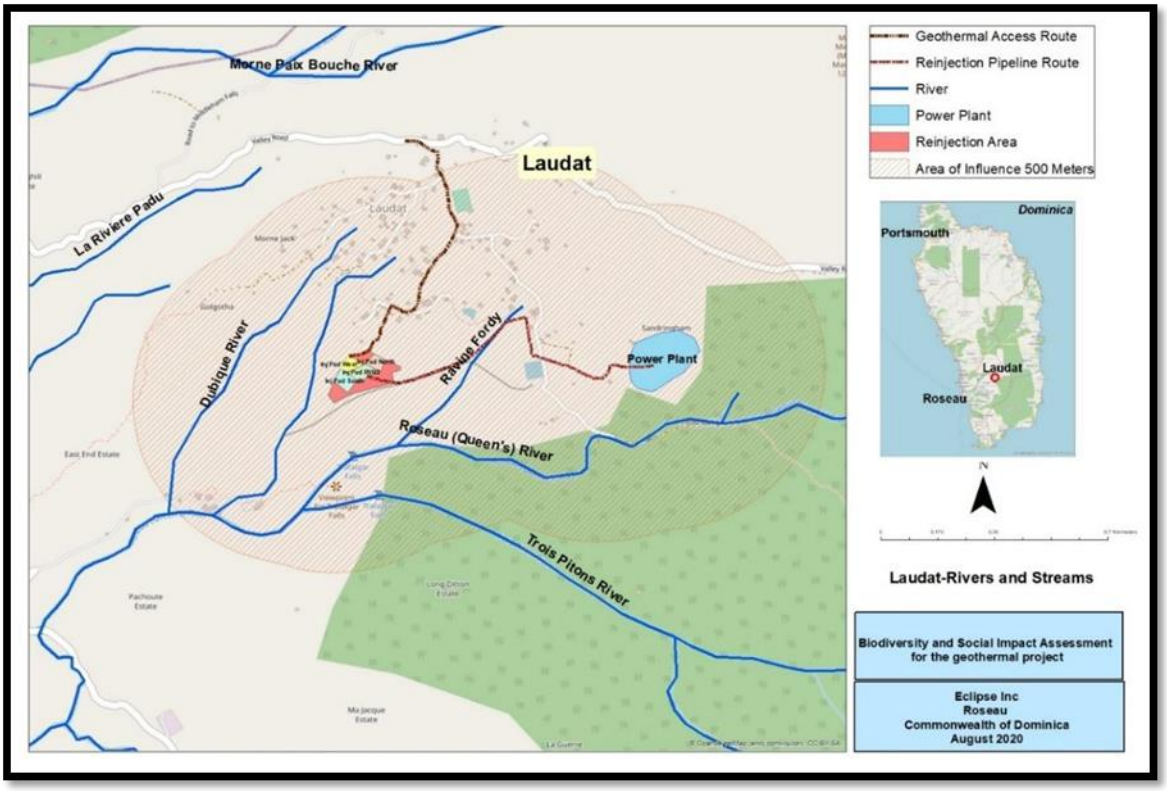
It also serves as a watershed for several ground water sources which spring out in the community of Trafalgar located about 500 meters downstream. Soil percolation tests conducted at 4 feet below the surface revealed characteristics of ground water including soil type and water flow at that depth.

When it rains, lateral drainage through the soil is rapid. A water table exists where there is an - occasional perched pan. Surface runoff from the zone of influence is drained mainly via to (2) perennial watercourses and two (2) intermittent ravines, in addition to a network of natural and man-made ditches. All water courses within the study area are tributaries of the Roseau River.

The permanent ravine (Ravine Fordy) which traverses the south-eastern section of the study area, drains into the Roseau River (Queen's River), to the south. Excess water from the spillways at the Laudat Hydroelectric Power Plant and DOMLEC's Balancing Tank respectively, empties into this permanent watercourse. It should be noted that surface runoff carried by the two large intermittent ravines is deposited over the steep cliff near DOMLEC's vertical hydro-electric water pipeline overlooking the Trafalgar Falls Visitor Center and Papillote Wilderness Retreat, respectively.

Additionally, there are two rivers located about half a kilometer to the north and south of the proposed project site. The Trafalgar River located to the south flows towards the Trafalgar community and the Providence River to the north flows towards the Boeri River in the Canefield Community.

***Figure 35**: Streamflow*



5.9 Protected Areas

Morne Trois Pitons National Park-World Heritage Site (MTPNP-WHS)

The Morne Trois Pitons National Park was established in 1975. The park is named after its tallest mountain, Morne Trois Pitons, which at 4,672 feet (1,424m) is the second tallest peak in Dominica. This national park covers an area of 16,980 acres (6,871ha), approx. 25 square miles (64.75 sq.km.) of legally protected forest in the south-central part of the island.

Morne Trois Pitons National Park is rich in natural resources and phenomena. It includes most of the representative natural features and processes which give the island landscape its character. The park encompasses five major mountains, two freshwater crater lakes, the Boiling Lake and a unique thermal area known as the Valley of Desolation, waterfalls and an expanse of undisturbed tropical rainforest and montane forest vegetation.

The park is well known for its rich biological diversity, and provides a habitat for over 45 species of birds, (including the endemic Imperial Parrot and Red-necked Parrot, two species of frog, crabs and crayfish several species of mammals (bats, agouti, opossum and feral cats), species of freshwater fish, four species of snake, at least five types of lizard and a wide variety of insects and other small invertebrates.

Located within the park are the headwaters of several major rivers, including the Roseau River, in the southern half of the island. The park is also the watershed for the island's hydroelectric plants in addition to potable water systems in the south of the island.

In 1997, the Morne Trois Pitons National Park was listed by UNESCO as the first World Heritage Natural Site in the Eastern Caribbean. The Park was formally inscribed as a World Heritage Site in August 1998. The Convention Concerning the Protection of the World's Cultural and Natural Heritage (The World Heritage Convention) provides for the designation of areas of "outstanding universal value" as World Heritage Sites, with the principle aim of fostering international cooperation in safeguarding these important areas.

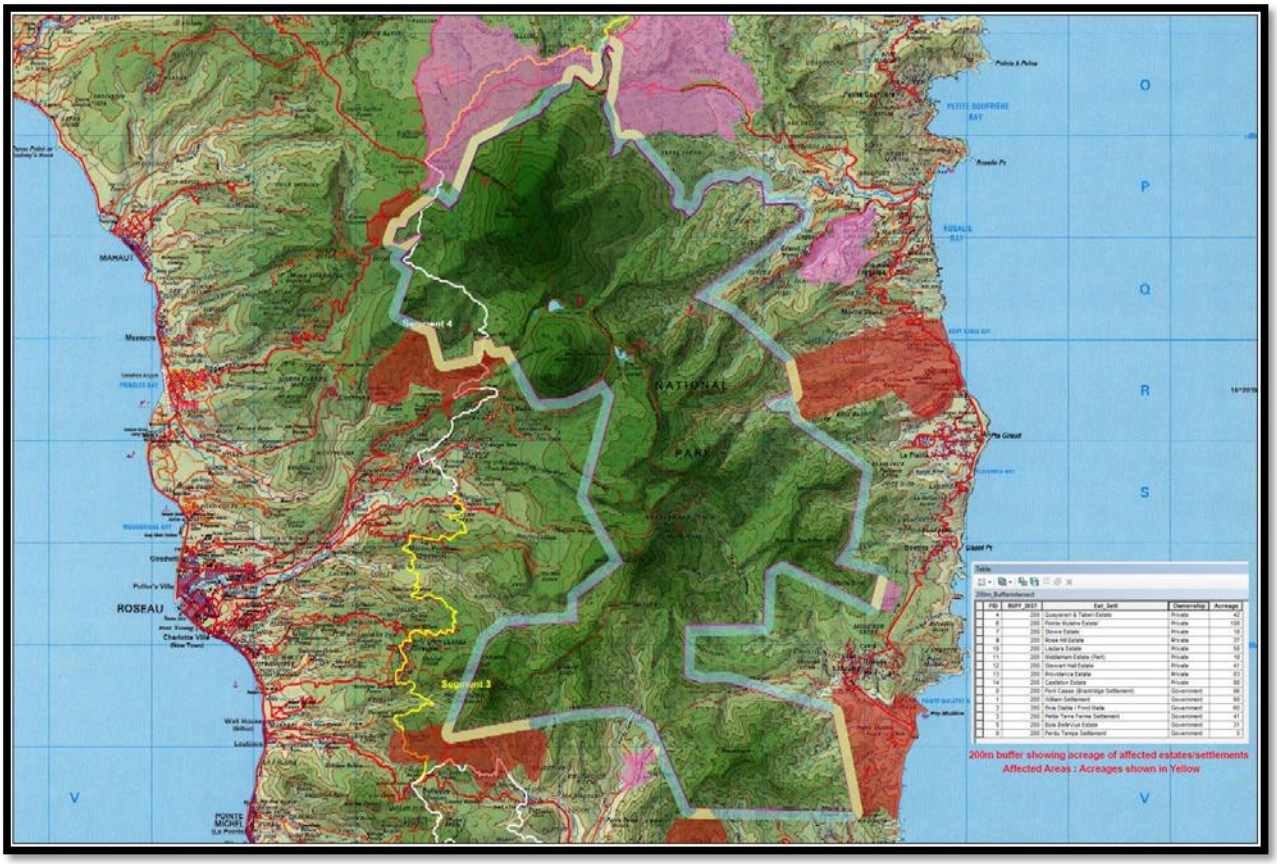
The Morne Trois Pitons National Park has been meeting its primary objectives of watershed protection, soil erosion control and preservation of the island's rich biodiversity in addition to providing a nature-oriented experience to local and foreign visitors.

As part of the requirements of the World Heritage Convention, all World Heritage Sites must establish a Buffer Zone to protect the integrity and "outstanding universal value" of the site. the proposed buffer zone recommended for adoption is as follows:

In the northern area of the Park from Corona to Newfoundland the depth of the proposed buffer has a range between 500 feet (152.4 m) in localities where residential development is dense and in close proximity to the boundaries of the Park (Corona) to 1,000 feet (305m) in areas where the land is under forest, marginal and state owned (Petite Terre Ferme). South of Corona the buffer follows the existing forest edge.

In the other areas of the Park, a 656.2 feet / 200m buffer zone is being recommended. This would apply to this section of the Park under consideration. No decision has been made on what activities are allowed in this zone.

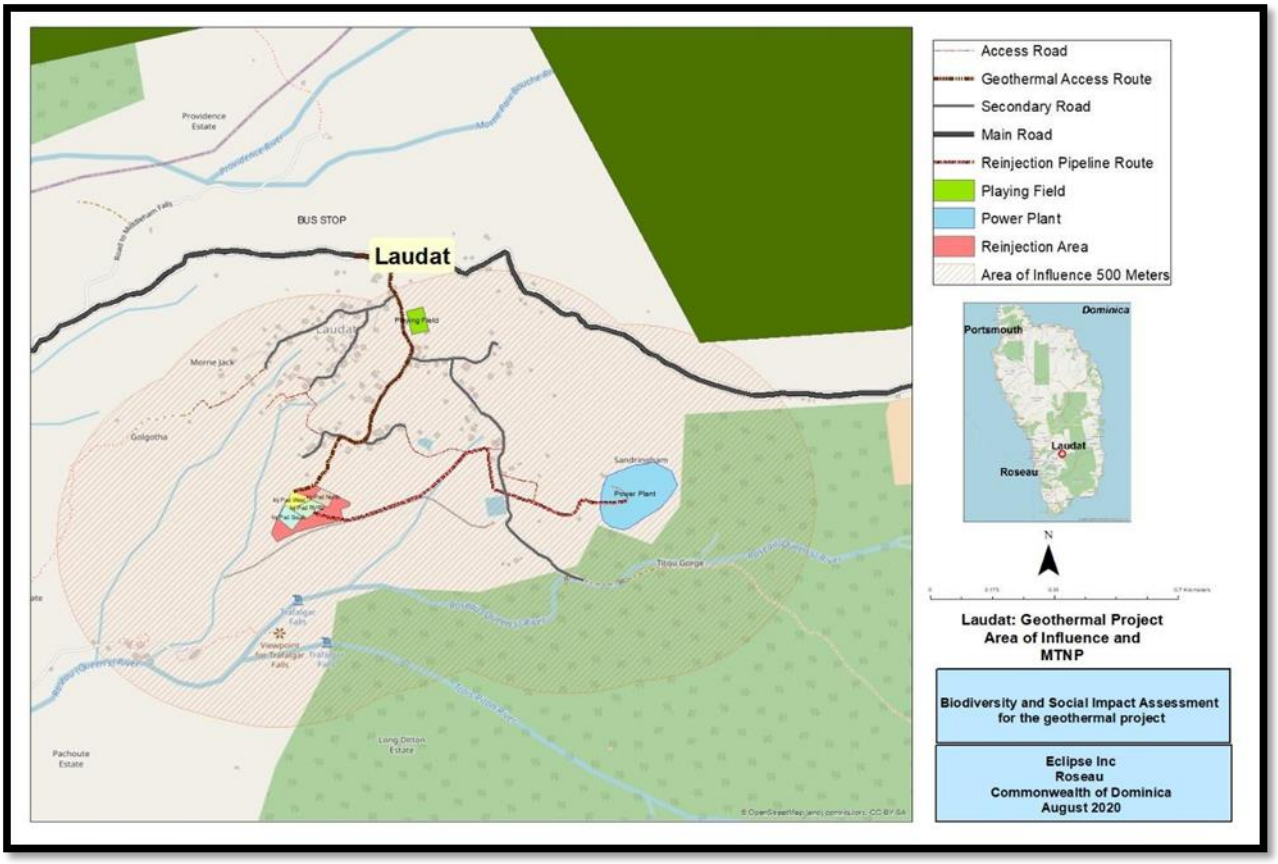
Figure 36: *Protected Buffer Zone*



However, it was proposed that these Buffer Zone must provide some form of protection to the biodiversity of the park, while enabling adjacent neighboring stakeholder communities to sustain livelihoods that are environmentally friendly.

With respect to the area of influence, the distance varies. It intersects with the Park boundary at coordinates 61°19'25.942"W 15°20'5.822"N (closest point) and the furthest distance (from the south) is approximately 1700 meters.

***Figure 37**: Intersection with Morne Trois Pitons National Park-World Heritage Site*



5.10 Ecology of the Area

Introduction

This section highlights the general ecology of the designated area of influence located on the southwestern periphery of the village of Laudat. Geographically it is west of Morne Micotrin and east of the steep escarpment in the vicinity of the Trafalgar Falls. The direct area of influence for the ecological assessment of the area corresponds to a designated geographical area, measuring approx. 830m long and 300m wide was established as the potential “area of influence” for the ecology.

5.10.1 Methodology for Assessing Terrestrial Biodiversity

Following the literature review and gap analysis of the available information, a rapid biodiversity assessment of the proposed project site was undertaken. The rapid biodiversity assessment comprised baseline surveys of the habitats and species within the zone of influence of the proposed project, providing additional raw data, necessary to complement and update the previous biodiversity assessments.

For the purposes of conducting the biodiversity assessment of the proposed Geothermal Reinjection Well and Re-injection Pipeline Route.

The assessment was conducted within the area of influence for ecology. The route for the reinjection pipeline (approximately 830 meters) was used as the alignment for the establishment of the transect line. The transect spans an area originating from the site of the proposed Geothermal Power Plant, follow the re-Injection pipeline and terminates at the reinjection well. Nine (9) quadrats/sample plots measuring 20m x 50m (100m2) were established alternately at 150meter intervals on either side of the transect line. GPS coordinates and elevation above sea level were recorded for each quadrat.

Baseline surveys within the area of influence were conducted over a three (3) - week period in July and August 2020. The field research phase coincided with the annual rainy season. Field assessments of the flora and fauna (terrestrial/aquatic) were done during the day in addition to nocturnal faunal surveys. In undertaking the field investigations, the study site (habitats/ecological zones) was traversed via secondary access roads, the DOMLEC hydroelectric pipeline corridor, and via a temporary trail/footpath cut through the vegetation.

A combination of transect and quadrat-based assessments was used to conduct detailed field surveys. The surveys provided information on vegetation types, floristic diversity, faunal diversity, possible presence of rare and threatened plant and animal species, and land-use within the area of influence.

The following general data was recorded at each quadrat:

- Specific location
- Unique identifier (Plot number i.e. Q#1)

- Geographical location using exact GPS coordinates
- Altitude /elevation and slope characteristics
- Habitat types and structure
- Photographs showing habitat structure and any notable plant species
-

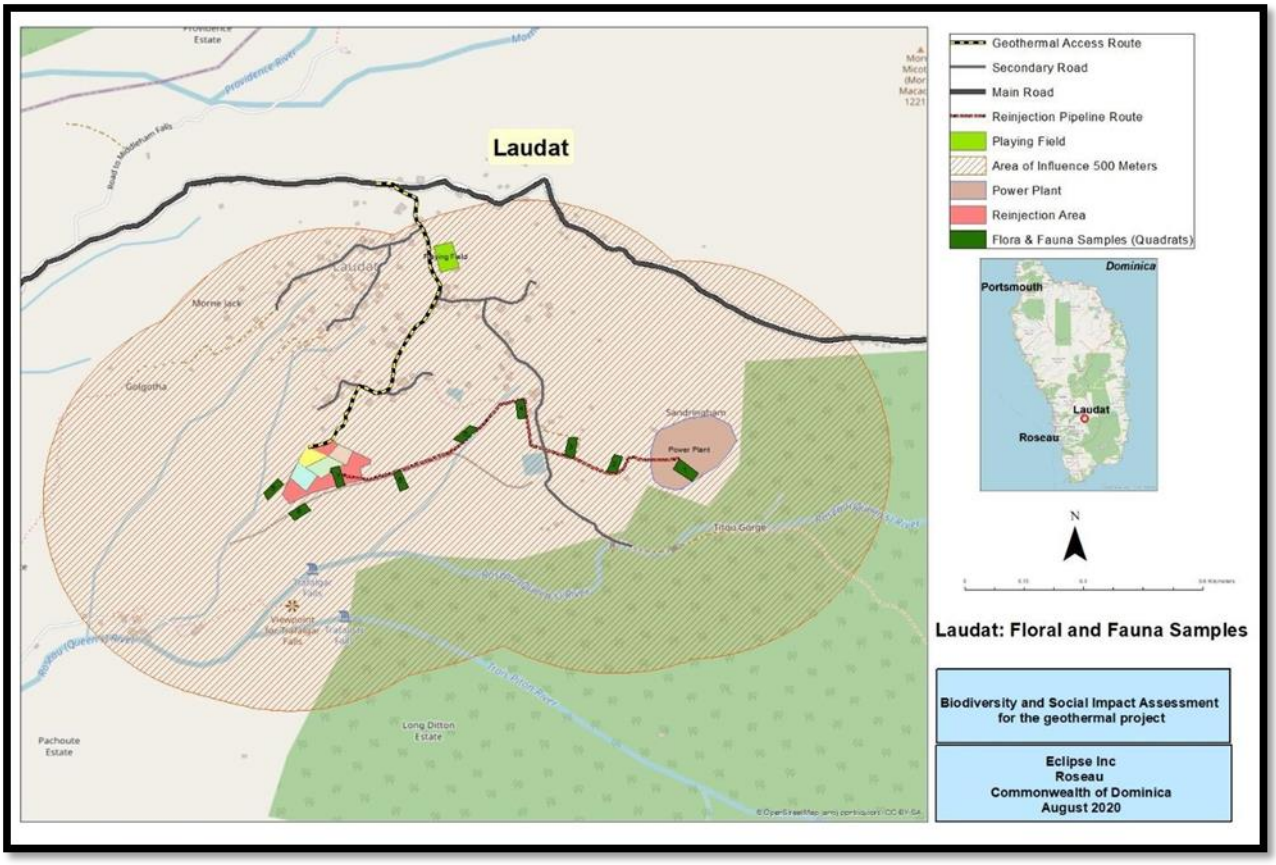
Within each quadrat, plant species occurring in the canopy, understory and ground cover were identified, tallied, and documented as far as possible. Percentage plot coverage of tree/plant species was recorded. Attention was paid to species of conservation importance (globally/nationally threatened species, endemic/restricted range species, migratory/ congregatory species), invasive species, the dominant, rare, endemic, invasive/alien species, including the species that are of economic importance to the local community- the uses of plant species, GPS coordinates were recorded at all survey points, quadrats and transects. In addition to direct observations of species and/or field signs, an assessment was made of whether any species of conservation importance and/or protected species are likely to occur in the study area based on the habitat available.

Diurnal and nocturnal surveys of faunal species were also conducted within the area of influence. All animal species observed within the quadrats and within a 25m radius of the transect line were identified and recorded. Identification of animal species in the field was done primarily through visual and auditory observation. Surveys of rivers/streams within the zone of influence were also undertaken. Scientific literature assisted with the identification of some invertebrate species.

All species of flora and fauna encountered within the area of influence were recorded and enumerated based on their occurrence and relative abundance. Rare or threatened species were identified and recorded using GPS coordinates. Photographs were used where possible to illustrate associated animal/plant species and the biophysical aspects of the habitats. Data gathered and observations made, were recorded on field notebooks and field data forms.

Anecdotal information regarding the status of the habitat (flora/fauna/land-use) was obtained through discussions with residents (farmers and hunters) from the community.

Figure 38: *Habitat Map of the Area of Influence*



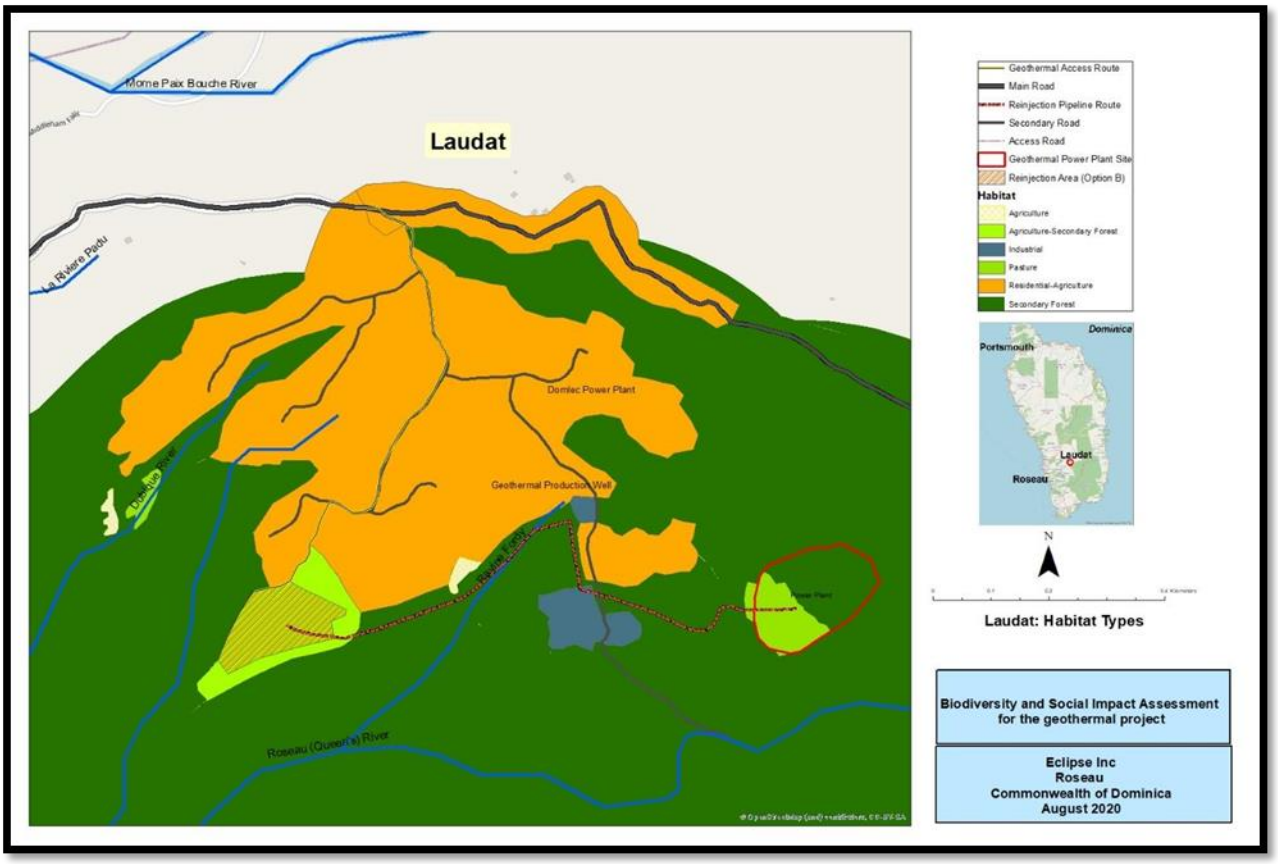
5.10.2 Habitat Description of the Study Area

The project's area of influence is situated within an ecological region originally classified as "primary rainforest". This habitat, in its pristine condition, was composed of viable assemblages of indigenous plant and animal species. However, field investigations and ecological data indicate that the natural primary rainforest which originally occupied the wider Laudat area, inclusive of the area of influence, has been extensively degraded and modified.

Much of the original natural forest vegetation within the area has been altered due to the impacts of human induced activities and tropical weather systems. Human activity such as extensive clearance of natural forests for agriculture, small-scale timber harvesting, charcoal production, firewood collection, livestock grazing, construction of residential homes, and installation of hydroelectricity infrastructure, has essentially modified the primary ecological

functions and species composition of the habitat. Several invasive plants have established a foothold in the area. The major habitats are therefore secondary forest and agriculture.

***Figure 39**: Habitat Types in Laudat*



Additionally, the aquatic sub-habitat (rivers and streams) within the study area has also been modified by harnessing the water resource for the generation of hydroelectricity and the introduction of non-native freshwater fish species.

5.10.3 Vegetation

Primary rainforest is the most diverse and extensive of all the vegetation types within Dominica. It is a tall, broad-leaved, evergreen rainforest, found occurring at altitudes between 305m and 915m (1,000feet and 3,000feet). The diversity and luxuriance of this forest formation is mainly as a result of abundant rainfall at mid-elevations. Much of the soil in areas of mature rainforest is a heavy red earth underlaid by an impervious hardpan.

Primary rainforest has a distinct stratification. It is divided into three strata or layers, with the dominant trees forming a primary stratum or closed canopy 27.5 - 33.5m (90 - 110 ft.) in height. The primary stratum allows little sunlight to filter to the lower strata. Typically, the primary stratum or canopy is formed by two dominant trees, the giant buttressed Chatanyé *Sloanea spp*. and the pillar-like Gommier, *Dacryodes excelsa*. These canopy species are the largest and tallest trees in the rainforest and typically form a dominant plant community referred to as the *Slonea/Dacryodes* association. Lianas, creepers and epiphytic plants are abundant high in the upper stratum where light conditions are more favourable.

A middle stratum forms a discontinuous layer averaging between 12 - 24m (40 - 80 ft.) in height. Trees usually found in this stratum are Bwa Kot *Tapura antillensis* with its fluted trunk, Mahot Cochon Sterculia *caribaea,* Palmiste *Euterpe broadwayi, Carapite Amanoa caribea, and* Bwa Diable *Licania ternatensis*.

A third layer or lower stratum has trees 5-12m (15-40ft) tall. The most common trees in this layer are Cré Cré *Miconia spp*., Yanga (a slender palm) *Geonoma pinnatifrons*, Bwa pichette *Eugenia spp*. with its prickly trunk, tree ferns *Cyathea arborea* and *Hemitellia sp*.

Typically, the forest floor is quite open. The forest floor or ground cover consists of a few herbs and shrubs but is generally sparse because of the small amount of sunlight reaching the forest floor. The seedlings of the forest trees also populate this area.

Currently, the main vegetation community within the area of influence is composed primarily of secondary rainforest at varying stages of succession. This modified habitat does not have the typical form, structure, and species composition of the rainforest proper. Generally, it does not have a clearly defined closed canopy but rather a fragmented canopy 12-18m (40-60ft) tall and an understory stratum 4.5-9m (15-30ft) high. The ground cover is very spare except on the forest edge.

As a result of the open canopy caused by selective forest clearance and hurricanes over the years, many opportunistic species from forest edges and riverbanks have moved in. Among the residual rainforest species and pioneer species forming a forest canopy across the quadrats

within the area of influence, are: bwa pipiri *Pithellobium jupunba,* poix doux *Inga lauriana*, pois doux mawon *Inga ingoides*, bwa riviere *Chimarrhis cymosa*, Palmiste *Euterpe broadwayi*, bwa bandé Richeria *grandis*, Chatanier *Sloanea spp*. bwa kano *Cecropia schreberiana* and, cré-cré, *Miconia* spp.

The understorey, roughly 4.5 – 9m (15-30 feet) tall, forms a dense thicket, occupied by a diversity of plant species comprises mainly of saplings of trees typically found in the canopy and middle stratum. Tree species occurring with the greatest frequency in the understorey, across all quadrats, include: tree ferns *Cyathea arborea* and *Hemitelia muricata*, bwa riviere Chimarrhis cymosa, palmiste *Euterpe broadwayi,* bwa blan *Simarouba amara*, bwa pipirie *Pithecellobium jupunba*, pwa doux mawon *Inga ingoides*, pwa doux *Inga lauriana*, maho kochon *Sterculia caribea and* laurier caca *Beilscheria sericea.* Other plant species frequently occurring in the forest understory include Balizé *Heliconia caribaea,* cré-cré *Miconia/Conostegia spp.,* bwa mal-estomac *Siparuna glabrescens*, rambling fern *Dicranopteris bifida, and* Razor-grass *Sceleria spp*

The ground cover on the forest floor across most quadrats is composed largely of herbaceous plants such as, parasol agouti *Selaginella flabellatta*, Z'ailes mouche *Asplundia insignis*, blue wax flower *Psychotria urbaniana,* bwa fou fou *Palicourea crocea,* wild ginger *Hedychium coronarium*, spiral ginger *Cheilocostus speciosus,* man-better-man *Achyranthes aspera*, and goat weed *Ageratum conyzoides*

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Also, there exist scattered areas of abandoned and active agricultural cultivations with tree crops, root crops, vegetables, and ornamental flowering shrubs. Most abandoned cultivations and sections of the hydro pipeline corridor have been taken over by secondary forest vegetation and herbaceous species such as balisier *Heliconia caribaea*, and capi *Ipomea tiliacea*, in addition to non-native invasive species, i.e., wild ginger *Hedychium coronarium,* elephant grass *Pennisetum purpureum,* and lemon grass *Cymbopogon citratus*. Some areas have been maintained as open pasture where livestock is grazed.

An analysis of the field data across all quadrats, revealed the tree species occurring with the greatest frequency in the canopy stratum, viz., bwa pipiri *Pithellobium jupunba,* poix doux *Inga lauriana*, pois doux mawon *Inga ingoides*, bwa riviere *Chimarrhis cymosa*, palmiste *Euterpe broadwayi*, chatanier *Sloanea spp*. and, la glu *Sapium caribaeum.* The most frequently occurring species in the understorey include, tree ferns *Cyathea arborea* and *Hemitelia*

muricata, bwa riviere Chimarrhis cymosa, palmiste *Euterpe broadwayi,* bwa blan *Simarouba amara*, bwa pipirie *Pithecellobium jupunba*, cré-cré *Miconia/Conostegia spp.,*pwa doux mawons *Inga ingoides*, and pwa doux *Inga lauriana.*

5.10.4 Assessment of Flora in the Area of Influence

The forest type is secondary rain forest with open canopy as a result of selective forest clearance, agricultural activities and hurricanes.

Tree species occurring with the greatest frequency in the canopy stratum, viz., bwa pipiri *Pithellobium jupunba,* poix doux *Inga lauriana*, pois doux mawon *Inga ingoides*, bwa riviere *Chimarrhis cymosa*, Palmiste *Euterpe broadwayi*, Chatanier *Sloanea spp*. and, La Glu *Sapium caribaeum.*

No endemic or threatened species of plants were found in the area. Some plants of economic importance to the community were identified for timber and charcoal production and/or firewood. However, the volume present was insufficient to support a commercial enterprise. A few herbaceous plants found on site were utilized as fodder for livestock or traditional herbal medicine. However, these plants are found in larger volumes in a variety of habitats in the community of Laudat.

Endemic Species of Flora

Species of flora endemic to Dominica were not recorded within the area of influence. However, a very small number of plant species that grow within the area are endemic either to the Lesser Antilles or to the wider Caribbean i.e. Balizé Heliconia caribaea, and Fougere (Tree Fern) Cyathea arborea.

Species of economic importance

No endemic or threatened species of plants were found in the area.

Some plants of economic importance to the community were identified for timber and charcoal production and/or firewood. However, the volume present was insufficient to support a commercial enterprise. A few herbaceous plants found on site were utilized as fodder for livestock and for traditional herbal medicine. Some of the tree species that grow on the site are economically important to the community but are found in similar locations in the community.

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Although the volume of timber present on the site is not able to support a commercial timber enterprise, tree species are utilized for charcoal production and firewood i.e. bwa bande *Richeria grandis*, Mille Branches *Magaritaria nobilis* and carapite *Amanoa caribaea*. Some of the herbaceous plants are utilized as fodder for livestock, i.e., man-better-man *Acyranthes aspera*), and traditional herbal medicine, viz. vervaine, *Stachyarpheta sp*., and mamizoo, *Lantana camara.*

People use wood from the area mainly for charcoal production. However, discussion with one charcoal producer located close to the AOI indicated that he does not rely entirely on wood from that area but obtains wood from other locations to produce charcoal.

5.10.5 Assessment of Fauna

Introduction

All of Dominica's major assemblages of terrestrial wild fauna are represented within the area of influence related to the proposed reinjection pipeline and reinjection well. These groupings include birds (resident and migratory), mammals, reptiles, amphibians, freshwater fish, crustaceans (freshwater and terrestrial), insects, arachnids, and other small invertebrates. Species from these animal groups and sub-groups were observed during the field investigations.

Given time constraints, and rapid nature of the field surveys, a restricted number of wildlife species were encountered. Various wildlife normally associated with the locality were not observed during the field surveys. However, the avifauna appears to be the most abundant animal group within the zone of influence. The absence of some animal species, particularly birds, has been attributed to factors such as, migration period, breeding season, hunting, and scarcity of fruiting tree species for foraging.

Birds

Birds as a faunal group, was the most abundant and diverse group of animals documented during field surveys. A total of thirty (30) bird species were visually and aurally encountered within the study area. The avifauna recorded, comprises primarily of resident species with and a

few migrants. The diversity of birds included parrots, hummingbirds, thrashers, fly catchers, solitaires, thrushes, herons, cuckoos and waterfowl, among other avian species typically associated with forest ecosystems and cultivations. The presence of the vulnerable, Red-necked parrot was confirmed, with recorded sightings of more than ten (10) parrots feeding on rainforest tree species, in an area earmarked for the construction of the Geothermal Power Plant. Several bird species normally associated with the area were not encountered during the field surveys. However, their existence was confirmed through anecdotal information gathered from residents of Laudat. The absence of some bird species can be attributed mainly to the scarcity of fruiting rainforest trees required for foraging. It should be noted that the reported presence of three (3) globally threatened species within the project's area of influence must be of concern. The species of concern are the Red-necked Parrot *Amazona arausiaca,* the Imperial Parrot *Amazona imperialis*, and the Black-capped Petrel or Diablotin, *Pterodoma hasitata.* All three (3) species are listed on the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species.

During the field surveys, Red-necked Parrots *Amazona arausiaca, (vulnerable)* were observed foraging within the area of influence. The Imperial Parrot *Amazona imperialis,(critical)* though not observed, is reported to utilize the forest and airspace within the locality as a migration corridor between its rainforest habitat around Morne Watt (Morne Trois Pitons National Park), and habitats in the Central and Northern Forest Reserve.

The nocturnal surveys within the area of influence could not confirm the presence of the Black-capped Petrel (endangered). However, nocturnal radar surveys conducted in 2015 by the research organization EPIC – Environmental Protection in the Caribbean, in collaboration with the Forestry, Wildlife and Parks Division, confirmed the presence of the Black-capped Petrel in the airspace over Laudat. Consequently, the use of high intensity lights during the construction and operation of the Geothermal Plant could adversely affect the nocturnal Black-capped Petrel, on its flyways to and from nesting grounds near the summit of Morne Micotrin and other mountain summits within the region.

Mammals

The opossum *Didelphys marsupialis* and one (1) insect-eating bat *Eptesicus fuscus* were the only two (2) mammalian species encountered during the field survey. The elusive Agouti *Dasyprocta antillensis* was not sighted, however, its presence was confirmed through field

markings such as animal droppings and animal tracks. Eleven of Dominica's native bat species (insectivorous, nectar-sucking and fruit-eating) associated with the rainforest ecosystem and cultivations are known to frequent. Rats were not observed but anecdotal information confirmed their presence.

Reptiles

The introduced, invasive Puerto Rican Crested Anole *Anolis cristatellus, the Ground Lizard (Abolo) Ameiva fuscata,* and the Dominica Skink (Zanndoli kléwan) *Mabouya dominicana* were the only reptile species recorded. Though not observed, reptilian species such as the Tree Lizard (Zanndoli) Anolis occulatus, the *Tree Gecko (Mabouya Hazyé) Thecadactylus rapicauda,* Lesser Antillean Iguana (*Iguana delicatissima),* Dominican Boa (Tèt-chyen) Dominica, *Boa nebulosa*, Black-and-White Checkered Snake (Kouwès Jenga) *Liophis juliae*, and the Worm Snake (Koulèv) Antillo*typhlops dominicana, are known to* frequent the zone of influence.

Amphibians

The Tink Frog, locally known as Gounouj (*Eleutherodactylus martinicensis)* was the only frog species identified and recorded. More than forty (40) individuals were recorded.

Insects and other small invertebrates

Several insect species were encountered and recorded, namely, stick insects, locusts, grasshoppers, beetles, weevils, katydids, butterflies, moths, and damselflies. During the nocturnal survey, the sounds of grasshoppers, katydids and crickets were widespread.

Endemic species of fauna associated with study area

A number of endemic, rare and threatened species were identified within the area of influence. With respect to the avifauna, the Red-necked Parrot, *Amazona arausiaca,* and the Imperial Parrot, *Amazona imperialis*. They are designated 'specially protected birds' under the wildlife laws of Dominica and other species endemic to the lesser Antilles or the Caribbean including Dominica are: The Black-capped Petrel *Pterodoma hasitata,* a nocturnal seabird reported nesting on the summit of Morne Micotrin. The blue-headed hummingbird (*Cyanophaia bicolor),* endemic to the islands of Dominica and Martinique, and the Plumbeous Warbler (*Dendroica plumbea),* endemic to Dominica and Guadeloupe, are also found in this area. (*Cyanophaia bicolor),* endemic to the islands of Dominica and Martinique and the Plumbeous Warbler

(*Dendroica plumbea).* With respect to the black capped petrel, the area is considered a "fly away" for the bird as it makes its way to the coast for feeding.

Other endemics are as follows:

- The tree lizard, *Anolis oculatus* (least concern).
- Ground lizard, *Ameiva fuscata*
- Dominican Boa *Boa, nebulosa.*
- Worm Snake (Koulèv) *Typhlops dominicana.*
- The Dominica ground lizard, (*Ameiva fuscata).*
- Plumbeous Warbler, *Dendroica plumbea (least concern).*
- The blue-headed hummingbird, *Cyanophaia bicolor, (least concern)* endemic to the islands of Dominica and Martinique.

5.10.6 Gaps and Limitations

Inadequate timeframe (3 weeks) within which to undertake ecological survey i.e., field assessment, data gathering, literature review, and report preparation. Field work was conducted only during the rainy season. Field work/ground truthing hampered by torrential rainfall and difficult field conditions resulting from severe damage done to the forest vegetation by Hurricane Maria.

<u>Recommendations</u>

More time should have been allocated for undertaking the ecological study to include the dry season. It is recommended that additional studies be undertaken in the dry season to augment the study.

5.10.7 Overview of the Ecology of the MTNPWHS

Natural Features to be Protected are as Follows:

- The Park contains the largest and most diverse and pristine forest in the Eastern Caribbean.

- It has been listed by Birdlife International as “Important Bird Areas, IBA” because it supports 3 globally threatened species - two endemic species of the Amazona parrots and the Forest thrush, Cichlherminia herminieri thus reinforcing the critical biodiversity of the area. 19 Lesser Antilles, EBA, Endemic Bird Area- restricted ranges birds.

Protection of other endemic plant and animal species.

- The Park lies within a Conservation International-designated Conservation Hotspot, a WWF/IUCN Centre of Plant Diversity and a Birdlife-designated Endemic Bird Area.
- Protection of watersheds - Contains the headwaters of most of the major streams and rivers in the southern half of the island and provides potable water to approximately 60% of Dominica’s population.
- Elfin Woodland occurs at the highest elevation, above 3000feet (914m). As such these areas are always targeted by telecommunication companies for establishment of communication towers and potential radar or electronic sites. There is at present one such site on Morne Micotrin where this type of vegetation is found. Such access has been responsible for the loss of significant elfin woodland in some countries and Dominica must guard against this.
- Fumarolic vegetation-One of the rarest formations on Dominica covering a total of 31 ha (Shanks & Putney 1979). Significant areas are found in the Valley of Desolation. It may be impaired by geological investigations. The occurrence of and potential impact to rare or endemic species of fumaroles associated vegetation should be considered when evaluating geothermal drilling.

A UNESCO-designated World Heritage Site under Criteria viii- “to be outstanding examples representing major stages of the earth’s history, including the record of life, significant on-going geological processes in the development of landforms or significant geomorphic or physiographic features” and Under criteria x. “To contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation”.

5.11 Water Quality and Freshwater Ecology

5.11.1 Water Quality

The purpose of the water quality assessment is to determine the water quality flowing through the proposed reinjection site, rivers within the community of Laudat and water which could potentially be affected by spills and leaks from the disposal of the geothermal waste water. The samples results were expected to establish a benchmark for future analysis and to serve as monitoring points for the reinjection well to establish whether geothermal fluid is leaching from the re-injection pipelines.

Methodology for Assessing Water Quality

Relevant environmental and health data was collated and reviewed prior to field assessment. The purpose of the water quality assessment was to determine the water quality flowing through the proposed disposal site, rivers within the community of Laudat and water which could potentially be affected by spills and leaks from the disposal of the geothermal waste water.

Field reconnaissance surveys and review of earlier studies

The field reconnaissance surveys / walk through surveys have been carried out using structured formats for data collection. The survey was carried out along the site of the proposed pipeline and the re-injection well site. The walkthrough allowed for the identification of potential points of contamination including settlements and settlement density, housing, streams, and other water bodies. It was felt that a detailed walk-through survey was sufficient to identify and update (if any) the environmental elements which could potentially be impacted by the project. Additionally, a review was conducted of ESIAs conducted by JACOBS, on behalf of the Dominica Geothermal Company Limited, to review methodology and findings from previous studies.

The sample points were chosen based on the potential risk of contamination from geothermal fluids being re-injected into the ground within the area of influence. Water samples were collected from four rivers located within the area of influence: one to the south and the other to the north of the proposed re-injection point and two points in the community of Trafalgar 500 meters below the proposed reinjection site with samples collected upstream and downstream of

the re-injection point. Additionally, surface water parameters were assessed along streams in the community.

The objective was to conduct laboratory analysis of the water for baseline quality analysis for contaminants which are known to exist in geothermal fluids including arsenic, fluoride, mercury, lead, salinity and other parameters such as temperature, conductivity, and elements such as phosphorus, sulfates and nitrates along stream and rivers within the project area.

Three (3) sampling trips were undertaken to establish baseline conditions, and it was established that the information and data collected were sufficient for the preparation of the ESIA. The samples results are expected to establish a benchmark for future analysis and to serve as monitoring points for the reinjection well to monitor whether geothermal fluids are leaching into the nearby waterways.

The points identified for monitoring included:

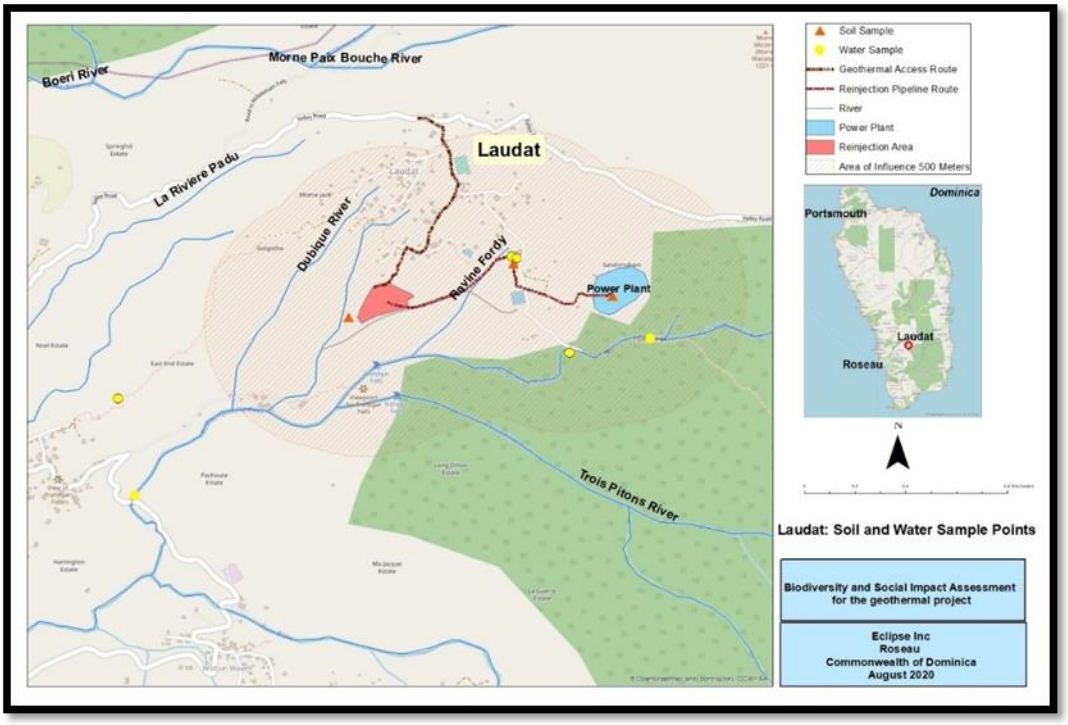
- Titou Gorge on Trafalgar River: the point is upstream from the point of reinjection and should be unaffected by the reinjection process.
- Wotten Waven Trafalgar Bridge: this site is downstream of the reinjection point
- Providence River: point is upstream of the reinjection point.
- Boeri River, Canefield: point located downstream of the reinjection site.
- Papillote River: point springs from the site of the reinjection site.
- Water bar Trafalgar: the point also springs from the reinjection site.

Table 5: *Water samples were taken at the following points*

Date	Coordinates		Location	Elevation
7/8/20	N 15°21.260	W 061°15.656	Titou Gorge	1536 ft.
	N 15°19.864	W 061°20.140	Providence River	1648 ft.
	N 15°19.430	W 061°20.617	Wotton Waven	755ft
	N 15°19.540	W 061°22.806	Boeri River Canefield	318ft
13/8/20	N 15˚32.617	W 061˚34.082	Water Bar Trafalgar	435ft
	N 15˚32.747	W 061˚33.894	Papillote River	450ft

Locations taken with Garmin eTrex 10

Figure 40: *Water Sample Points*



Methodology-Water Quality Laboratory assessment

Six samples were analyzed by the Dominica Bureau of Standards Nature Island Center for Testing Excellence for two parameters: Salinity and Cadmium. The lab did not have the capacity at the time to evaluate the other parameters for effective evaluation of the water quality.

Results

Titou Gorge and Wotten Waven

The Titou Gorge and Wotten Waven sample sites are located on the Trafalgar River and flows into the Roseau or Queens River. The analysis of samples conducted by the Dominica Bureau of Standards and previous analysis conducted by *Caraïbes Environnement Développement & Cull*, 2015a, indicates good water quality as a result of the apparent lack of human activity along the river banks and upstream of the sample sites. The locations can be of medium sensitivity (JACOBS, 2018) to the impacts of the pipeline and reinjection.

Papillote River

This source of water for this river emanates from aquifers identified at the proposed alternative location of the reinjection site about 500 meters below in the community of Trafalgar. The river could be considered of major sensitivity to the potential impacts based on sensitivity assessment methodology with the receptor having little capacity to absorb the changes and having little opportunities for mitigation.

Table 6: *Water Quality Results*

Parameter (ppm)	Titou Gouge	Wotten Waven	Providence River	Boeri River	Water bar	Papillote
Salinity	85.5	100	86.3	63.1	115	212
Cadmium	0.009	0.009	0.011	0.010	0.009	0.010

Table 7: *Reference Guidelines*

Parameter	Matrix	Guideline Value	Reference
Cadmium	Protection of Aquatic Life	0.288 µg/L	Ambient Water Quality Guidelines for Cadmium Canadian Water Quality Guidelines (CWQG)
	Soil	3 mg/Kg	E Directive 86/278EEC CCME

CWQG: Canadian Water Quality Guidelines for protection of aquatic life (2014) EC: European Commission

Dominica Bureau of Standards (2020)

(**Analysis was supervised by Lisa Sandy Microbiology Laboratory Supervisor)**

The above results indicate that Salinity and Cadmium presence in the water samples are higher than the guidelines for drinking water quality based on international standards including the Canadian Water Quality Guidelines, and WHO guidelines for Drinking Water Quality.
Guideline values identified for protection of aquatic life by the Canadian Water Quality Guidelines for Cadmium is 0.288 µg/L which indicates that Cadmium levels are within the standard for protection of aquatic organisms.

(https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/cadmium/cadmium.pdf)

The request for additional analysis for other parameters of concern including analysis for the following pollutants, could not be done by the laboratory due to testing equipment malfunctions. It would have been necessary to establish a baseline for these pollutants since geothermal wastewater may contain these pollutants.

- Arsenic
- Mercury
- Lead
- Fluoride
- Boron

Additional water quality parameters will be necessary at sample points identified to monitor water quality during the project cycle. The parameters to be analysed include

- Biological Oxygen Demand; (BOD)
- Copper
- Total Chromium
- Manganese
- Mercury
- Nickel

Other pollutants of concern include cyanide, toxic organic chemicals, oily materials, and volatile materials as well as from thermal characteristics of the discharge (e.g., elevated temperature). The analysis is necessary to monitor leaks in the pipeline and spills which may leach into the nearby water bodies.

Field tests were also conducted at the above sample points to ascertain physical and chemical properties of the water flowing in the rivers.

Table 8: *Field Water Tests Conducted at Above Locations*

Site	pH	Temperature	Conductivity
Titou Gorge	8.4	25.4°c	195
Providence River	8	25°c	173
Wotten Waven	8.1	25.5°c	168
Boeri River	7.9	26.1°c	190
Water Bar	7.4	25°C	No reading
Papillote River	7.6	25.2°C	160

Date	Field Analyst	Equipment Used
10/8/2020	Sylvester St Ville	HACH DR 900 Multi-Parameter Meter Field Water Tester

Table 9: *Reference Guide*

Parameter	Maximum Value for Protection of Aquatic Life	Reference guideline
Temperature	32°C <1°C daily fluctuation	EPA Quality Criteria for water (1986) 440 5-86-001
pH	8 – 9	EPA Quality Criteria for water (1986) 440 5-86-001

Previous water quality studies were done along the rivers located in the immediate area of the proposed geothermal plant and reinjection site. Baseline surveys conducted for ESIA Volume 2 lists water quality parameters and guideline values for three points on the Roseau (Queens) River at points upstream and downstream of the proposed site. The Queens River flows through the city of Roseau. It is supplied by rivers flowing through Laudat and Trafalgar and could be impacted by the proposed geothermal wastewater reinjection.

(Water Quality analyzed for the ESIA Volume 2 is hereby referred with permission from the Dominica Geothermal Company).

***Table 10**: Water Quality Guidelines*

	Roseau River Upstream		Roseau River Downstream		Blanc River Downstream				French Water Quality Standards*					USEPA**		ANZECC***
Parameter	Dec-13	Mar-14	Dec-13	Mar-14	Dec-13	Mar-14	Unit	Limit of detection	Very good quality	Good quality	Fair quality	Poor quality	Very poor quality	Freshwater CMC acute	Freshwater CCC Chronic	
Ammonium (NH4)	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	0.5	1.5	4	8				0.006
Nitrites (NO2)	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	2							
Nitrates (NO3)	<0.3	<0.3	0.55	<0.3	<0.3	<0.3	mg/L	0.3	0.03	0.3	0.5	1				0.7
Orthophosphates (PO4)	0.06	<0.02	0.04	<0.02	0.04	<0.02	mg/L	0.02	0.1	0.5	1	2				
Total Phosphorous (P)	~	0.04	~	0.04	~	0.04	mg/L	0.01	0.05	0.2	0.5	1				0.01
BOD5	28	<3	15	<3	10	<3	mg/L	3	3	6	10	25				
Kjeldhal Nitrogen (N)	0.7	0.6	<0.5	<0.5	<0.5	<0.5	mg/L	0.5	1	2	6	12				
Total Nitrogen	~	0.58	~	0.47	~	0.38	mg/L									0.15
COD	<30	<30	<30	<30	<30	<30	mg/L	30	20	30	40	80				
Suspended solids	<2	<2	8	2	13	4	mg/L	2								
Mineral micro pollutants																
Arsenic (As)	1.7	2.1	5.3	8.1	0.5	0.4	µg/L	0.2						0.34	0.15	0.013
Cadmium (Cd)	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	µg/L	0.025						0.0018	0.00072	0.0002
Total Chromium (Cr)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	µg/L	0.2						0.016	0.011	0.001
Copper (Cu)	0.4	0.6	0.9	0.5	0.7	0.3	µg/L	0.2								0.0014
Manganese (Mn)	93	45	34	17	125	100	µg/L	5								
Mercury (Hg)	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	µg/L	0.015						0.0014	0.00077	
Nickel (Ni)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	µg/L	0.2						0.47	0.052	

(JACOBS, 2018) ESIA Volume 2; Dominica Geothermal Company

The results of water quality analysis conducted on the rivers are within the World Health Organization guidelines and standards for drinking water of 2018.

Analysis

Results from physical and chemical analysis conducted by the Dominica Bureau of Standards and field analysis conducted for the purpose of this study indicate that the river characteristics at the point of sampling are good based on the World Health Organization standards for water quality. Results for salinity and cadmium are within the standards for the WHO, the European standards and Canadian Water Quality Guidelines for Protection of Aquatic Life (2014).

Traces of cadmium were identified at levels much less than the guideline standard of 3 x 10^{-3} µg/l. for water quality. This is indicative of all the water sample points on the Trafalgar River, the Providence and Boeri River, the Papillote River and the point at the Water Bar in Trafalgar.

While the local laboratory was unable to undertake analysis for metal and other pollutants requested, analysis of water quality published in the ESIA report of JACOBS (2018) listed water quality analysis conducted in 2014 and 2015 at three sites on the Roseau River by *Caraïbes Environnement Développement & Coll* (2015a/b). The dissolved oxygen levels were generally good while the analysis found traces of copper (Cu), arsenic (As) and manganese (Mn) in water samples. Arsenic was elevated above USEPA Guidelines (acute and chronic) and ANZECC Guidelines and copper was elevated above ANZECC Guidelines. These elements are naturally present in volcanic formations and as a result elevated concentration above ANZECC Guidelines are not unexpected. High concentrations of manganese are probably due to natural origins. (JACOBS 2018).

Gaps and Limitations

The preparation and development of this assessment were limited by several factors including the country's limited capacity to monitor water quality. The water quality parameters identified as constituents of geothermal wastewater are necessary to establish a baseline for future monitoring could not be done due to testing equipment failures at the country's only laboratory. The research was also constrained by limited national capacity to conduct in-depth water quality analysis to better inform the findings and to develop appropriate mitigation and monitoring measures for the monitoring of the reinjection of the geothermal fluids. Consequently, there was no analysis conducted to assess the levels of pollutants of interest in the selected rivers and streams within the area of influence.

Recommendations

Three sampling trips were undertaken to establish baseline conditions, and it was established that the information and data collected was sufficient for preparation of the ESIA given the short time frame for undertaking the ESIA. However, it is recommended that further sampling be undertaken prior to construction of the project to establish the magnitude of any natural variability in the system. This will provide a robust basis for comparison with ongoing monitoring during the construction and operations stages.

Additional water quality parameters will be necessary at sample points identified to monitor water quality during the project cycle. The parameters to be analysed include

1. Biological Oxygen Demand, (BOD).
2. Copper
3. Total chromium
4. Manganese
5. Mercury
6. Nickel

Other pollutants of concern include cyanide, toxic organic chemicals, oily materials, and volatile materials as well as from thermal characteristics of the discharge (e.g., elevated temperature). The analysis is necessary to monitor leaks in the pipeline and spills which may leach into the nearby water bodies.

5.11.2 Freshwater Fauna

Methodology for Undertaking Aquatic Surveys

Standard surveys involved the use of nets. Data recorded include the number of fish and other aquatic fauna. The length of the individuals captured was not measured. The habitat characteristics (river habitat type, substrate, water depth and flow) of the location of the netting sites were recorded. Fish was released into the river immediately.

Each survey location was photographed and mapped, with GPS coordinates of the location recorded and included in the project's geographic information database.

Local fishers and villagers were interviewed to identify aquatic species, patterns and extent of local use. The data collection for fish was undertaken in conjunction with the water quality survey. Three sites were selected in each river for fish surveys.

***Table 11**: GPS Coordinates for Survey Points*

Selected waterways	GPS Coordinates
Liviere Miwal/Roseau or Queens River	15^{o} 19 726' N 61^{o} 19.631'W Elevation: 537m
Wavine Bouk (1)	15^{o} 19. 961' N 61^{o} 19.722'W Elevation: 573m
Wavine Bouk (2)	15^{o} 19 928' N 61^{o} 19.744'W Elevation: 565m
Providence River	15^{o} 20 189' N 61^{o} 20 120'W Elevation: 509m
River Estate Boeri River	15^{o} 19 444' N 61^{o} 22.936'W Elevation: 52m
Dubik River	15^{o} 19 378' N 61^{o} 20.255'W Elevation: 262m
Trafalgar/ Wotten Waven Crossing	15^{o} 19 266' N 61^{o} 20 333'W Elevation: 227m

Sampling was conducted at selected points on permanent watercourses i.e. Wavine Bouk and Liviere Miwal in the zone of influence. The other survey sites were Morne Paix Bouche River at Providence, Dubuque River or Siwo River near Papillotte Guest House, Roseau River at Trafalgar, and River Estate on Boeri River. GPS coordinates were recorded for each survey point. Surveys comprised direct observations, searching the vegetation and crevices, flipping/turning-over stones, and use of a net for trapping. Photographs were taken of species directly in the water and trapped species. All trapped specimens were released back into the river at the point of sampling.

Results

Aquatic Fauna

Dominica's permanent and fast flowing watercourses provides habitat for eleven (11) freshwater shrimp species, (i.e. the *Atya* species and *Macrobrachium* species); one (1) freshwater crab *(Guinotia dentata),* and approximately forty-five (45) in-land freshwater fish species which include Mountain Mullet (*Agonostomus monticola)*, Burro Grunt (*Pomadasyus crocro*), Spotted algae-eating Goby (*Sicydium punctatum*), River Goby (*Awaous banana),* American Eel (*Anguilla anguilla)*, Stippled Clingfish (*Gobiesox punctulatus*), freshwater mollusc (*Clypoleum punctulata*) locally known as 'Vio". All of these species are sought for food. However, the assessments only concluded the presence of a few species which include: the shrimp or Kakador (*Atya innocuous),* freshwater crab *(Guinotia dentata),* Mountain Mullet (*Agonostomus monticola)*, and Goby (*Awaous banana)*, observed and recorded at some of the survey points. (See tables below for results of freshwater species recorded at each site).

Furthermore, the assessments also concluded that the permanent watercourses surveyed within the Area of Influence serves as habitat for introduced non-native species, namely, Tilapia *(Tilapia spp.)* and Guppy *(Poecilia reticulata)*.

5.12 Ground Water

There is currently no known or accessible research on groundwater resources in Dominica. An excerpt from Jacobs NZ ESIA indicates the following:

"In general, however, groundwater flow and composition in the area will be influenced by the climate, topography, geomorphology and geology of the island. Regionally, it would be expected that groundwater would flow from the inner parts of the island, where groundwater levels would be the highest, towards the low lying coast, discharging to the sea, while locally groundwater would be expected to flow towards the valleys following the topography of the surface water catchments. Groundwater would be discharged locally through springs or as base flow to the streams/rivers. The groundwater could be located either within perched aquifers within the pyroclastic deposits (as a result of areas of low permeability materials within the deposits) or through secondary permeability features such as fractured or well jointed lava flows. Reference to hot springs (geothermally influenced) springs has been made within the Du Mas Estate debris flow deposits.

High annual rainfall on will provide regular groundwater recharge and sustained base flow in the lower reaches of the rivers. However, knowledge of the groundwater-surface water interactions in the mountains is limited, and the proportion of rainfall which recharges aquifers that discharge into streams is unknown".
However, there is evidence of ground water reservoirs in Dominica, within the Community of Laudat and evidence of this resource within the AOI.

The project area falls within the Roseau River watershed, one of the largest watersheds in Dominica. It also serves as a watershed for several ground water sources which spring out in the community of Trafalgar located about 500 meters downstream.

Soil percolation tests conducted at 4 feet below the surface revealed characteristics of ground water including soil type and water flow at that depth. The soil in this specific area is very deep and moderately well drained. Soil type characteristic is grayish brown, loamy-sand surface underlain by dark yellowish brown to very pale brown loamy subsoils. A sandy base resides at a depth of 3ft 6 inches indicative of a shallow aquifer flowing beneath the surface. Water permeates through the soil at a rate of 0.3 minutes per inch indicative of a sandy underlying layer and the lack of resistance in the soil.

When it rains, lateral drainage through the soil in this area tends to be rapid indicating the existence of a water table where there is an -occasional perched pan.

This source of water for **The Papillote River in Trafalgar** emanates from aquifers identified at the proposed alternative location of the reinjection site about 500 meters below in the community of Trafalgar. The freshwater springs along the access road to the Trafalgar Falls are evidence of subterranean aquifers emanating from the area.

In addition to this, the steep cliffs in the vicinity of the Trafalgar Falls, and above the Trafalgar Falls Tourism Facility and Papillote Wilderness Retreat, may be prone to rockslides, as evidenced by a major rock fall which occurred in the vicinity of the taller waterfall in the mid-nineties (circa 1995). In addition, in the early 1990, when DOMLEC was constructing a vertical pipeline from Laudat to the Trafalgar Power Station, they recognized the unstable nature of the cliff and reinforced it by drilling and inserting metal rods into the rock face to help stabilize it.
It should be noted that the Trafalgar cliff is located approx. 300 meters from the proposed site of the reinjection well. As such it is recommended that a hydrogeological survey of the area is undertaken to evaluate the possibility of ground water flow within the area so as to augment the baseline information and to provide the necessary data for future planning.

5.13 Air Quality

5.13.1 Introduction

The complete absence of polluting industry and vehicle traffic in the project area augurs well for excellent air quality outside windy periods and when cultivated fields are burnt which produce smoke. Small amounts of hydrogen sulphide create an odor nuisance as there are numerous geothermal vents in the area.

Geothermal electricity production does not burn fuel and generally emit very little air pollutants. Of concern however is the production of hydrogen sulphide, carbon dioxide and mercury.

Hydrogen sulphide, (H_2S) has a distinct rotten egg odour at very low quantities.

Carbon Dioxide (CO_2). A colorless, odorless gas, CO_2 is released into the atmosphere primarily as a byproduct of burning various fuels. Geothermal steam is generally condensed after passing through the turbine, but CO_2 does not condense, and instead passes through the turbine to the exhaust system where it is released into the atmosphere through cooling towers.

Mercury - Mercury, if present in a geothermal resource that is used for power production, could result in mercury emissions, depending upon the technology used.

Assessment

Air Quality was not measured since there is limited capacity in the country to monitor ambient air quality. JACOBs (2018) used predictive modeling techniques to predict ground level concentrations for hydrogen sulphide (H_2S) as a result of steam concentrations from the proposed power plant with areas closest to the power plant towers having the highest concentrations of H_2S for a 1 hour time weighted average, (JACOBs 2018).

Similarly, predictions were made for Mercury concentrations with modeling predicting concentrations of Mercury during power plant operations at 0.53µg/m^3, (JACOBS 2018)
Dominica does not have standards for H_2S or Mercury, however, the levels predicted during plant operation are below the WHO levels for (LOAEL) Lowest Observed Adverse Effect Level which is 1500µg/m^3 for H_2S and 1µg/M^3 for Mercury, (WHO, 2000).

5.14 Noise

5.14.1 Methodology - Ambient Noise Measurement

Noise assessments were also conducted at eight locations within the project area to obtain a baseline for noise levels.

Ambient noise measurements were taken during the daytime on August 10, 2020 between 3:01 pm and 4: pm. Noise levels were taken at eight points in the community including the site of the proposed power plant and the reinjection site. The survey samples were taken at intervals and points where noise is expected to be generated during the project cycle.

Table 12: *Noise Assessment Location Points*

Date	GPS Location	Time	Noise levels
10/8/20	N 15 33098 W 61 32580 elevation 538.7 M	Cal time 2:52pm	Max 60.3db
10/8/20	N 15 33156 W 61 32891 elevation 509m	3:01pm	Min 45.5dbA Max 60.1dbA
	N 15 3319 W 61 3292 elevation ; 498.05	3:09pm	Min 47.1dbA Max 51.3dbA
	N 15 3344 W 61 33124 Elevation 551	3:18pm	Min low Max 55.6dbA
	N 15 3325 W 61 3331 elevation 506	3:22pm	Min low Max Low
	N 153312 W 61 3356	3:33pm	Min low Max 51.9dbA
	N 15 3338 W 61 3345 Elevation 508	3:45pm	Min Low Max 55.4 dbA
	N 15 3355 W 61 3323 Elevation 551	3:50pm	Min 10 Max 56.4A
	Post calibration	3:53pm	

A Type 2 sound level meter was calibrated before and after sampling at 94 dBA. Ambient noise measurements were measured with the sound level meter switched to its FAST (F) time weighting, A- weighting which is approximate to frequency response of our hearing system.
During the day the sky was clear with a calm wind. Background noise such as traffic, community noise from the public was taken into consideration.

SOUND LEVEL METER		CALIBRATOR	
Mfg: ***Extech***		Mfg: ***Extech***	
Model: ***407730***	Serial #:***9901415***	Model: ***407744***	Serial #:
	Name: *Digital Sound Level Meter*		Name: *Sound Level Calibrator*
Field Calibration: Pre Cal Date: August 10 at 2:52 pm Post Cal Date: August 10 4:00pm Field calibration OK: Yes :X No: Field equipment Calibrated By: ***Sylvester St Ville***			
Measurements Obtained: outdoors			

5.14.1 Analysis

The World Bank Group (WBG) recommends noise limits for residential locations in accordance with its Environmental, Health and Safety (EHS) Guidelines. These guidelines have been adopted from Guidelines for Community Noise, World Health Organization, 1999 and are values for noise levels measured outside a dwelling. The noise level guidelines from the WBG have been reproduced in the following table.

***Table 13**: Noise Level Guidelines*

Noise Level Guidelines[54]		
	One Hour L_{Aeq} (dBA)	
Receptor	Daytime 07:00 - 22:00	Nighttime 22:00 - 07:00
Residential; institutional; educational[55]	55	45
Industrial; commercial	70	70

(Source: Environmental Health and Safety Guidelines International Finance Corporation (IFC))

The noise levels obtained is indicative of community noise generated from light traffic to rustling of trees. The results of the noise levels obtained reveal very low noise to absolute quiet. Excessive noise levels have been known to lead to adverse health conditions including loss of sleep, annoyance and lead to cardiovascular and psychophysiological effects, reduce performance and provoke annoyance responses and changes in social behavior (WHO, 2018).

Figure 41: *Noise Levels Obtained*

Date	GPS Location	Time	Noise levels
10/8/20	N 15 33098 W 61 32580 elevation 538.7 M	Cal time 2:52pm	Max 60.3dbA
10/8/20	N 15 33156 W 61 32891 elevation 509m	3:01pm	Min 45.5dbA Max 60.1dbA
10/8/20	N 15 3319 W 61 3292 elevation ; 498.05	3:09pm	Min 47.1dbA Max 51.3dbA
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10/8/20	N 15 3338 W 61 3345 Elevation 508	3:45pm	Min Low Max 55.4 dbA
10/8/20	N 15 3355 W 61 3323 Elevation 551	3:50pm	Min 10 Max 56.4 dbA
10/8/20	Post calibration	3:53pm	

6.0 SOCIO-ECONOMIC BASELINE SURVEY/EVALUATION

6.1 Introduction

This section provides a description of the existing social framework of the community of Laudat to include demographics, lifestyle, social infrastructure, services, and livelihood activities. This will serve as a yardstick for assessing any social impacts of the proposed re-injection well pad, pipeline and associated infrastructure on the community and for recommending strategies geared at mitigating negative impacts or maximizing positive socio-economic impacts. A socio-economic survey was undertaken to obtain the required data.

6.2 Population Demographics

Based on the 2011 census the village of Laudat has a population of about 321 individuals comprising 174 male and 147 females living in 128 households (Government of Dominica, 2011). It is part of the Roseau Valley which includes the other communities of Morne Prosper, Wotton Waven/Casseau, Copthall, Fond Cani and Trafalgar/Shawford. Laudat is considered the portal to some of the most popular tourism locations in Dominica like the Boiling Lake, the Freshwater Lake, the Titou Gorge, Boeri Lake and Section 4 of the Waitukubuli National Trail and is one of the closest communities to the Morne Trois Pitons National Park World Heritage Site. It is also a tightly knit community with strong family ties. 96% of households polled in the baseline study were originally from the community.

Population Size and structure

In 2001, the population of the Laudat was 324. The census data of 2011 indicated a 6 % decrease to 321. Results of the recent socio - economic baseline survey indicated that 52.6%, of the individuals were males and 47.4%, were females indicating no change from the 2011 census.

Household size

The average number of persons per household is three (3). The households polled constituted the following age groups:

Table 14: *Age Groups of Households Surveyed*

Age Range	Percentages
0-10	10.5%
11-14	1.5%
15-20	11.3%
21-30	12.0%
31-40	14.3%
41-50	14.3%
51-60	15.8%
61-70	14.3%
70 and over	6.0%

Age of population

12 % of the population is under 15. 37% is between 15 to 40 and 35% 50 years and over.

Ethnicity, culture and religion

The population is predominantly of African descent with 96.2%. 4%, were of White/Caucasian decent. 98.5% indicated English as their mother tongue. The community was named after a French citizen named Laudat who settled in the community (ref. Roseau Valley Guide, Papillote Press, London). The culture of Laudat is reflective of the Dominica culture that was influenced by the Kalinago, French, British and Africans (brought over by the French as slaves), creating a Creole society evident in language, food, art and music. The majority of the community is Roman Catholic with other denominations like Seventh Day Adventist, Methodists and Pentecostals.

Gender Relations

The GoCD implemented a National Policy and Action Plan for Gender Equity and Equality in 2006. The policy seeks to provide a framework towards promoting and advancing the social, economic and political rights of women and men and ensure gender equity and equality. A report undertaken in 2013 indicated that from 1993 to 2003, at a national level, females have outperformed their male counterparts in education and health. With respect to longevity, the report indicated that women outlive men as is evidenced by the number of female centenarians 20 to male centenarians 10.

52.6%, of the population in Laudat is male and 47.4%, is female. In terms of employment in the major sectors, Men dominated the agricultural, tourism and construction sectors, while women dominated the public sector and vending.

In terms of location of employment in the community, 52.4%, of the employed individuals (both men and women) are employed within the community while 33.3%, are employed in the city. A question was posed to the female in the household survey to find out what types of employment they were engaged in at the community level. This question generated fifty-five (55) responses, with eleven (11) respondents not offering a response. The responses were grouped as follows:

- 56 % are housewives
- 17 % are employed
- 6% of the women polled were students
- 2% care for the elderly
- 2 % did gardening
- 2 % Teach English online to Chinese students
- 17 % did not respond

Education

7.5 % of the population had tertiary level training while 21% had intermediary training. Overall, the literacy level of the population is quite high. The table below indicates levels of education.

Table 15: *Education Levels of Survey Participants*

Level of Education	Percentages
Primary	25.0%
Secondary	36.8%
Community Collage	21.1%
University	7.5%
Other	6.0%
Not Stated	3.0%

6.3 Land/home Ownership

90% of the dwellings were owner occupied, 4% were rented and 6%, stated “other”. Most houses in Laudat appear to be in good physical condition and are built to withstand major hurricanes. However, there are several vacant and/or closed dwelling units that appear to have been abandoned following the passage of hurricane Maria. The 2011 Population and Housing Census indicated that out of 148 dwelling units, in Laudat, 20 were vacant and 11 were closed. This may then be a prevailing trend for the community. The baseline survey indicates that 90% of households polled were originally from Laudat.

In terms of property insurance, 26% of households were insured. The majority, 74%, had no insurance.

Vehicle ownership- 54% of families owned vehicles. This means that 46% may be commuting on public transportation.

The closest business facility to the project site, Roxy’s Mountain Lodge, is 215, meters while the closest residential building is 122m.

6.4. Economic Profile -Employment/Livelihood

6.4.1 Employment

Government is the major employer for the community followed by construction as a result of the boom in this industry following Hurricane Maria. The other sectors are agriculture, tourism and vending. 53.8% of the individuals polled were employed, 45.3% unemployed. 0.9% did not respond. 81.0% of those employed were employed full-time, while 17.5% were employed part-time.

The 34.9 % of individuals polled as “Other” were employed in call centers, auto mechanics, baking, carpentry, tutoring, community nursing, consulting, cosmetics, journalism.

31.8% of the respondents polled “Other” worked in the Private Sector, with 1% being Self-employed.

Figure 42: *Occupational Status of Community by Gender*

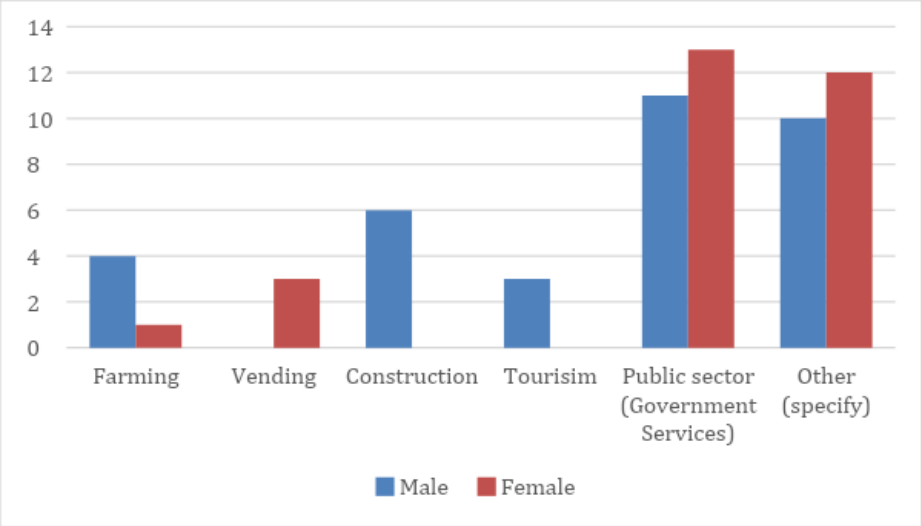


Table 16: *Occupational Status of Community by Gender*

Gender	Farming	Vending	Construction	Tourism	Public sector	Other (specify)	Total
Male	6.3%	0.0%	9.5%	4.8%	17.5%	15.9%	54.0%
Female	1.6%	4.8%	0.0%	0.0%	20.6%	19.0%	46.0%
	7.9%	4.7%	9.5%	4.8%	38.1%	34.9%	100.0%

A larger percentage of women worked in the public sector and vending than men. A larger percentage of men worked in farming, construction and tourism than women.

In terms of location of employment**,** 52.4% of the employed individuals are employed within the community while 33.3% are employed in the Roseau area.

Types of Employment women are engaged in at the community level:
This question generated fifty-five (55) responses, with eleven (11) respondents not offering a response. The responses were grouped as follows:

- 56 % are housewives

- 17 % are employed
- 6% of the women polled were students
- 2% care for the elderly
- 2 % did gardening
- 2 % Teach English online to Chinese students
- 17 % did not respond

Income of employed persons

The income groupings of employed persons are shown below:

Table 17: *Income Groupings of Employed Persons*

Income Range	Percentages
Under $500 per month	3.2%
$501 - $1000	31.7%
$1001 - $1500	15.9%
$1501 - $2000	17.5%
$2001 - $3000	12.7%
Above $3001 per month	9.5%
Not Stated	9.5%

Tourism Sector

Tourism plays an important role in the economic life of the Laudat community. More recently eco-tourism activities have been increased through improved tourism marketing and promotion and have improved livelihood opportunities in areas of home stays, tour guiding, roadside vending and food and beverage services.

This is due to Laudat's proximity to several tourist sites, including:

- Morne Trois Pitons National Park: This is a UNESCO Natural World Heritage Site, within which the lakes, Middleham Falls and Titou Gorge are located.
- Boiling Lake: This site is in the Morne Trois Pitons National Park but the trail to the lake begins at Laudat.
- Freshwater Lake: This Lake is also within the Morne Trois Pitons National Park and is the source of the Titou Gorge and Roseau River.

- Boeri Lake: The trail to this lake begins at the Freshwater Lake and it is within the Morne Trois Pitons National Park.
- Middleham Falls: This site has an entrance near the road to Laudat and it is in the Morne Trois Pitons National Park.
- Titou Gorge: This site is the closest to the community of Laudat. It is also the start of the trail to the Boiling Lake.
- Waitukubuli National Trail: Segment 4 of this trail starts at Wotten Waven and ends at Pond Casse. This Segment offers views of five (5) mountains and showcases the natural hot spas at Wotten Waven. This Segment also traverses the community of Laudat and through the Morne Trois Pitons National Park.

None of these tourism sites are to be directly affected by the project. Titou Gorge is the closest site to the project and users may experience delays in accessing it (and the start of the trail to the Boiling Lake) due to increased traffic and movement of heavy-duty equipment through the existing road.

There are two established small accommodations in the vicinity of Laudat and two within the community. They are:

- Symes–Zees Villa and Secret Hill Villa are located approximately 1 and 1½ miles respectively, from Laudat.
- Rocky Mountain Lodge is located within the community. This establishment has 11 rooms and offers guests a creole cuisine, bar and restaurant, organized island tours and hikes and a massage parlour.
- Nature's Cabin is also located in the hills of Laudat. This facility is a secluded one (1) bedroom cabin offering relaxation and connection to nature to its guests.

Agriculture Sector

Agriculture in the Laudat community is based on subsistence farming. This includes largely the growing of root crops, vegetables, horticulture, and the rearing of animals, especially chickens and small ruminants. There are also permanent crops such as citrus and coffee. It is reported that agriculture is the second highest income earner after tourism and that mainly women are involved in agriculture, especially in vegetable farming and horticulture.

Poverty Alleviation

The 2009 Dominica Poverty Assessment report indicates that, for the Rest of parish of St. George inclusive of Laudat, the number of poor individuals were 892 or 16.3%. This was the third lowest after St. John (10.2%) and the City of Roseau (12.8%). This represented an average of a little above one half percent above the national average of 28.8%.

While emigration may have helped to contain the potential for poverty, T.S. Erika, Hurricane Maria and now the COVID-19 Virus are new avenues for poverty. However, there are some alleviation measures initiated by the Government to cushion the effects of poverty on the residents of Laudat and the rest of Dominica, i.e. the "YES WE CARE", Housing and NEP programs, among others.

The baseline survey indicated that participation in poverty alleviation measures may not be as widespread in Laudat as in other communities. With respect to institutional or social development support to households, 16% of respondents benefitted from this support with 82% of respondents indicating no benefits.

6.5 Social and Physical Infrastructure and Services

Public assets

The following represent the distance of the project site from community infrastructure:

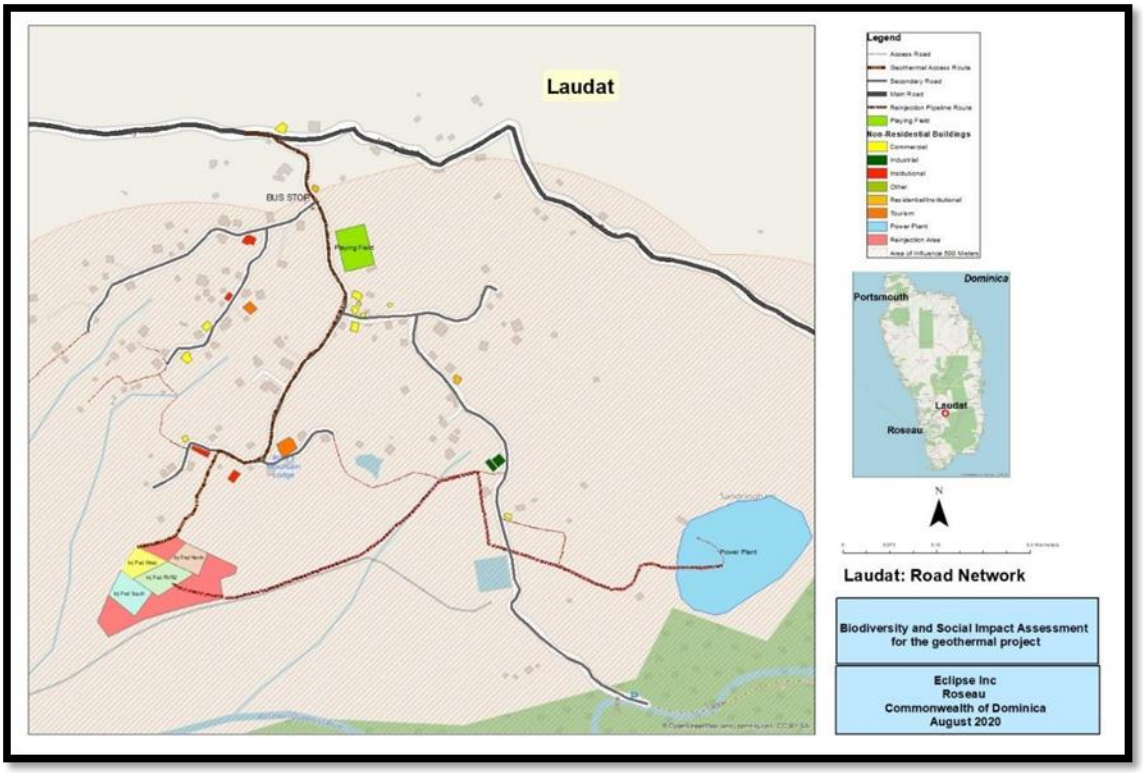
Distances:

- Church (Catholic): 121 meters
- Former school building: 150 meters
- Closest secondary road: 150 meters

Road Network

The road network leading to Laudat is narrow and winding, however, it is well maintained. The village roads are also narrow but are also well maintained, especially the beautiful hedges planted along the edges. There is a main bus stop which provides some shelter from adverse weather conditions and some parking spots to prevent stopping on the main village road. A few roads lead to dead ends, without adequate turning-points.

Figure 43: *Map of Laudat Road Network*



Peak traffic hours are reported due to the morning rush of the work force and their return on afternoons, as well as visitors and trade vehicles during the midday hours. The following were considered peak traffic hours for Laudat.

- 7:00 AM to 7:30 AM
- 1:00 PM to 2:00 PM
- 4:00 PM to 6:00 PM

Education (Schools/Culture/Resource Centers)

There are no schools in the community. Children from Laudat attend primary school in the adjacent community of Trafalgar and in the capital city, Roseau.

Health Centre/Services

The community is served by a Health Center where a visiting nurse administers health services twice monthly on a Monday. Services offered include maternal and child health care, elderly

care to include visits to elderly, hypertension and diabetic services and home visits with those who are unable to access care at the facility.

Other services including doctor's visits and vaccination services are obtained at the Trafalgar Health Centre or the Roseau Health Centre. Emergencies are dealt with at the Casualty Department of the hospital in Roseau.

Banking Services

There are no banking services within the community. The following banking services utilized by the community are located in the capital city, Roseau:

- 27.4% of respondents utilized a Credit Union
- 59.0% used other banks
- 13.6% did not state their banking preference

Other Assets

- 1 Bus Stand
- 1 Playing Field
- Three (3) churches – Roman Catholic, Brethren and Seven Day Adventist Churches

Public Utilities

Electricity: The majority of homes in Laudat are connected to the DOMLEC network. DOMLEC also operates a Hydro Power Plant in Laudat with pipelines running from the Fresh Water Lake to that Power Plant.

Potable Water: Water is provided for the residents of Laudat by the Dominica Water and Sewerage Company Limited (DOWASCO) through a water system with an intake from the Morne Paix Bouche River. A 2,100 imperial gallon tank, at the intake, provides storage which supplies approximately 90% of households at Laudat. There are also several public standpipes.

Solid Waste Collection and Disposal: The Dominica Solid Waste Management Corporation (DSWMC) collects waste once a week, on Thursdays, from the community.

Businesses serving the community

The following businesses are owned by residents

- Bakeries (2)
- Mini-Mart
- Restaurant/Bar/Tavern (2)
- Retail Grocery/Liquor Shop (3)
- Guest Houses (2)
- Poultry Farm (1)

Ecosystem Services

Based on the biodiversity resources of the AOI, there is very little dependence by the community on these resources. With respect to the terrestrial resources, the volume of timber present within the area is not sufficient to support a micro- timber enterprise. Some tree species like bwa bande *Richeria grandis*, Mille Branches *Magaritaria nobilis* and carapite *Amanoa caribaea* are utilized for charcoal production and firewood. However, discussion with one charcoal producer located close to the AOI indicated that he does not rely entirely on wood from that area because of the paucity of the resources, but obtains wood from other locations to supplement what is available to produce a load of charcoal.

Some of the herbaceous plants are utilized as fodder for livestock, i.e., man-better-man *Acyranthes aspera*), and traditional herbal medicine, viz. vervaine, *Stachyarpheta sp*., and mamizoo, *Lantana camara.*

Information from the stakeholders' workshops indicated that in terms of utilization of aquatic resources, some fishing takes place in the rivers and streams for species like crayfish and fish as well as for drinking water and other domestic purposes

6.6 Health- General Health and Illnesses

Generally, data on health conditions are limited. However, the district nurse confirmed hypertension and diabetes as the main cause of morbidity in the community. The responses to the baseline survey showed that 71%, of the individuals polled did not have a medical condition while 27.8%, suffered from a medical condition.

71.4% polled had no medical condition while 27.8% identified other medical conditions. The following were the medical conditions specified:

- Hypertension: 30% of respondents with a medical condition suffered from hypertension.
- Diabetes: 22% of respondents with a medical condition had diabetes.
- Mental Illness: 8% of respondents with a medical condition had some type of mental illness.
- Asthma: 6% of respondents with a medical condition had asthma.
- Cancer: 4% of respondents with a medical condition had cancer.
- Chest Pains: 4% of respondents with a medical condition had chest pains.
- Hernia: 4% of respondents with a medical condition suffered from hernia.
- Joint Pains: 4% of respondents with a medical condition suffered from joint pains.
- Other: 18% of respondents with a medical condition had other types of varying illnesses, as follows:
    - Arthritis
    - Blindness
    - Glaucoma
    - Low Blood Pressure
    - Prostate Cancer
    - Stroke
    - Theoretic Tuber
    - Cholesterol
    - Physically Challenged

6.7 Historical and Cultural Resources

Discussions with community members indicate that there are no historical and cultural resources in the community.

6.8 Social Problems Facing the Community

The response from the survey indicated the following:
68% of respondents said yes and 30% answered “No” to the question on whether there were social problems facing the community.

The responses to the questions, at the stakeholders’ consultation and in the social survey, as to whether there was domestic violence in the community were as follows:

- “nonexistence”
- “none”
- “every home has their issues”
- “crime of passion”

Social problems identified by respondents were grouped into 5 categories as follows:

- Drug Related: 56.8% of respondents
- Land Dispute: 11.4% of respondents
- Unemployment/Poverty: 11.4% of respondents
- Alcoholism: 4.5% of respondents
- Other: 6.8% of respondents

6.9 The Community’s Perception of the Well-pad and Concerns

The survey indicated that 22.0%, of the households interviewed, stated that they were near the reinjection well. 54.0%, felt that they would be directly affected by the Geothermal Project.
Of the one hundred and nineteen (119), individuals (11 and above) polled, 62.2%, indicated that they were in favor of the Geothermal Reinjection Well in the Community.

“Is this family residence close to the location of the proposed reinjection well?”

- 22%, of respondents answered “Yes”
- 74%, of respondents answered “No”

- 4% did not respond

"Has your household been (or will be) directly affected by the geothermal project?"

- 54%, of respondents answered "Yes"
- 44%, of respondents answered "No"

Are you in favor of a geothermal reinjection well in your community?"

- 62.2%, of the individuals polled were in favor
- 33.6%, were not in favor
- 4.2%, did not respond to the question

List any concerns that you may have.

Respondents listed eighty (80) concerns regarding the reinjection well in the community. These concerns were grouped as follows:

- Favorable/Positive: 23.8%, of the concerns were comments which reflected positively on the geothermal reinjection well in the community.
- Not Favorable/Negative: 51.2%, of the concerns reflected negatively on the geothermal reinjection well in the community.
- Not Sure: 11.2% were undecided on any possible outcome.
- None: 13.7% had no concerns.

Table 18: *Residents' Concerns*

Negative Responses	*Positive Responses*	*Undecided*
Will affect Natural Resources	Will provide work and development	Any (4)
Pollution (5)- Noise pollution, building, water community	Can decrease cost of electricity	Can't answer
Fumes can affect individuals	Chances of employment	Have to learn more about it
Destroy all the trees	Creating employment	Need more information on project
The fumes and vibration, not accepted by many	Development	Not as yet (2)

Getting everyone sick	Employment (4)	Not enough information
Get us all sick/ Health problems	Employment purposes	Not sure
Hazardous	Exposure for community	The unknown
Think it makes us prone to volcanoes	Have a positive impact on the community – create employment	Unknown future
Decrease in the value of land -People don't want to buy land in the area	Help create jobs	
It's too close	I don't see how it is harming my community	
Area is prone to earthquakes	If done properly…no ill effect to us	
Lack of information	No effect	
Leaks from pipelines	None (6)	
Loss of property by members of the community and loss of privacy persons are not paid what it's worth	Not in a bad way because young people will be employed	
Pollution in the community maybe harmful	Not in any negative way at this moment…learning about it more currently	
Will encourage migration	Creates employment	
People may lose land that could be used for agriculture or construction		
Permanent destruction of the place		

6.10 Safeguards the Community Would Like to See

There were sixty-nine (69) responses to this question. They are grouped as follows:

- Safety: 33.3%, of the safeguards suggested were related to safety measures.
- Social: 14.5%, of the suggested safeguards were related to social issues.
- Health: 13.0%, of the suggested safeguards were health related.
- Other: 4.4%; of the suggested safeguards were grouped as "Other**".**

6.11 Comments and recommendations on the geothermal project

The question: "Would you like to make any general comments and/or recommendations regarding the geothermal project in your community?"

There were twenty-eight (28) responses to this question, and they were grouped as follows:

- Economic: 28.6%, of respondents made comments and/or recommendations that were related to economics.
- Psycho-social: 32.1%, of respondents made comments/recommendations which were of a psycho-social nature.
- Environment: 21.4%, of respondents made comments/recommendations that were related to the environment.
- Other: 17.8%, of respondents made comments/recommendations which were grouped as "Other".

***Table 19**: Table of Recommendations*

Economic (35.7%)	*Psycho-social (17.9%)*	*Environmental (25%)*	*Other (21.4%)*
Economic advantages	Request for more community outreach activities	Ensure it is well maintained	Critics of the project to be properly informed when trying to discourage others from going through with the geothermal project which can develop the country
Ensure it benefits the villagers	Rejection of the project	I don't like it and it will damage the community	Don't kill us.... success in completion
Persons whose land is within the area would like to be compensated since they can't live there anymore	Training for community	Not in favour. Would not want any volcanic activity to occur due to tampering with nature	Good luck
Hope the planning goes well and land surveyed will be paid for	Require weekly updates on the project	Should not be in close proximity to community	Hopes for success
I hope after all of this that Laudat benefits	Would like the government to be honest	Sulphur leaks may affect biodiversity in forest and	I wish them success in this project

from it	about it	river	
Is a good thing for competition and hopes that the people in the community get jobs?		That's is not good and will cripple the whole of Dominica	Wish for the completion
Pay persons what their land is worth and ensure that the product is lower than what electricity is being priced now. also, speed up the process of the development and construction		There is the possibility of using wind, hydro and solar. Since the project is not attracting foreign exchange it would be a failed project	

6.12 Climate change and Environmental Impacts on the community

Impact of hurricane Maria and other potential major hazard to the community:

The major effect of hurricane Maria on households appeared to be “Damage or total destruction to Dwelling/Business” with 76.0% reporting thus and 58 % reporting “Loss of Livestock/Crops”, Impact of Hurricane Maria on the community is outline in the table below:

***Table 20**: Impact of Hurricane Maria on Households*

Impact of Hurricane Maria	*Percentage*
Damage or total destruction of Dwelling/Business	76.0%
Lost Jobs	26.0%
No Food	24.0%
Death of a family member	2.0%
Loss of livestock/crops	58.0%
Migration of member of the household	18.0%
Other (specify)	4.0%
Did not have any major effect	12.0%

Major hazards facing the community

68% of households saw the Major hazards facing the Community as Landslides, High Winds and Fumes.

Table 21: *Community Perception of Hazards impacting them*

Major Hazards facing the Community	*Percentages (5)*
Land Slides	68.0
High Winds	62.0
Fumes	40.0
Eruptions	36.0
Flooding	10.0
Fire	4.0
Other	12.0

6.13 Impact of COVID-19 on the Community

Table 22*: Impact of COVID-19*

Impact	Percentage (%)
Economical	59.5
Psychological	7.1
Social/Health	95
Not Affected	23.8

Sixty percent of the community indicated that COVID-19 affected them economically while 24 % indicated that it had no effect on them. The rest of the community indicated that the effects were related to their health and social wellbeing as well as psychologically as a result of having to quarantine and to limit their social activities.

NGO's/CBO's

The Laudat community does not have a Village Council. An inactive Village Improvement Committee (VIC)has been reactivated during the course of this study (October 2020)

6.14 Assessment of Landowners

Introduction

The proposed geothermal pipeline and reinjection well is expected to be undertaken in the village of Laudat, the site for the Geothermal Power Plant project. The proposed reinjection well and pipeline component will not displace any households. However, it is expected that 4.92 acres of land will be acquired from 4 land owners for the purpose of well construction and a 10 meter corridor each from an additional 8 land owners for the purpose of laying of the pipeline (1.18 acres). The purpose of the report is to evaluate the social and economic impact on the proposed land acquisition for the pipeline and reinjection of geothermal wastewater in Laudat. Land will be acquired by the Government of Dominica either through negotiated agreement or by Compulsory Acquisition under the Land Acquisition Act 1946.

Where land acquisition will result in physical or economic displacement, a Resettlement Action Plan (RAP) will be completed prior to project construction. The contents of the Resettlement and/or Livelihood Framework, and/or any Resettlement Action Plans and Livelihood Plans will follow the principles and requirements as outlined in the World Bank PS 5, and further elaborated in the IFC Guidance Note on PS 5 with special attention to Annex A, Outline of a Resettlement Action Plan. A well-established land acquisition process has been followed by DGDC and the GoCD. The Abbreviated Resettlement Action Plan (ARAP) already endorsed and published by the World Bank for the power plant site and previous reinjection sites, will be updated to accommodate all additional land acquisition requirements for additional components of the overall project.

National Regulations

The Land Acquisition Act, Chapter 53:02, regulates the acquisition of land by the state and outlines procedures in acquiring private lands for state use.

The Land acquisition Act list procedures for the following

1. Acquisition of land and abandonment of acquisition.
2. Appointment and powers of Board of Assessment.
3. Determination of Small Claims for Compensation.
4. Provisions Governing Assessment of Compensation.

Provisions for the compulsory acquisition of land consists of an evaluation of the market value of the land conducted by the Department of Lands, a Cabinet decision authorising acquisition,, followed by a negotiation or agreement to compensation with the relevant land owner. The government may compulsorily acquire by two publications in the Official gazette at any stage in this process. Compensation values are determined by the government Valuations unit of the Ministry of Lands. The department uses the market value in the calculation of compensation to landowners

World Bank

While World Bank guidelines differ from local land acquisition guidelines. (JACOBS 2008) A gap analysis conducted for the Dominica Geothermal Company highlighted the differences and lists measures to address the gaps identified.

Table 23: *Gap Analysis - Land Acquisition Guidelines*

Conflict/Gap	Local Legal Framework/Policy	World Bank Policy Requirements	Measures to Address Conflict/Gap
Restoration of livelihoods and living standards	There is no existing legislation or official policy document that specifically supports resettlement initiatives in Dominica except for that created specifically in response to TS Erika and Hurricane Maria	OP 4.12 Involuntary Resettlement: Section 6 (c) – Where necessary compensation should also include measures to ensure that displaced persons are offered support after displacement for a transition period, the time likely to be needed to restore their livelihood and standards of living. The displaced persons should also be provided with development assistance such as land preparation, credit facilities, training or job opportunities, in addition to the other compensation measures stipulated.	The Social and Environmental Safeguards of the World Bank take precedence. All PAPS should be eligible for full compensation benefits per World Bank Policy requirements

Support for displacement	World Bank type policy pertaining to the restoration of income sources and livelihoods, support after displacement for a transition period; do not apply except as has been developed in response to natural disasters	Section 2 (c) – Displaced persons should be assisted in their efforts to improve their livelihood and standards of living or at least to restore them in real terms, to pre-displacement levels or to levels prevailing prior to the beginning of project implementation, whichever is higher.	The Social and Environmental Safeguards of the World Bank take precedence. All PAPS should be eligible for full compensation benefits per World Bank Policy requirements
Development assistance	The provision of elderly assistance, employment under the National Employment Programme; Free health services for Elderly and needs based social support are all available to qualifying PAPS	Section 2 (c) – Displaced persons should be assisted in their efforts to improve their livelihood and standards of living or at least to restore them in real terms, to pre-displacement levels or to levels prevailing prior to the beginning of project implementation, whichever is higher.	The Social and Environmental Safeguards of the World Bank take precedence. All PAPS should be eligible for full compensation benefits per World Bank Policy requirements
Opportunity to derive development benefits from project	There is no existing legislation or official policy document that specifically supports resettlement initiatives in Dominica	Performance Standard 5, Section 9 – The client will also provide opportunities to displaced persons to derive appropriate development benefits from the project,	The project will create temporary job opportunities during the civil plant and pipeline construction While some of the jobs will require specialized skills that may not be available locally, for non-specialized jobs, the project is expected to create equal employment opportunities for both men and women. In that regard the DGDC will as far as possible ensure that service providers give priority to the employment of workers originating from the Roseau Valley Communities

Timing for the Payment of Compensation and Taking possession of Land Acquired	The Land acquisition Act Chpt. 53:02 is silent on the timing for compensation payments Sections 3 and 5 permits for access to lands any time after the publication	OP 4.12 Possession of the land acquired and related assets only after compensation has been paid.	The Bank's policy will take precedence. Identification of landowners and tenants has already been done and notification to the authorized officer completed. MOUs and a Cooperation Agreement have been signed between DGDG and the Ministry of lands in November 2019 to facilitate implementation and reporting

Institutional Arrangements for land acquisition

The Lands and Surveys Division has a process in place for addressing land acquisition including any grievances associated with this process. As such, DGDC will work closely with the Division during the resettlement process for this Project to ensure consistent coordination.

The following are procedures covered by the Act are applicable to the land acquisition process required for the geothermal project:

- Preliminary notification and power to enter the land: if the Commissioner of Lands (the Authorized Officer) determines that any land is required for public purpose and it is necessary to make a preliminary survey or other investigation of the land, he/she may cause the publication of notification to that effect; and thereafter it shall be lawful for the Authorized Officer or his/her agents to enter on to the land to undertake the investigative works required.

- Power to apply land to purposes of acquisition without waiting for formal vesting: at any time after the publication of a notification of the intention to acquire land for public purpose, it appears to the authorised officer that this land should be acquired, he/she may make an immediate declaration to that effect; and it is lawful for him/her to direct the Authorized

Officer to do any work on the land connected with the use for which the land is being acquired.

- Appointment of Board of Assessment: In the event that the parties cannot reach agreement on compensation to be paid, a Board of Assessment may be appointed and granted full power to assess, award and apportion compensation in such cases, in accordance with the provisions of the Act.

Sections 3 of the Land Acquisition Act permits access to the land for investigative purposes before compensation is paid; Section 5 allows the government to take possession of land acquired and to commence development before compensation is paid. These provisions are not consistent with the World Bank's policy on involuntary resettlement, which states that the client will take possession of land acquired and related assets only after compensation has been made available and, where applicable, resettlement sites and moving allowances have been provided to the displaced persons in addition to compensation.

Landowners Assessment Methodology

A questionnaire was prepared, and identified landowners were interviewed. The objective was to get the perspective of these landowners on the proposed acquisition of their land and the geothermal project pipeline and reinjection well and to obtain information from them on the extent of the impact of acquisition on their social, physical or economic livelihoods The information will be used to assist the developers in mitigating any negative consequences which may be brought about as a result of the acquisition. The forgoing information was obtained through interviews of the listed landowners with interviews covering the following areas:

- Demographic information
- Household details
- Household Survey of directly affected land user
- Livelihood details
- Asset inventory for houses to be relocated
- Income and business
- Economic activities and spending
- Land acquisition
- Perceptions

- Vulnerabilities

A list of twelve landowners was provided by the Dominica Geothermal Development Company, the developers, to obtain the above information and get the perspectives of those whose land is to be acquired. Nine representatives including three (3) landowners were interviewed. Could not be interviewed. One representative did not returnThe representative of two landowner who are deceased, did not respond to requests to be interviewed, and at the time of interview, there was no local representative or contact for the other. The interview was not applicable to the other landowner, the Dominica Electricity Services Company

Land Use

The proposed site is covered in large trees and shrubs with little agriculture being practiced except for 1 portion of located to the north of the proposed reinjection site where fruit trees and vegetables are being cultivated for household use. There are no landowners residing on the proposed reinjection site and no structures except for a dilapidated shed located on the eastern plot.

Table 24: *Landowner Demographic*

Land Owner	Sex	Age	Occupation	Marital Status	Household members	Highest education
001	M	45-60	Business	single	3	Secondary
002	F	>60	Business	Divorced	3	tertiary
003	F	>60	Social Worker	Married	3	Tertiary
004	(James Jno Baptiste		No response from representatives			
005	F	>60	Retired	Widowed	5	Primary
006	M	>60	Retired	single	2	primary
007	DOMLEC		Not applicable since this landowner is a company			
008	F	45-60	Lawyer	Single	1	Tertiary
009	F	>60	Retired	Separated	1	Primary
010	F	>60	Retired	Married	3	Primary
-011	F	>60	Retired Rep. of deceased	Married	3	Primary

			Landowner			
012	Garfield Rolle		Deceased no representatives identified			

Eight landowners (66%) surveyed lived in Laudat and three (25%) lived outside the community. All seven households are comprised of more than one person with the average household having about 2.6 residents. The total population is 21 persons with one landowner being the Dominica Electricity Company. Ten females and 11 males reside in the surveyed households. There are 3 children with 0 below the age of 3 years and 10 occupants above the age of 60 years. English is the main language of the landowners.

Figure 44: *Age range of occupants of the Landowner's Households*

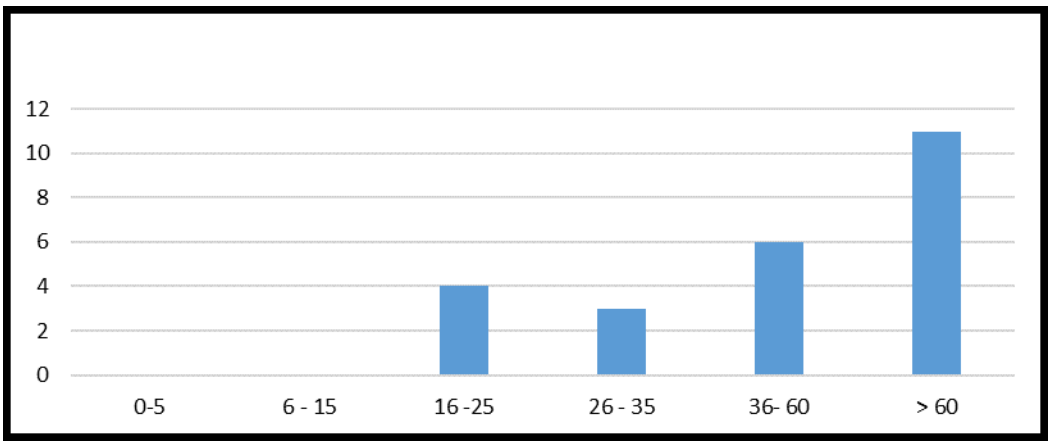
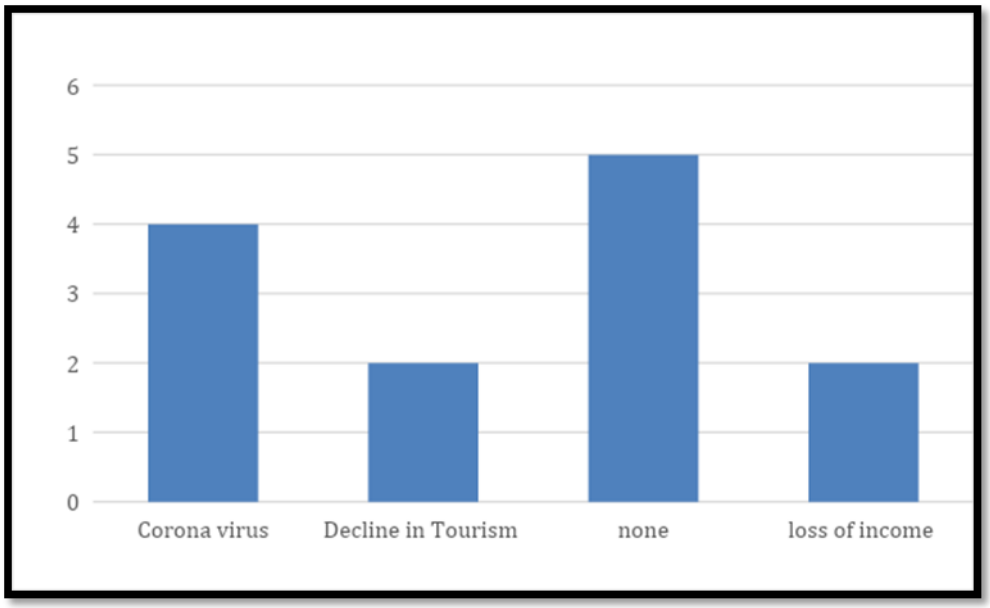


Figure 45: *Main Fears and Challenges*



Asset inventory

No asset inventory was done since there are no houses to be relocated from the project site.

Average family income exceeds $20000.00 per annum although there are two (15.4%) landowners who do not have a regular income source. All those interviewed could meet their basic needs including food, utility payments and clothing. All residences belonged to the landowners or family members.

***Figure 46**: Average Family Income*

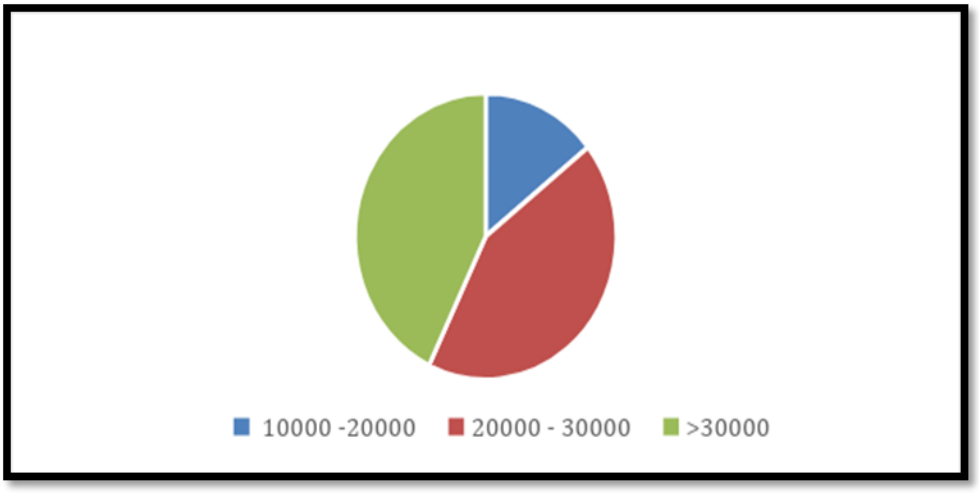
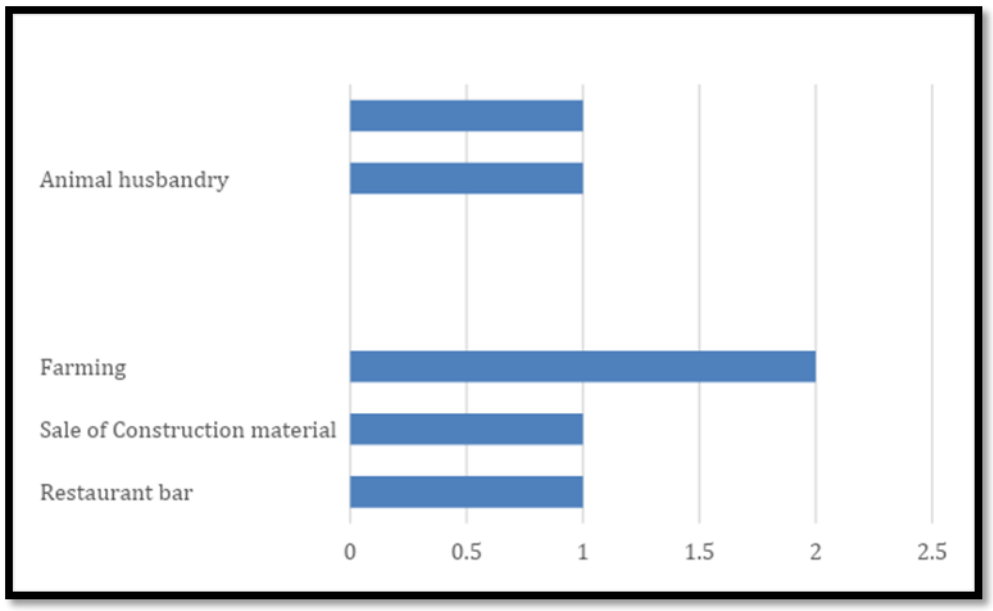


***Figure 47**: Other activities Undertaken by Landowners*



Indebtedness

Individuals were not willing to say whether they were indebted to lending institutions.

Drinking water

Every landowner has access to potable water from an approved source. They are connected to the DOWASCO pipelines with water connections to their homes.

Household Income

Seven additional members of the landowners' household generated income contributing to household income. Only one was aware of the income generated by his wife.

Occupations of other household members included

1. Engineer
2. Tourism worker
3. Social worker
4. Mechanic
5. Clerical worker
6. Students

Figure 48: *Occupations of other members of the households*

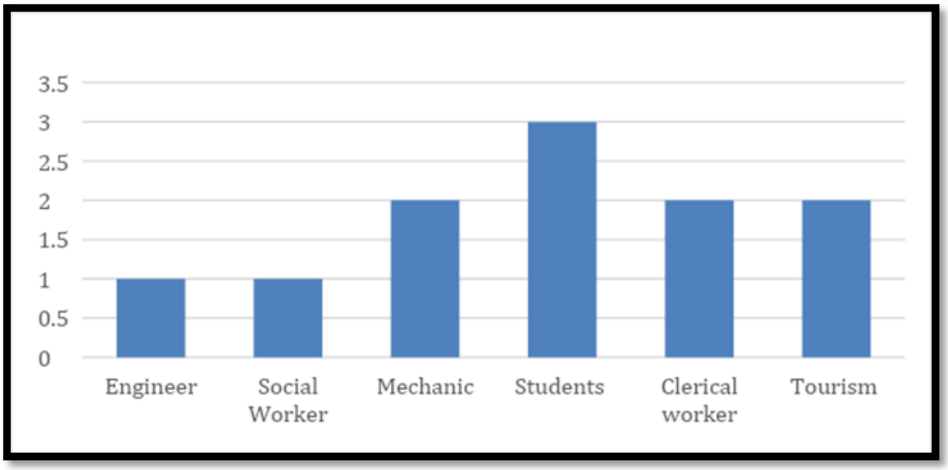
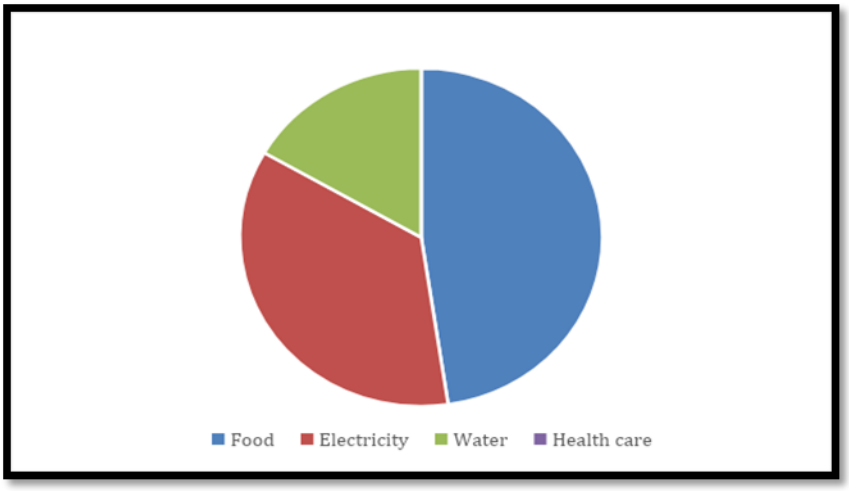


Figure 49: *Average Household Spending*



Perceptions of the Project

The DGDC has informed all landowners of the intention to acquire their property with everyone agreeing to sell the property for the purpose of development of the project. The process is now with the Lands and Surveys Department. Preliminary surveys have been done and permission to acquire/enter into lease agreements is being sought as per the established mechanism. No valuations have been done nor have prices been agreed upon and no compensation has been paid. Individuals hope that the development of the project will realize reduction in the cost of electricity however no one identified other benefits which will be derived out of the project.

Land Acquisition, Physical Displacement

For the construction of the reinjection well and pipeline corridor a total amount of 4.92 acres of land will be acquired for the purpose of the project. The proposed acquisition of the land for the reinjection well will not affect landowners economically since only one individual presently farms the north western corner where fruit trees and vegetables are being planted.

The pipeline route is expected to occupy a ten-meter corridor from eight landowners. This route is expected to run parallel to the present Dominica Electrical Services water pipeline and is not expected to cause displacement of residents or landowners in that area.

Entitlement for compensation

Landowners will be entitled to compensation for compulsory acquisition of the land based on established regulations. Compensation will be at replacement cost based on assessed market value as established by the Board of assessment established under the Dominica Land Acquisition Act. Land users are also entitled to compensation based on loss of income or assets.

Compensation will be one or more of the following as applicable to the landowner

1. Cash payment for the land being acquired
2. Cash payment for the crops located on the land
3. Income restoration for the loss of a business or significant agricultural loss.
4. Livelihood restoration assistance; and
5. Additional support for identified vulnerability

Since there are no structures located on the land it is not expected that compensation will be given for structures.

Vulnerable populations

Vulnerable parties are often at a disadvantage to participate and benefit from social and economic opportunities in their communities or need special assistance to do so. Particular attention must be paid to those who have been identified as being vulnerable. Women and the elderly and any other group identified as vulnerable should be identified and mitigation measures identified to reduce the potential impact.

Six land owners or representatives of these land owners are female who are expected to be impacted by the project. One landowner is 87 years old and suffered a Cerebro-Vascular Accident (CVA) and is unable to take care of himself. The impact however is expected to be minor since, in most cases the land is not being used.

Compensation and Payment procedure

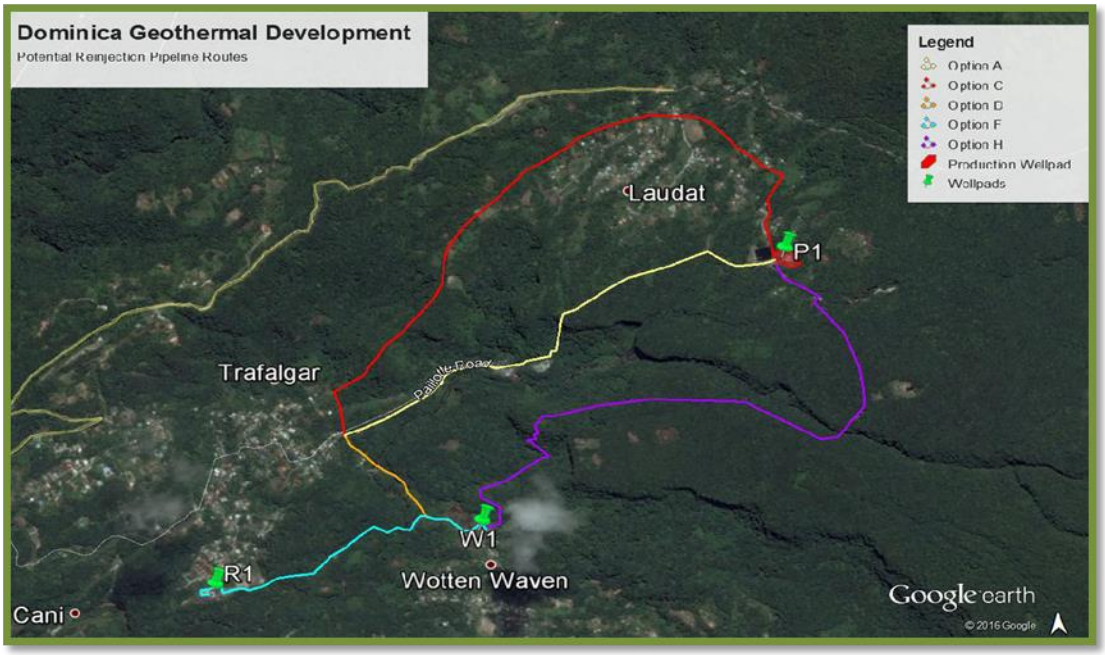
Formal property evaluations for all of the affected properties will be completed by the GoCD Division of Lands and Surveys prior to construction followed by negotiations with the affected parties. Records of all negotiations will be submitted to the DGDC as per the Cooperation agreement between the Ministry of Lands and the DGDC. The established procedures for acquisition and grievances will be utilised.

7.0 ASSESSMENT OF ALTERNATIVES

Several optional sites were selected for a reinjection pipeline from Laudat to the village of Trafalgar. Information from Jacobs (ESIA Vol 5) indicated that these routes were evaluated on the basis of the constructability, topography, geohazard exposure (i.e. landslides, rock fall, etc), estimated capital costs, operational considerations and social and environmental constraints. The pipelines were expected to run from WW-P1 to WW-01 and/or WW-R1. The options were as follows:

- Option A - Follows DOMLEC's hydropower pipelines across easily navigated topography and would need to utilize DOMLECs existing bridge which currently carries the penstock. Construction would be simpler in this section and there is adequate space for expansion loops. The pipeline would then need to descend the 60/80m vertical cliff, alongside the existing hydro pipeline. Once the cliff has been descended, the route runs alongside the river and road.
- Option C – This is the longest route and would require pumping of brine (~80kW – 100kW load) from WW-P1 at 554m asl to 615m asl. The route would follow the existing penstock route, before traversing to the north and west of Laudat to avoid the village itself and associated road/accessway crossings. The pipeline would descend down a steep and narrow ridge line on which the Waitukubuli National Trail presently runs.
- Option D – From the point where the Trail meets the road, the pipeline would cross the river, supported on the new bailey bridge, before following the road to Wotten Waven and pad WW-01.
- Option F – This section of pipeline would go from WW01 to WW-R1. The pipeline would follow the river crossing the gorge with a pipe bridge near the river junction. The last 200m before the football field would follow a narrow track with minimal space for expansion loops. The track has steep slopes and would require rockfall protection. Space for construction in this part of the trail is limited.
- Option H - This route would traverse cross country from WW-P1 to near the old aerial tram station. From there the pipe would cross the Breakfast River Gorge using a suspension bridge of 50 – 70 m. The pipeline would then cross relatively flat terrain before descending a short section of narrow pathway, which broadens and eventually comes out by WW-017.

Figure 50: *Map Outlining Options A - H*



In 2019 a new route, Option A, was selected as shown in the map below.

Figure 51: *Option A*

All options including Option A, would result in more significant disturbance of the habitat. They were much longer routes, were expected to cross at least 2 gorges and would have a greater impact on the landscape, soil and surface water and on biodiversity and ecosystem services. Additionally, they proved to be financially unfeasible and were abandoned in favour of the preferred location southwest of the village of Laudat.

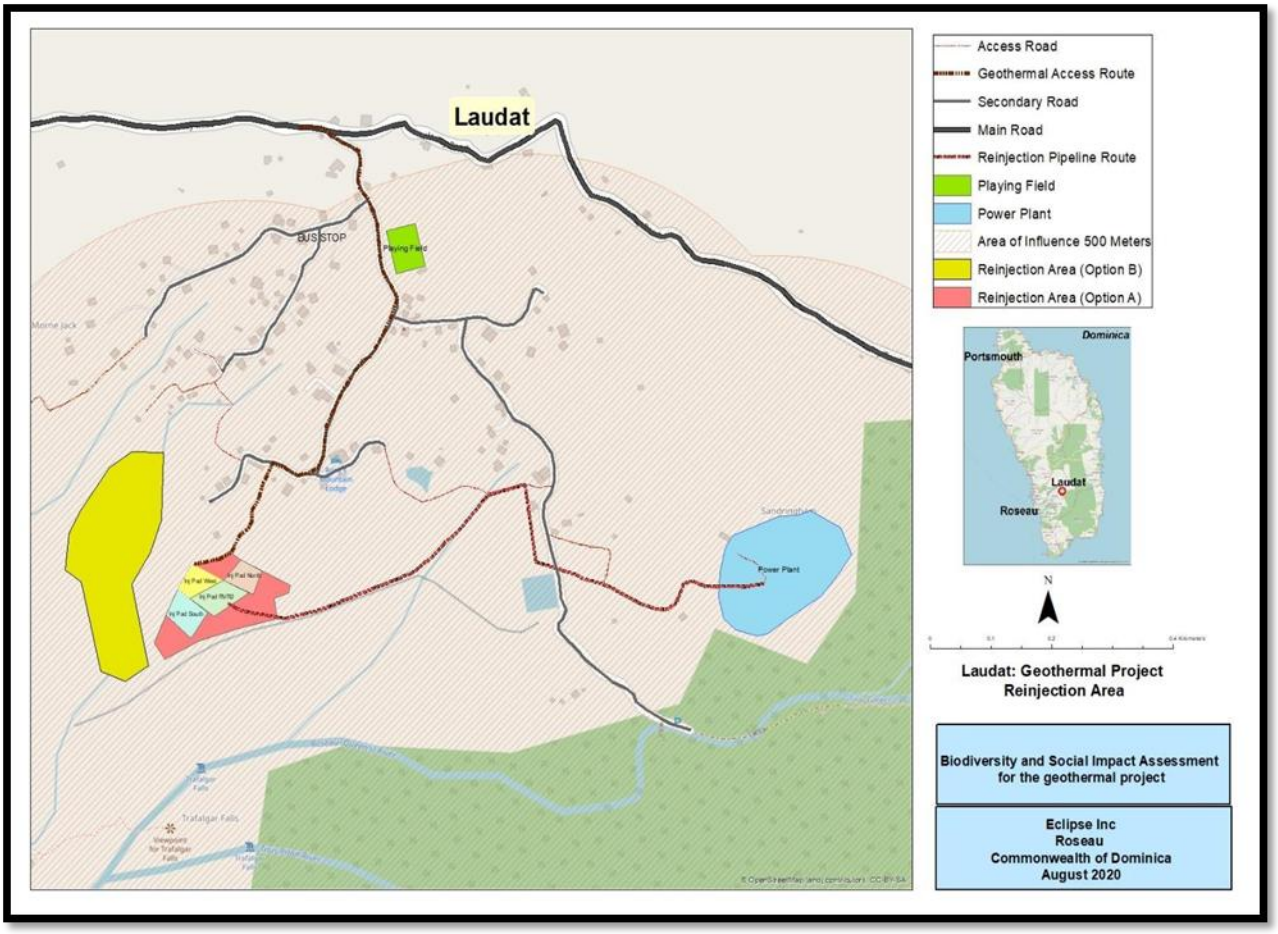
Reinjection area options for the current project

An on-site survey of the preferred location was conducted by the DGDC to evaluate the suitability and accessibility. Two sites, Site #A & Site #B were proposed for drilling of the re-injection well. Factors considered in the site selection included accessibility, the level of road construction required, distance from the production well, land requirements, complexity of land ownership and land acquisition.

Site #A, the preferred site, is located approx. 630 meters from the Production Well, at an elevation of 525m (1,722ft) above sea level. Site #B, the alternative site, is situated approx. 830 meters from the Production Well, at an elevation of 594 meters (1,948 ft.) above sea level. The re-injection pipeline serving both site options would follow a similar route to that of DOMLEC's hydroelectric pipeline corridor. Both sites are located on private land.

Site # B is located approx. 200 meters north of Site #A, on a low ridge straddled by two intermittent water courses (dry ravines). The site is relatively flat and utilized for subsistence agriculture and livestock rearing. The vegetation is made up of secondary forest, agricultural crops, invasive lemon grass and wild ginger. The dry ravines flanking the area become raging torrents when it rains heavily, with the potential to trigger stream bank erosion and land slippage.

***Figure 52**: Map showing sites A and B*



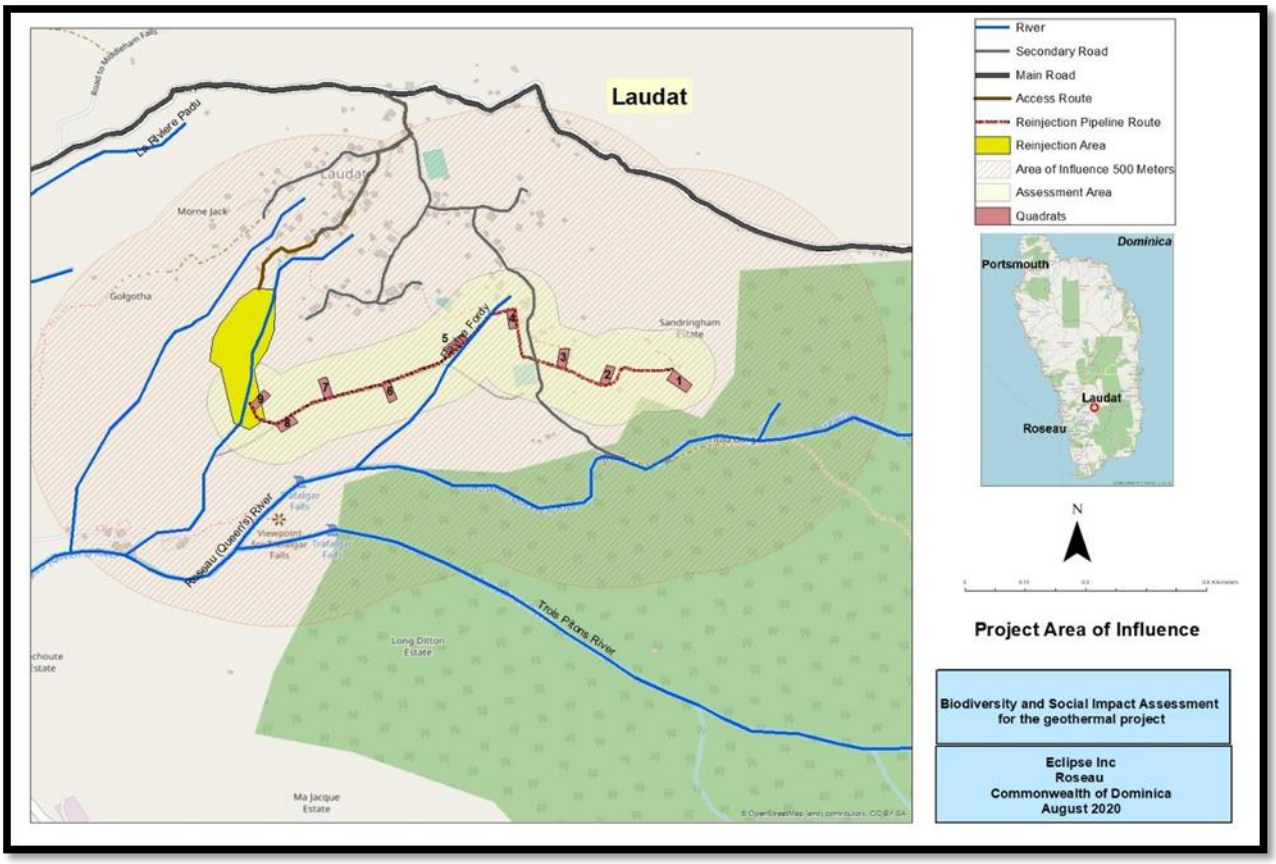
An evaluation of environmental and social aspects of the alternative re-injection well location and pipeline routes compared to preferred option indicate the following:

Alternative Site B

A major disadvantage with respect to the environmental aspects of the alternative site, Site #B, is its location on a narrow ridge between two watercourses. The site could be susceptible to soil erosion and land slippage during drilling and operation of the reinjection well, thereby posing a threat to the well pad and pipeline. Accelerated soil erosion and land slippage could also result in sedimentation of rivers downstream in the Roseau Valley. It requires additional clearing of forest vegetation, and construction of an aerial pipeline bridge across one ravine, to allow for the installation of the final 200 meters of the re-injection pipeline. In terms of soil characteristics,

there was a sandy base at a depth of 3ft 6 inches indicative of a shallow aquifer flowing beneath the surface. Water permeated through the soil at a rate of 0.3 minutes per inch. This is indicative of a sandy underlying layer and the lack of resistance in the soil. This also indicates a poor water holding capacity and a high probability for accidental potential groundwater contamination.

Figure 53: *Site B - Alternative Site*



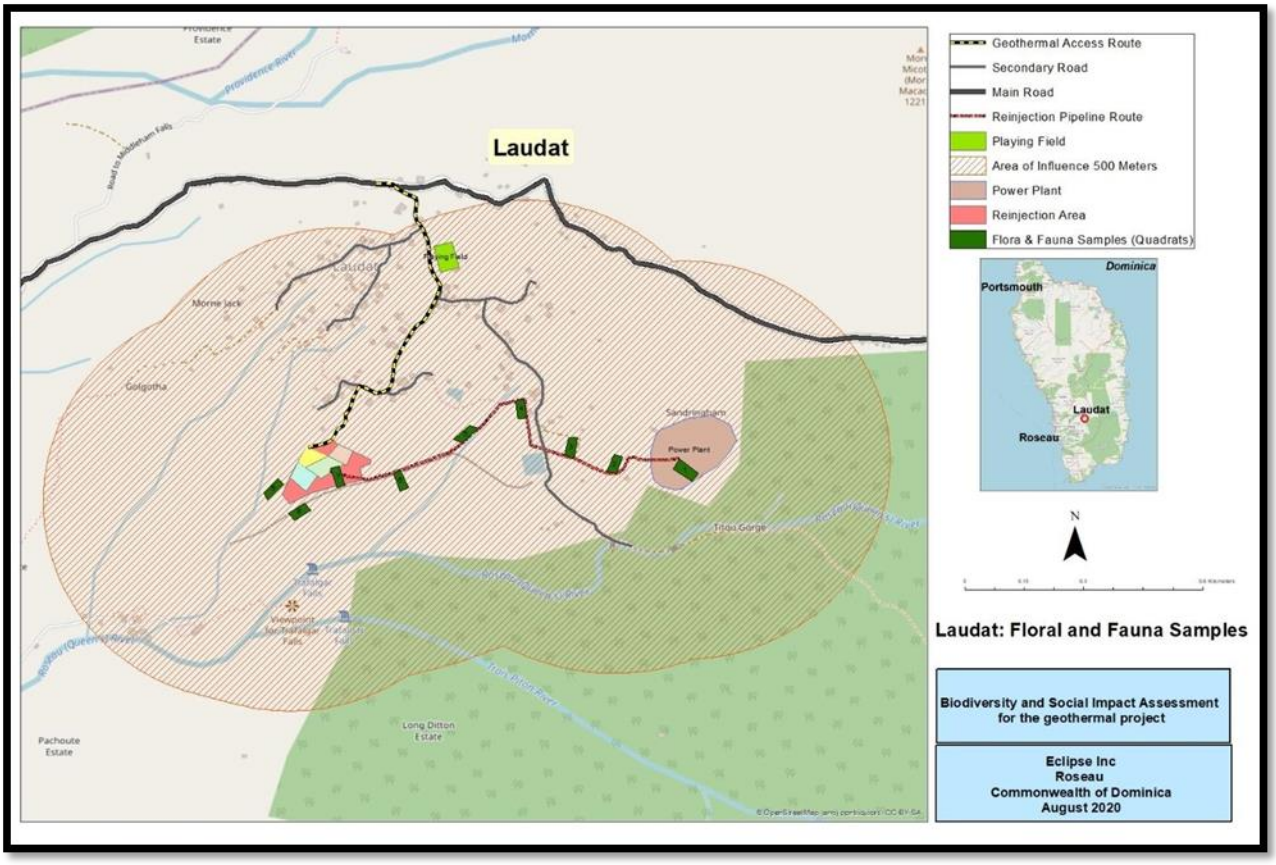
Preferred Site - A

The preferred site is located on gently sloping land. The site is under secondary forest vegetation and residual agricultural crops. The site is fringed by a dry ravine on its northern side and the hydro pipeline corridor to the south. The Roseau River is also located some distance away on its southern side.

It will avoid major disruption of the village roads; (ii) requires an easier pipeline route; (iii) the pad is within reasonable distance from major waterways; (iv) the existing access road can be improved to facilitate access for the drilling rig and for pipeline construction; (v) extensive

clearing of forest vegetation will not be required (vi) In terms of soil characteristics, it shows better water holding capacity. Additionally, subsurface soil does not indicate any subsurface aquifer which could potentially be modified or contaminated from spills at the well pad site.

Figure 54: *Site A - Preferred Site*



Conclusion

While the preferred site presents a better option than the alternative site, it should be noted that the project area falls within the Roseau River Watershed. It also serves as a watershed for several ground water sources which spring out in the community of Trafalgar located about 500 meters downstream. Soil tests and water drainage patterns indicate that there are aquifers within the zone of influence. However, there are no hydrogeological studies to ascertain the location of aquifers in the area. It is important that a hydro-geological study of the area is undertaken before construction and operation of the well pad and reinjection well.

8.0 ASSESSMENT OF IMPACTS

8.1 Methodology

The environmental and social risks and impacts of the project have been assessed in accordance with World Bank Performance Standard 1 and good industry practices. The assessment will be proportionate to the potential risks and impacts of the project, and will assess, in an integrated way, all relevant direct, indirect, and cumulative environmental and social risks and impacts throughout the project life cycle, including those specifically identified in ESS2–10.

The impact assessment predicts and assesses the Project's likely positive and negative impacts, in quantitative terms to the extent possible. For each of the environmental aspects listed above, the assessment determines the sensitivity of the receiving environment and identifies impacts and assesses the magnitude and overall significance of environmental impacts. An ESIA will always contain a degree of subjectivity, as it is based on the value judgment of various specialists and ESIA practitioners. The evaluation of significance is thus contingent upon values, professional judgement, and dependent upon the environmental context. Ultimately, impact significance involves a process of determining the acceptability of a predicted impact.

8.1.2 Defining Impact

There are various ways that impacts may be described and quantified. An impact is essentially any change to a resource or receptor brought about by the presence of the proposed project component, project discharge or by the execution of a proposed project related activity. The assessment of the significance of impacts and determination of residual impacts takes account of any inherent mitigation measures incorporated into the Project by the nature of its design.

In broad terms, impact significance can be characterized as the product of the degree of change predicted (the magnitude of impact) and the value of the receptor/resource that is subjected to that change (sensitivity of receptor). For each impact the likely magnitude of the impact and the sensitivity of the receptor are defined. Generic criteria for the definition of magnitude and sensitivity are summarized below.

8.1.3 Direct vs. Indirect Impacts

A direct impact, or first order impact, is any change to the environment, whether adverse or beneficial, wholly or partially, resulting directly from an environmental aspect related to the project. An indirect impact may affect an environmental, social or economic component through a second order impact resulting from a direct impact. For example, removal of vegetation may lead to increased soil erosion (direct impact) which causes an indirect impact on aquatic ecosystems through sedimentation (indirect impact).

8.1.4 Magnitude Criteria

The assessment of impact magnitude is undertaken by categorising identified impacts of the Project as beneficial or adverse. Then impacts are categorised as ‘major’, ‘moderate’, ‘minor’ or ‘negligible’ based on consideration of parameters such as:

- Duration of the impact – ranging from ‘well into operation’ to ‘temporary with no detectable impact’.
- Spatial extent of the impact – for instance, within the site boundary, within district, regionally, nationally, and internationally.
- Reversibility – ranging from ‘permanent thus requiring significant intervention to return to baseline’ to ‘no change’.
- Likelihood – ranging from ‘occurring regularly under typical conditions’ to ‘unlikely to occur’.
- Compliance with legal standards and established professional criteria – ranging from ‘substantially exceeds national standards or international guidance’ to ‘meets the standards’ (i.e. impacts are not predicted to exceed the relevant standards) presents generic criteria for determining impact magnitude (for adverse impacts). Each detailed assessment will define impact magnitude in relation to its environmental or social aspect.
- Any other impact characteristics of relevance.

***Table 25**: General Criteria for Determining Impact Magnitude*

Category	Description
Major	Fundamental change to the specific conditions assessed resulting in long term or permanent change, typically widespread in nature and requiring significant intervention to return to baseline; would violate national standards or Good International Industry Practice (GIIP) without mitigation.
Moderate	Detectable change to the specific conditions assessed resulting in non-fundamental temporary or permanent change.
Minor	Detectable but small change to the specific conditions assessed.
Negligible	No perceptible change to the specific conditions assessed.

8.1.5 Sensitivity Criteria

Sensitivity is specific to each aspect and the environmental resource or population affected, with criteria developed from baseline information. Using the baseline information, the sensitivity of the receptor is determined factoring in proximity, number exposed, vulnerability and the presence of receptors on site or the surrounding area. Generic criteria for determining sensitivity of receptors are outlined in Table 2.2 below. Each detailed assessment will define sensitivity in relation to its environmental or social aspect.

***Table 26:** General Criteria for Determining Impact Sensitivity*

Category	Description
High	Receptor (human, physical or biological) with little or no capacity to absorb proposed changes
Medium	Receptor with little capacity to absorb proposed changes
Low	Receptor with some capacity to absorb proposed changes
Negligible	Receptor with good capacity to absorb proposed changes

8.1.6 Impact Evaluation

The determination of impact significance involves making a judgment about the importance of project impacts. This is typically done at two levels:

- The significance of project impacts factoring in the mitigation inherently within the design of the project; and
- The significance of project impacts following the implementation of additional mitigation measures.

The impacts are evaluated taking into account the interaction between the magnitude and sensitivity criteria as presented in the impact evaluation matrix in Table 2.3 below.

Table 27: *Impact Matrix*

		Magnitude			
		Major	Moderate	Minor	Negligible
Sensitivity	High	Major	Major	Moderate	Negligible
	Medium	Major	Moderate	Minor	Negligible
	Low	Moderate	Minor	Negligible	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

The objective of the ESIA is to identify the likely significant impacts on the environment and people of the project. In this impact assessment, impacts determined to be 'moderate' or 'major' are deemed significant. Consequently, impacts determined to be 'minor' or 'negligible' are not significant.

Impacts resulting from the construction and operational phases of this project will be outlined under the headings of Social and Environmental

8.1.7 Mitigation

Mitigation measures are actions taken to avoid or minimise negative environmental or social impacts. Mitigation measure includes those embedded within the design (as already considered as part of the impact evaluation) and any additional mitigation required thereafter. Additional mitigation will be implemented to reduce significant impacts to an acceptable level; this is referred to as the residual impact. The mitigation hierarchy should be followed: avoid, minimise,

restore or remedy, offset, compensate. Mitigation measures should be clearly identified and linked to environmental and social management plans.

8.1.8 Monitoring

Monitoring is not linked to the impact evaluation but is an important component of the ESIA and allows for evaluation of the effectiveness of mitigation measures. Monitoring is required prior to, during and after construction is completed. The purpose of monitoring activities is to enable periodic assessments of environmental impacts during the different phases (construction and operation) of the project. It also allows for comparing these impacts with those foreseen during the planning process. Monitoring provides useful feedback which allows the developer to correct in a timely manner, any environmental problems resulting from the project activities.

The environmental monitoring responsibility must be undertaken by an independent public agency. Its specialists and inspectors will be responsible for timely monitoring of the environmental aspects of the project during normal working operations in addition to monitoring of agreed indicators while ensuring that the recommended mitigation measures are implemented.

8.1.9 Residual Impacts

Those impacts that remain once mitigation has been put in place will be described as residual impacts.

8.1.10 Cumulative Impacts

The assessment of cumulative impacts will consider the combination of multiple impacts that may result when:

- The Project is considered alongside the existing facilities.
- The Project is alongside other existing or proposed projects in the same geographic area or similar development timetable.

- Impacts identified in different environmental and social aspects of the ESIA combine to affect a specific receptor.

The assessment of cumulative impacts will identify where particular resources or receptors would experience significant adverse or beneficial impacts resulting from a combination of projects (inter-project cumulative impacts). To determine the full combined impact of the development, potential impacts during construction and operational phases have been assessed

9.0 SOCIAL IMPACT ASSESSMENT

Only impacts that are considered major, moderate, and minor will be assessed and mitigation and monitoring ascribed.

9.1 Employment and Income Generation

Generation of direct employment

During construction and to a lesser extent, operation, there may be generation of direct employment of unskilled and semi- skilled and or skilled persons from the community. However, for semi-skilled and skilled this will depend on the availability of the requisite skills within the community. Employment generation for the construction of the powerplant will be approximately 20 to 50 persons inclusive of persons outside of the community (DGDC). During operations the number will be greatly reduced.

Indirect employment may be realized through the supply of goods and services through the small businesses operating in the community, e.g. agricultural produce to the small restaurants/ bars, bakeries, and also through supply of services to the project staff and workforce.

Loss of employment

Once the project construction is complete, there will be some loss of employment to some members of the community who were previously employed in the construction works.

The sensitivity of the affected population is considered medium since opportunities for employment are limited.

The magnitude is considered minor since the potential number of jobs is low when compared to the unemployment rate in the community.

Significance: The generation of employment is considered beneficial and its significance minor.

Further Enhancement

- DGDC to activate its related procedure "Local Labour and Opportunities Development Plan" (DGDC -SOC- 004), which includes vocational training to assist the community in obtaining jobs with the project as well as the responsibility of the EPC contractor to maximize as far as is possible local employment and income generating activities from and within the community and monitoring procedures to evaluate employment levels and income generating activities.
- Contractors should be required to employ residents of the community as long as the required skills are available. Consequently, a register of persons with the relevant skills should be prepared to expedite the process for employment.
- Attempts should be made to employ women on the project.
- The hiring process should be transparent to help the community to understand strategic staffing decisions for the Project.
- Inform community on number of residents employed.
- Prior to project completion, assist employees who would no longer be employed, in transitioning to other employment opportunities.

Monitoring

- Number of skilled and unskilled persons recruited including women.
- Number of persons receiving training.

Table 28: *Rationale for Scoring and Assessment*

Aspect	Size	Scoring	Assessment Rationale
Employment and Income generation	Local community	Reliability level; High	From past experience from similar project in other communities, past ESIA's and professional opinion
		Impact Balance: Positive	Local persons will be employed during construction
		Type of Impact: Direct and Indirect	Job creation and increase income for families and purchase of services in the food and beverage sector and small shops
		Magnitude: Minor	Based on skills available. Most of the jobs will take place during construction phase
		Probability: Likely	It is likely that local persons will be hired- unskilled and skilled, if available base
		Duration: Short to medium term	During construction phase, employment will be medium term. Operational will be long term

9.2 Impact on Tourism

Tourism plays an important role in the economic life of the Laudat community. More recently eco-tourism activities have been increased through improved tourism marketing and promotion and have improved livelihood opportunities in areas of home stays, tour guiding, roadside vending and food and beverage services. Tourism has been seriously impacted by COVID-19 and tourism business in the area has suffered economically. Women are the main vendors and are predominantly employed in the tourism sector; hence the impact on women will be greater.

Potential Impact

The main effects on tourism may emanate from the following:

- Increase in traffic that could temporarily slow down tourism transportation especially during the high tourism season expected to recover only towards the end of 2021. The cruise ship season normally starts in October through to April and the high season starts from October to March
- There will be positive impact to restaurants and possibly the accommodation sector as a result of an increased labour force expected during construction from sales and services
- During operations there will be limited traffic so the impact will be minimized

There will be no impact on areas of attraction and the World Heritage Site. With respect to improvement of the access road, expansion and resurfacing will have no impact on traffic since it is away from the major vehicular roads. It is expected that the impact will be temporary and will decrease during operations. Given these outcomes the impact on tourism is considered negligible.

9.3 Road Networks and Traffic

Introduction

The objective of this is to assess the impacts of increased traffic resulting from the proposed construction of the reinjection pipeline and the drilling and operation of the geothermal well and to recommend relevant mitigation measures. As a result of the short time frame, traffic counts for the area could not be undertaken.

Assessment of impacts

The impact will be assessed based on methodology outlined earlier. An analysis of traffic during construction and operation will be assessed taking into consideration the increase in volume of traffic in relation to the road network and the impact on existing road users and the community.

Baseline information has indicated that the existing road network is narrow and winding with minimal pedestrian sidewalks. There is one bus stop centrally located at the intersection of this main road with some parking spots to reduce road blockage. The baseline information also indicated that 54% of families owned vehicles. This suggests that 46% may be commuting on public transportation.

All equipment required for the project will be transported from the Port located in Woodbridge Bay Sea port in the capital city, Roseau to Laudat- a distance of approximately 2 km.

Construction traffic

During construction there will be increased traffic from haulage trucks and transportation of bulky items like drill rigs, mud pumps cement silos, large cranes and 20-foot containers. Bulky construction equipment like rollers, compactors will be required, among others. It is expected that equipment will be stored on site until the completion of the construction process.

The Laudat road is an access point for several tourism attractions and the Morne Trois Pitons National Park. Additionally, during the cruise ship season between October to April passenger buses ply this route. When cruise tourism resumes, it is feasible to work with the tourism department and cruise handlers to reduce conflicts with respect to the various road users.

Haulage trucks and other transportation will compete with buses, private and other vehicles on the road which is narrow. Public information and awareness will reduce potential negative impacts. Traffic generation resulting from this is short term. The significance of the impact of this is considered minor.

There will also be increased traffic from the transportation of potential employees into the project site. Twenty (20) to fifty (50) employees including local are expected to be employed for the construction of the pipeline. The number of persons expected to commute to the community will not exacerbate traffic and is considered to be insignificant.

The impact of traffic on the farmers in this area will be negligible, most farmers walk to their farms and there are alternative roads that farmers can use to park their vehicles. Access to the actual farm is through small trails or walkways. Hence the impact will be negligible.

Pedestrians will be at risk due to the absence of road shoulders in the area and this could cause accidents. Cyclists, adults, and children use this road. There are no cycling lanes for cyclist and increased traffic during construction could cause accidents. The impact is negative and direct. The magnitude of the impact is minor, and the sensitivity is medium. The significance of this is considered minor.

Operational Traffic

There will be minimal traffic during operations except when undertaking maintenance work expected to be undertaken annually of bi-annually. Traffic will be significantly reduced within the community hence the impact will be negligible.

Mitigation Measures

Develop and implement a traffic and transportation management procedures to include the following during the construction phase:

Establishment of operation time for which haulage trucks ply the routes so that it is not done during peak traffic hours and ensure that haulage trucks operate within specified hours as designated in the Plan

- Erection of a speed bump at a strategic area to reduce speed.
- Erection of a pedestrian crossing in the location of the bus-stop.
- Ensuring that vehicle hired for transportation are maintained to reduce exhaust emission

- Signs shall be erected at strategic locations to provide information to the public on project activities being undertaken, to alert them to the use of heavy vehicles and to encourage them to exercise caution and to co-operate with project management.
- Review maintenance schedule for vehicles hired for transportation to ensure that they are being maintained.
- Sensitize communities on construction activities

Monitoring

- Review Traffic and Transportation Management plan to ensure that it is being implemented
- Number of stakeholder meetings convened
- Monitor traffic accidents in the community
- Monitor Complaints filed by the community
- Sensitization programmes shall be monitored to ensure implementation

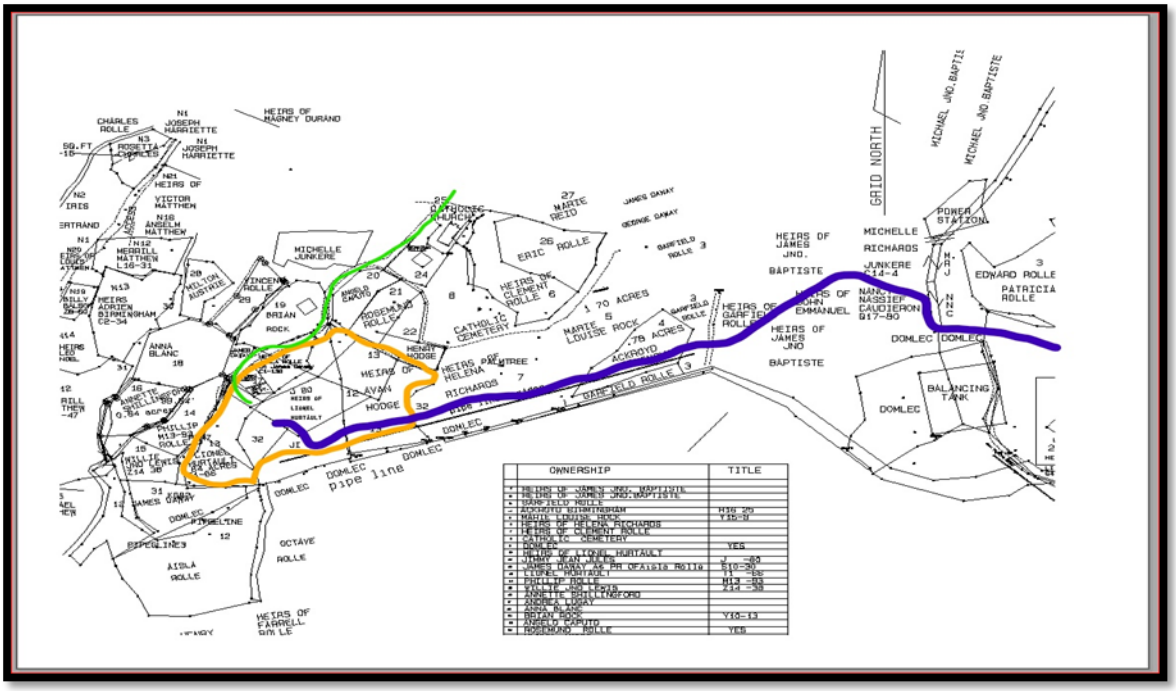
9.4 Land Acquisition and Resettlement

The proposed project is not expected to displace any household however it is expected to acquire 4.92 acres of land from 4 land owners for the purpose of well construction and a 10 meter corridor each from an additional 8 land owners for the purpose of laying of the pipeline (1.18 acres). Acquisition will be undertaken by the Government of Dominica under the Land Acquisition Act Chapter 53:02. This may be accomplished through negotiation or compulsorily as allowed under the Act.

Baseline data indicated that preliminary discussions were held with all landowners by the relevant authority and an evaluation of all properties has been undertaken.

The proposed land for acquisition is predominantly abandoned agricultural land covered in large trees and shrubs with very little agriculture being practiced except for a small area located to the north of the proposed reinjection site with limited agricultural production. There are no landowners residing on the proposed reinjection site area and no structures except for a dilapidated shed located on the eastern plot.

Figure 55: *Land Acquisition Map*



An assessment of landowners indicated that they were informed by the DGDC of the intention to acquire their property with everyone agreeing to sell the property for the purpose of development of the project. They indicated that the issue of price has not yet been agreed upon. Landowners expressed their hope that the development of the project will realize reduction in electricity rates. However, they did not identify other benefits which will be derived out of the project.

Purchase of land will reduce the acreage of land available for agricultural production. However, land purchase will not directly affect the livelihood of the majority of landowners since most of the land was currently lying fallow - uncultivated agricultural land.

There is a risk that landowners may not agree on a mutually agreed compensation package or a compensation process. This is likely to occur but can be addressed through negotiation. Land ownership is traditionally a very sensitive issue hence the level of significance could be moderate. Recommendations are being put forward to mitigate any risk associated with this. Discussions with landowners indicate that they are willing to sell their land if the price offered is acceptable.

Potential impacts

The following evaluates the potential social impacts on the landowners identified during the interview process.

Although land acquisition is not essentially affecting the income of the affected landowners, some believe that they have no control over the acquisition process and believe that they have no choice in the process. One farmer is expected to undergo income loss along the northern end of the proposed site.

***Table 29**: Impact Sensitivity*

Sensitivity criteria	Contributing Criteria
Low	All landowners have alternatives for income generation and that no residences are located on the proposed site
Medium	There are limited alternatives for the landowners for income generation and land users affected by the acquisition
High	There are no alternatives for income generation of landowners and land users

Table 30: *Criteria for Impact Magnitude*

Magnitude	Criteria
Small	The land is not necessarily affecting income of the landowners. The number of people affected is relatively small
Medium	The land acquisition poses moderate impact on the income level of the affected owners. There may be temporary disturbance to income generation. The affected people encounter difficulties to recover their income level due to limited available options of income generating activities
Large	The land acquisition poses significant negative impact on the income of the majority of landowners. There are no other livelihood options for the land affected people to recover.

The baseline study of the landowners confirms that all landowners have alternative means of income generation and that the land being acquired by the project is not their main source of income. Thus, the land acquisition will not negatively affect the owners (low sensitivity)

The impact magnitude of the acquisition of agricultural land for the project is considered to be minor given the land used for agriculture is limited and only a small amount of subsistence farming is done on one plot by one farmer. Most landowners only do backyard farming with five having adequate land around their residence for that purpose resulting in low sensitivity.

The significance of the impact is therefore assessed to be negligible.

Management Measures

In order for the project to meet national and international guidelines and standards and World Bank Safeguard polices the project should undertake the following measures.

1. The existing “Abbreviated Resettlement Action Plan” in line with World Bank requirements and developed by Jacobs in 2018 is already being implemented by DGDC
2. DGDC to continue to implement the existing “Grievance Redress Mechanism” for concerns related to land acquisition. This GRM should be accessible, relevant and user friendly. It is posted on the DGDC website and copies are available from the DGDC office and CLO.

Encourage speedy and timely payment process for landowners. The Ministry of lands is the body responsible for paying once negotiations are complete and cabinet has approved the payments.

9.5 Community Health and Safety

The proposed project is not expected to significantly impact the health of the community of Laudat. The community is served by a health centre and visiting nurse and forms part of the broader Roseau Health District which provides primary care services to residents of the community. The Roseau Health Team provides numerous services including doctors' visits, care of the elderly, maternal and childcare and other services as may be required. Additionally, environmental health services are provided as a disease prevention service achieved through inspections and monitoring of environmental factors which could lead to disease.

Potential impact

The major health issue identified in the baseline survey was chronic illnesses like diabetes, hypertension with 6% complaining of respiratory problems like asthma. The major pollutants will include particulate matter, carbon monoxide, SO2 and NO from exhaust emission from vehicles. Persons most at risk will be persons with asthmatic conditions, children, and the elderly.

During construction of employees will be at greater risk than the community since they will be on site and exposed to potential hazards resulting from dust inhalation, loud noise and vibration, exposure to chemicals or other hazardous materials and emissions from geothermal waste water, material used in road rehabilitation and construction, injury from accidents from use of machinery, accidental falls, and accidents relative to use of equipment or vehicles and / or use of heat or fire.

Existing environmental conditions such as water and air/noise quality, waste management and community safety could be impacted from modifications which may arise as a result of the project. The magnitude of the modifications however could be considered minor and will only be of concern during the construction phase of the project and is not expected to create any impact during the operation phase.

Significance

Considering a medium sensitivity, the impact of the project on community health problems can be considered minor during construction and negligible during implementation.

Mitigation Measures and Monitoring

Mitigation measures outlined under “Air Quality” to reduce the impact on air quality will reduce negative impact on the health of the community.

Community health prevention measures should be implemented including:

1. Erection of signage to alert residence of dangerous areas including construction sites and safety measures to be undertaken
2. Water quality monitoring to include potable and recreational waters for disease organisms and chemicals
3. Speed humps to be erected to reduce speed of vehicles moving through the community
4. Alerting community residents when unusual activities are to be undertaken such as drilling
5. Undertake public awareness programmes to educate the community on safety, health and environmental issues.
6. Continue to train community on emergency procedures.

Monitoring

Grievance filled by the community regarding health and safety should be tracked specifically and carefully responded. They should include associated monitoring data when necessary such as noise monitoring records at the resident’s house.

Residual Impacts

With implementation of mitigation measures, residual impacts will be reduced from minor to negligible.

9.6 Occupational Health and Safety

The health and safety of site workers could be affected by the following hazards.

- Noise.
- Moving parts, cutting equipment, sharp edges.
- Heat.
- Emissions from combustion of fossil fuels.
- Hazardous substances and material
- Vibrations
- Psychological stress
- Disease because of close proximity to others

All of the hazards outlined above are applicable to the on-site labour force actively engaged in construction. With respect to the health and safety of the workforce, the Contractors are expected to put the following mechanisms in place:

- Safeguard the health and safety of all workers engaged in the construction of the pipelines and reinjection well through the implementation of sound OHS practices and guidelines
- Ensure the safety of all those visiting the site for the purpose of monitoring or oversight
- Ensure that workplace activities are confined to the site and does not spill into the nearby community.

Guidelines and Standards

Dominica is guided by numerous pieces of legislation enacted to protect workers health and safety and subscribes to international conventions for the protection of workers health.

Dominica's Employment Safety Act, No. 3 of 1983, provides for the safeguard of safety and health at work and makes provisions for the provision of Personal Protective Equipment to all workers for protection from injury and protection from workplace accidents. The Accident and Disease Notification Act also makes provision for reporting of injuries, accidents and near misses at the workplace to ensure that similar incidents do not occur in the future and to also assure that an investigation is undertaken.

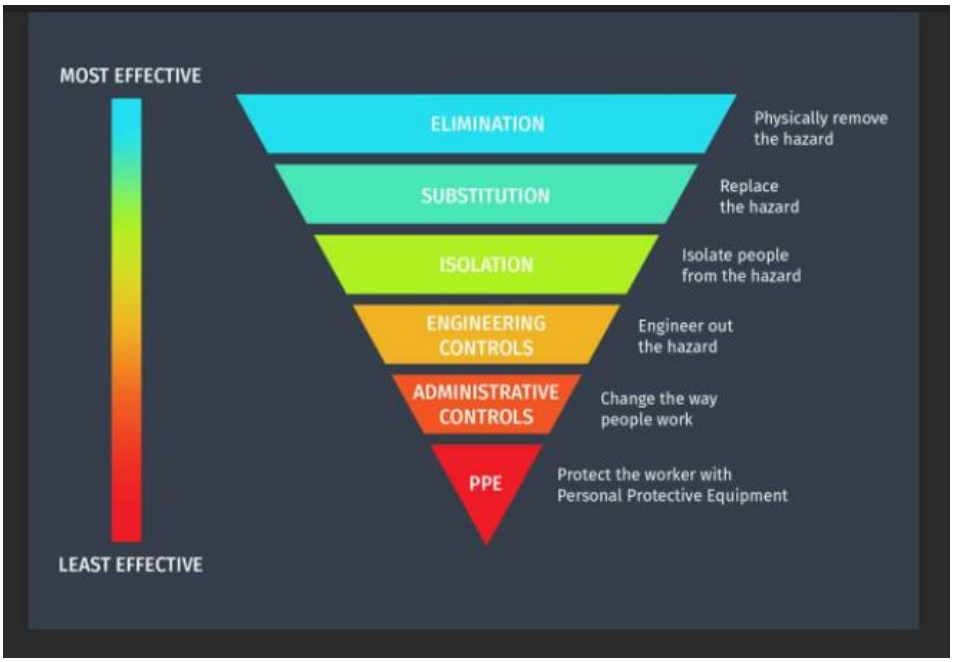
The country also has labour standard laws to establish relationships between employer and employee and also subscribes to the conventions of the International Labour Organization.

Additionally, the Dominica Geothermal Company has developed a Health and Safety Manual to guide health and safety standards at the company's worksite.
All health and safety plans, guidelines and standards developed for the project will need to meet the guidelines established by the laws of Dominica and the International Labour Organization conventions ratified by Dominica.

Workers health and management plans developed for the purpose of worker safety and health must also be in compliance to the WBG/IFC Occupational Health and Safety Guidelines'

The project is expected to employ workers during the construction phase which are expected to be exposed to the rigors of construction and the various associated hazards. Work is expected to be guided by the Safety hierarchy Hazard Control to minimize or eliminate workplace hazards.

Figure 56: *Management Process for Controlling Risk*



The management process allows for using the most effective means of controlling risks or using a combination of measures including eliminating the risk, substitution, isolation, engineering controls, administrative controls and PPEs.

Significance

Table 31: *Impact on the Health & Safety of Workers*

Category	Description
Extreme	Workers exposed to adverse conditions heat, electrical current without protection
Major	Exposure to hazards with limited controls, PPEs, No Management systems for control
Moderate	Workers exposed to hazards with controls but not separated from the hazard.
Minor	Workers exposed but with PPEs to reduce exposure
Insignificant	No hazardous activities taking place at worksite

The proposed project therefore is expected to have a minor impact on the health and safety of workers considering that workers will be nearest to the point of impact. We consider the likelihood of adverse consequence from the construction activities on workers to be low considering the implementation of worker safety plans. This assessment is based on the above matrix for impact magnitude.

Mitigation measures

The following mitigation measures are already developed by the DGDC and in place for implementation:

- An Environmental, Social Health & Safety Policy
- An environmental Health & Safety Risk Assessment Mechanism
- A hazardous substance, waste and wastewater manual
- A health and Safety Management plan

- The Contractor should adopt the ESF/ Safeguard Interim Note: COVID-19 Considerations in Construction & Civil Works Project
- A health and safety plan should be developed by the Contractor to safeguard the health and safety of employees. The health and safety plan should include:
    - The obligation of the contractor to protect the natural environments against sources of pollution from site activities to ensure safe and healthy working conditions for workers

- Prevent, avoid or reduce risks and impacts on the health and safety of the local community
- Keep on site the necessary safety equipment and material (including masks, ear plugs, temperature checks of employees, gloves etc) for use by workers and visitors
- Description of responsibilities for site-related health issues
- Development of blowout prevention procedures to include monitoring and logging.

- Conduct training for personnel on site
- Site activities must be evaluated to reduce hazards and protect workers health and safety in accordance with World Bank Group Environmental Health and safety guidelines and World Health Organization Threshold limits values for occupational exposure.
- Site managers should develop health and safety registers as mandated by the Accident and Disease Notification Act and establish procedures for assessment. All workers should be provided with the appropriate safety equipment and should be trained in their use. Site managers should instill a safety culture among site workers through compliance, training, reward, and monitoring.

Monitoring

- Review management procedures, policies and programmes for health and safety on an annual basis to ensure conformity and successful implementation
- Daily records should be kept of all injuries and accidents on site
- A health and safety officer should undertake training of workers in proper use of PPEs and to monitor daily, the safety of workers
- All worker safety plans should be available for inspections by the Environmental Health Department inspectors

Residual Impacts

The implementation of mitigation measures should help the significance to stay at a minor level.

10.0 ASSESSMENT OF ENVIRONMENTAL IMPACTS

10.1 Introduction

The project must comply with environmental regulation, guidelines and standards in both the construction and operational phases of the project. This includes compliance to Physical Planning regulations, Environmental Health Guidelines, Health and Safety Standards for construction and operation of the facility and Good Management Practices developed for operational safety.

10.2 Habitat Screening

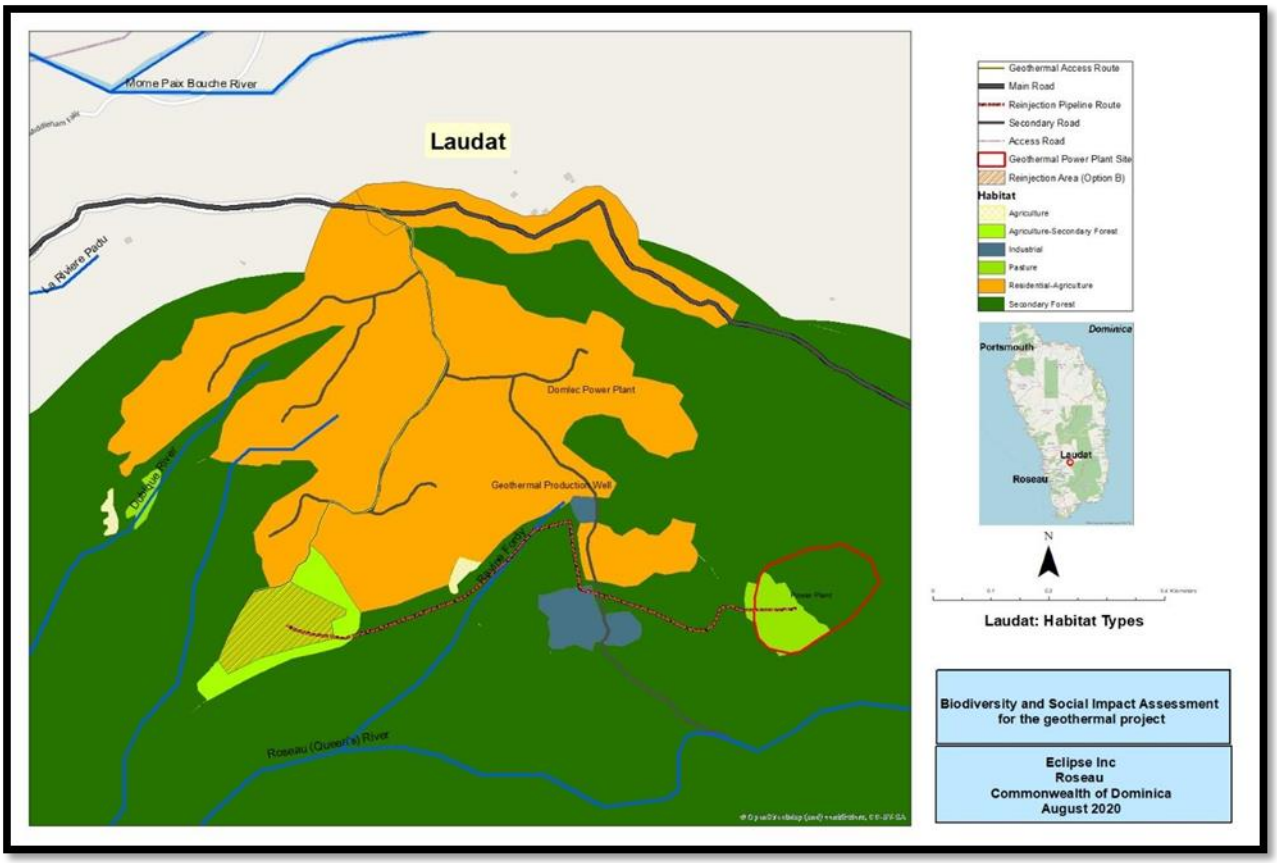
Under IFC Performance Standard 6 (PS6), habitats can be defined as Modified, Natural or Critical as follows.

- Modified Habitat: Modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological function and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands.
- Natural Habitat: Natural habitats are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition.
- Critical Habitat: Critical habitats are areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered11 species; (ii) habitat of significant importance to endemic and/or restricted range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes.

Habitat in the Area of Influence

The main habitats of the AoI area are secondary forest and agricultural habitat. However, the ecological field surveys have indicated sustained assemblages of plant and animal species that are native and has sustained its ecological function and species distribution. Hence it is considered a natural habitat

***Figure 57**: Main Habitats at the Project Area*



Critical habitats are areas with high biodiversity value, including:

- Criterion 1: Critically Endangered (CR) and/or Endangered (EN) species
- Criterion 2: Endemic or restricted-range species
- Criterion 3: Migratory or congregatory species
- Criterion 4: Highly threatened and/or unique ecosystems
- Criterion 5: Key evolutionary processes

Criterion 1-4 are based on numerical thresholds.

Criterion 1: Critically Endangered (CR) and/or Endangered (EN) species

Thresholds for criteria 1 are as follows:

- The criteria for critically endangered or endangered species are >0.5 of global population and ≥5 reproductive units
- Areas that support globally important concentration of IUCN Red-listed or Vulnerable species the loss of which would result in the change of the IUCN Red-list status to EN or CR
- Areas that contain important concentration of nationally/regionally listed EN or CR species

With respect to threshold 1, the Imperial Parrot, *Amazona imperialis* (CR), endemic to Dominica, and the Black-capped Petrel (EN) are known to utilize this area only as a flight path. At the national level, post hurricane Maria, the population of the Imperial Parot is not known, but is expected to have decreased as a result of mortality of the birds and destruction of nesting sites. The numbers worldwide or nationally, of the Black-capped Petrel are not known.

With respect to threshold 2 of Criterion 1, -the Red-Necked parrot is listed by IUCN as a Vulnerable species and was observed feeding on fruit trees in a limited location within the AoI. Data from the Forestry Division indicate that there are approximately 1200 species of the Red-necked parrot. The parrot resides primarily in rainforest canopies in two major habitats of the MTNPWHS and the Morne Diablotin National Park but over the years, they have been observed feeding on agricultural land and some agricultural crops. The AOI does not support or contain important concentration of this species. It does not contain typically old growth rain forest feeding or nesting trees for the parrot. Field research revealed a minimal number of parrots feeding. The area where the parrots fed was restricted to a small area within quadrat 2.

Based on the above information, the area does not qualify as meeting the threshold 1 or 2 for Criterion 1 for these species.

Criterion 2 – Endemic or Restricted Range Species

IFC Guidance Note GN74, defines the term endemic as “restricted-range”. Restricted range refers to a limited extent of occurrence (EOO). For terrestrial vertebrates and plants, restricted range refers to those species *with an* EOO of less than 50,000 square kilometers (km2) fall within this definition.

The threshold for criteria 2 is as follows: Areas that regularly hold ≥10% of the global population size AND ≥10 reproductive units of a species.

Four (4) endemic reptiles identified within the study area are the tree lizard or “zanndoli” *Anolis oculatus*, the ground lizard (*Ameiva fuscata*), the Dominican Boa *constrictor nebulosus* and the Worm Snake (Koulèv) *Typhlops dominicana* as well as two other endemic species of birds.

There is limited information on global population for these species. As such an assessment of the frequency and distribution of the species within the AoI will be used as a proxy. In the absence of information, the precautionary principle approach will be applied. An evaluation of the threshold of these species is given in the table below in lieu of the absence of information on global population. It entails an evaluation of the number of individuals identified during the ecological assessment, the extent of suitable habitat, and localities.

The population of the reptilian and avian species on site was minimal except for the avian Plumbeous warbler. Based on observed and recorded numbers and distribution within the AOI and this would translate to very small representative units. Most of these reptiles and avian species found there exhibit a wide range including the existing habitat of the AoI.

As such the AoI is not considered a critical habitat for these species listed in the table below.

Local Name	Scientific Name	On-Site Status	IUCN Conservation Status	Evaluation of threshold for criterion 2	Habitat
Tree Lizard Zanndoli	*Anolis oculatus*	Dominican Endemic (LC)	LC	No species were recorded in any of the nine quadrats during the biodiversity evaluation. Residents and some landowners indicated that they are present in the area	Abundant in natural and modified habitat.
Boa or Tèt-chyen	*Boa constrictor nebulosa*	Dominican Endemic (LC)	LC	No species were recorded in any of the nine quadrats during the biodiversity evaluation. Residents and some landowners indicated that they are present this area	Widespread in moist and natural habitat
Black-and-white checkered snake (Kouwès jenga)	*Liophis juliae juliae*	Lesser Antillean Endemic (LC)	LC	No species were recorded in any of the nine quadrats during the biodiversity evaluation. Residents and some landowners indicated that they are present in this area	Widespread in coastal and modified habitat
Worm Snake Koulev	*Antillotyphlops dominicana*	Dominican Endemic (LC)	LC	No species were recorded in any of the nine quadrats during the biodiversity evaluation. Residents and some landowners indicated that are present in the AoI	Found in coastal areas and in modified and natural habitats Small population
Ground Lizard or Abolo (recorded	Philodoscelis Fuscatus	Endemic (LC)	LC	One species was recorded in quadrat 9.	Found in dry lowland areas in natural and modified habitats Small population
Plumbeous Warbler, Chik-chik, Papya	*Dendroica plumbea* (LC)	Dominica Endemic (LC).	LC	Common in Dominica 31 species were recorded	Found a wide area-moist and dry forest, modified and natural habitat Large population
Blue-headed hummingbird	*Cyanophaia bicolor (LC)*	Endemic to Dominica & Martinique		One species was sighted	Abundant in natural and modified habitat. Small population

***Table 32**: Endemic Species within AoI*

Criterion 3: Migratory and Congregatory Species

With respect to criteria 3, no migratory or congregatory species were identified.

Criterion 4: Highly threatened and/or unique ecosystems

The only potentially threatened or Unique ecosystems identified in Dominica are Elfin Woodland and coastal swamp forests. Neither of these forest types fall within the AOI. Hence this Criterion is not triggered.

Criterion 5: Key evolutionary processes

Most islands including Dominica are small and discrete and tend to have high endemism as a result of evolution of new species. In addition, they have large numbers of other vascular and non-vascular species relevant to size and their ecosystem is influenced by altitudinal and micro climatic characteristics which lend itself to a large biodiversity of fauna and flora. But still the AoI itself does not qualify as Critical Habitat under Criterion 5.

Evaluation of Ecosystem Services

Ecosystem services are defined as benefits people derive from the ecosystem. PS 6 provide a framework for identifying and managing ecosystem services through the identification of priority ecosystems services. PS6 identifies 2 types of priority ecosystem services as follows:

- Type 1 – Environmental services over which the project has direct management control or significant influence and where impacts on these services may have adverse impact on the affected community
- Type 11 - Environmental services on which the project is directly dependent for its operations and the project has direct management control or significant influence on the services

Ecosystem services identified by the community were as follows:

Provisioning services- (Type 1 priority ES)

The community indicated that the AoI did not offer provisioning services of any significance. The volume of timber present was minimal for local or commercial purposes or even for fuel wood (charcoal production). This area was not critical or important for herbaceous plants for livestock and medicinal purposes. The AoI consists of abandoned agricultural areas and minimal to no livestock. There was only one active agricultural farmer within the AoI whose land will not be acquired.

In terms of cultural and recreational services (Type 1 and 11 priority ES)

Fishing was identified by the community. Hunting or other recreation or sacred values were not identified as ecosystem services important to the affected community. The rivers used for fishing are not going to be affected by the project and fishing as an activity will not be interrupted.

With respect to aesthetic amenity, the infrastructure to be built in the AoI is not clearly visible from the core area of the village of Laudat. However, the site can be seen from viewing points in the upper part of the village and along the road above the village, leading to the Freshwater Lake.

Regulating and Supporting Services (Type 1 and 11 priority ES)

The AoI is part of the broader watershed area for the Roseau River Watershed. By its very nature it will contribute to climate regulation, carbon storage and sequestration among others, as well as erosion control. This is a high rainfall area where flooding will occur during the rainy season.

Conclusion

The assessment has indicated that the AoI for the construction and operation of the geothermal well and pipeline do not have features that will likely qualify it as a critical habitat.

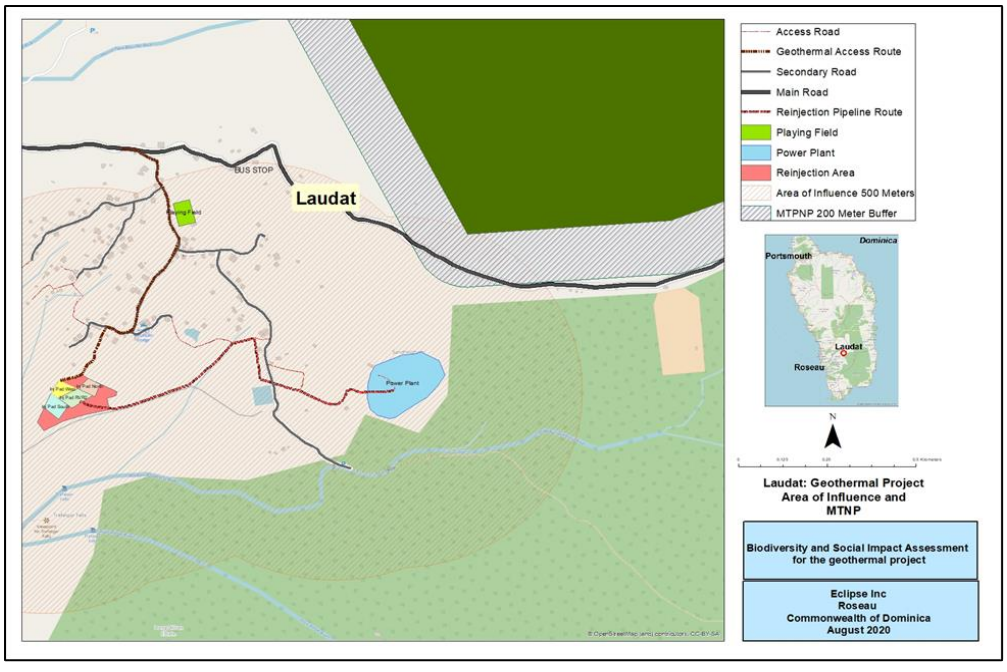
10.3 Evaluation of Biodiversity

10.3.1 Evaluation of Potential Impacts on MTPNP

The geothermal project's exploration and production infrastructure in Laudat, viz., production well and proposed power plant, re-injection pipeline and re-injection well, are located just outside the Morne Trois Pitons National Park, a UNESCO World Heritage Site.

The MTNP is a KEY Biodiversity Area and has been ranked for irreplaceability in an IUCN thematic study on terrestrial biodiversity (2013). It is a site of global importance particularly for two amphibian species Eleutherodactylus amplinympha and Leptodactylus fallax), and for three avian species; Red-necked Parrot Amazona arausiaca, Imperial Parrot Amazona imperialis, and Black-capped Petrel, Pterodroma hasitata. All three (3) species are listed on the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species.

Figure 58: *Area of Influence and MTNP (with buffer)*



The distance from the boundary of the MTPNP to the geothermal project's area of influence varies. The closest distance, approx. 500 meters (0.3 mile) is at the point where it crosses the

park boundary and the furthest distance from the south, is approx. 1700 meters (I mile). Also, the project's area of influence overlaps a section of the park's proposed buffer zone (200m), approx. 3.8 hectares (9.4 acres). No legally binding decision has been made on what should be allowed within the buffer zone.

However, the proposed activities within the area of influence will not have an impact on this buffer area within the Park since there is no plan to utilize this area for project activities.

The potential impacts of the construction phase of the reinjection well and pipeline on the Morne Trois Pitons National Park may occur from noise generated from heavy equipment, from clearing of vegetation and possible vibration from drilling as well as night-time illumination. These potential impacts on animal species vary considerably, but could potentially result in species reduction, stress, and reduction of ecological connectivity. These risks have been assessed as moderate to low since there is a possibility of non- fundamental and temporary change in the behavioural aspects, specifically for the avian population of the red-necked parrot and the black-capped petrel. The MTNP is a critical habitat for the above-mentioned species.

Mitigation and Monitoring

- Any revegetation within the area of influence after construction will entail replanting of feeding trees for the Red-necked parrot.
- For any proposed lighting, light intensity should be minimized and averted downwards and to be installed at minimum height level below the flight path of the avian fauna

Monitoring

- Continue monitoring in the area of Laudat for any potential impacts on the OUV of the property from the exploration phase of the geothermal project and to ensure that any impacts from the operational phase can be detected in a timely manner and properly mitigated

10.3.2 Evaluation of Fauna and Flora

Construction of the pipeline

<u>Impact on Fauna</u>

- Adverse, short term impacts on aquatic habitats and species (e. g. fish and other aquatic fauna) resulting in mortality of aquatic species due to sedimentation of the waterways near the construction site and downstream.
- Clearing/removal of natural vegetation (trees and shrubs) to facilitate construction of geothermal infrastructure, will directly reduce the wildlife habitat in the short term, medium-term and long term.
- Noise generated from construction activities will adversely disturb fauna, particularly birds, resulting in their temporary relocation thereby reducing biodiversity in the immediate vicinity of the construction /project site.

Impact on Flora

There will be a reduction of secondary forest from clear felling for the reinjection pipeline. However, the volume of vegetation lost is small (approximately 5 acres) compared to the overall size of secondary forest present. Regeneration will occur except in designated areas required for maintenance. The impact on flora is minor, sensitivity is medium, and significance is minor.

Drilling of the Reinjection Well

The drilling phase will generate direct impacts temporarily (during the drilling period) due to the use of drilling machinery. Drilling is expected to generate the following:

- Noise
- Vibration
- Gases, most probably hydrogen sulphide that will affect air quality
- Light that will affect wildlife
- Surface water contamination that can affect fauna and flora
- Potential poisoning of wildlife that make make contact with the water retention tank with geothermal fluid and drilling mud.

Impact on Fauna

- Noise and vibration will have an impact on wildlife and will cause migration from the site if measures are not in place to reduce these impacts. Design measures for drilling are expected to reduce vibration and noise. Drilling will also be temporary most likely for 6 weeks. Hence the impact on wildlife will be minor.

- Light Security lights at night, if installed, will affect the wildlife and the Black-capped Petrel that use this area as a “flight path” and may cause disorientation to adults and fledglings. This will be temporary, and wildlife will adjust to this through use of alternative sites within Laudat.

- The light will also attract insects and an increase of insect predators to the site.
- The volume of insects that may be attracted to the site can alter the habitats of predators and increase the mortality of the insects attracted to the site.

However, given the short timeframe for drilling the impact will be short term and negligible.

Operation

During operation there is the potential for poisoning of wildlife that may make contact with the water retention tanks and with geothermal fluid and drilling mud. There is also a risk of increased animal mortality due to poaching pressure. Some wildlife species, particularly the Agouti (*Dasyprocta leporina*), Manicou (*Didelphis marsupialis*) and the River Crab (*Guinotia dentata*) may be exposed to poaching by construction workers. The significance of the above potential impacts on the fauna is considered minor.

The surface area round the platform will be regularly cleared of vegetation. The original flora will not be allowed to re-colonise this space during this period of time. The impact will be minor, and the sensitivity will be medium. The significance of the impact is considered minor.

Conclusions

The area under study is not of “special significance” in terms of a unique habitat, to the growth and survival of the wildlife. Since they are itinerant, they will move to other areas and mortality rate will not be sufficiently significant to affect their overall population. The anticipated negative impacts are minor negligible and may not necessarily result in any significant adverse effects upon the biodiversity of the area of influence. The impacts on plant and animal communities would mostly be short-term and insignificant.

Table 33: *Matrix Table & Rationale*

Aspect	Size	Scoring	Assessment Rationale
Flora, fauna & Biodiversity	Construction and Operation	Reliability level; moderate	Based on field observation, expert opinion and scientific data
		Impact Balance: Negative	Cutting of trees, reduction of habitat, noise, light, have an adverse impact on fauna and flora
		Type of Impact: Direct	The impact is direct
		Magnitude: Moderate	They can adapt to impact from construction and operation
		Probability: Likely	Impacts will occur during construction of pipelines and reinjection well and during drilling
		Scope: restricted	Impacts will occur at project site
		Duration: Long- term	As long as the area is used for geothermal purposes as outlined, the impact will persist
		Reversibility- recoverable	With mitigation measures the impact on the site will be negligible

Mitigation Measures and Monitoring

Mitigation measures

A management plan for the control of weeds and invasive plant species should be prepared. Approximately ¾ of the length of the reinjection pipeline corridor overlaps with DOMLEC's hydro-pipeline corridor. DOMLEC undertakes routine clearing of encroaching vegetation within its pipeline corridor as an integral activity of the pipeline maintenance schedule. Therefore, there must be a system for collaborative management of the pipeline corridor between the DGDC and DOMLEC, to ensure biodiversity restoration.

Specifically, **for fauna**, the following measures are recommended:

- Noise levels from construction activity should be minimized where possible, to reduce the adverse impacts on wildlife species.
- The use of herbicides should be avoided as much as possible for vegetation clearing prior to and during construction activities to avoid adverse impacts on wildlife.
- Construction workers should be oriented not to engage in any illegal hunting or poaching in the project area and must be made aware of Dominica's Wildlife Laws.
- Hunting of game species should be prohibited on the project site and the hunting Regulations adhered to.

- As far as is possible, endemic species of wildlife should be caught with the assistance of the Forestry &Wildlife Division and relocated to similar types of forest on daily basis before the start of construction work and subsequent construction activities.
- Sedimentation of aquatic ecosystems should be minimized to avoid adverse impacts on fauna.

For flora, vegetation clearing should be carefully evaluated in order not to negatively affect the limited plant genetic resources in the project area.

- Extent of land clearing should be minimized where possible to reduce the impact on wildlife and biodiversity.
- The use of herbicides should be avoided as much as possible for vegetation clearing prior to and during construction activities.
- Disturbed areas should be re-vegetated utilizing appropriate native plants as much as possible, to increase biodiversity and minimize the adverse effects on the native flora.
- Felled trees could be provided to the community for livelihood activities like production of wood chips, charcoal production etc.
- As far as is possible, endemic species of wildlife should be caught with the assistance of the Forestry &Wildlife Division and relocated to similar types of forest on daily basis before the start of construction work and subsequent construction activities.

In line with performance Standards 6, Jacobs proposed “a biodiversity offset to ensure that the project achieves No Net Loss of natural habitat and as close to No Net Loss of all habitats as far as is possible” This will be adopted for the purpose of this assessment and includes the following :

- Habitat cleared will be minimum possible, with any way-leave area required of the minimum width necessary. This will contribute to minimising habitat fragmentation.
- A biodiversity offset will be created to a minimum equivalent to the Natural Habitat lost under the Project Area.
- A Habitat Management Plan (HMP) will be developed to establish the biodiversity offset required to achieve No Net Loss of Natural Habitats, with input from local specialists and stakeholders as appropriate.

- To reduce the impact of fragmentation of habitats by the reinjection line and to minimise severance effects, the pipeline will have under/overpasses installed at intervals along its length. The exact nature and positioning of these will be developed during detailed design. In addition, because the pipeline is located above-ground, smaller animals are expected to be able to pass under it.

Monitoring

The EPC Contractor should undertake the following good management practices:

- Implement dust-suppression measures such as covering vehicles transporting materials, ensuring vehicles use wheel wash facilities at site, and use of water spray dust suppression systems.
- Highly noisy activities should be undertaken during daylight hours where possible.
- Inductions/toolbox talks for staff should include reference to measures required to protect biodiversity.
- Vegetation clearance activities should commence outside the breeding season for five key threatened species identified, to minimise impacts on breeding animals. The breeding seasons of the three bird species are overlapping, between January and August.
- Use temporary fencing to prevent inadvertent damage outside designated construction areas.
- Avoid piling of clear-felled vegetation on standing live vegetation which would hinder movement of wildlife.
- Any replanting / landscaping should use native or endemic species to prevent the incursion of opportunistic invasive species.
- Machinery and vehicles should be cleaned upon entry/exit, and any soil brought on or off-site screened for invasive species or plant pathogens.

Residual Impact

The implementation of mitigation measures would reduce the impact to negligible, but monitoring will have to be continuous to evaluate the biodiversity of the site.

10.4 Impact on Aesthetic Amenity/Landscape

The project's area of influence has a landscape where man-made components already exist, particularly the hydro-power station, balancing tank (reservoir) and ancillary facilities, in addition to the geothermal production well site (WW-P1& WW-03). The proposed reinjection well platform and reinjection pipeline will constitute a new intrusive landscape component that could potentially alter the quiet, rural, and remote character of Laudat. Generally, the rural ambience will be negatively impacted because of the stark contrast of industrial components against the existing scenery. The major impacts will be the visibility of the pipeline if it will be placed above ground with its relevant support system.

Impact on landscape aesthetic amenity

Constructing a reinjection drilling platform and reinjection pipeline on the preferred site, may further alter a natural landscape which has already been impacted by the activities involved in hydro-electricity production. The land area projected to be occupied by the proposed reinjection platform and reinjection pipeline will constitute an open man-made space overlooking the outstanding landscape of the Roseau Valley inclusive of Morne Micotrin. It should be noted that this does not pass through the residential area.

Visual impacts

Site preparation during the preliminary stages of construction of the reinjection well and reinjection pipeline, will require the clearing and removal of natural forest vegetation at the proposed drill site (approx. 2 hectares/4.6 acres) and along the pipeline corridor (approx. 1 km x 10m). Additional site preparation will involve the use of earth moving equipment to excavate, level and compact the reinjection platform site and to clear the pipeline corridor and access routes. The clearing of natural vegetation and related earthworks at the project site to facilitate construction activity, will negatively impact the visual integrity of the zone of influence.

The development of the reinjection site will bring together several structures and buildings of an industrial nature in the same location. The drilling platform will contain many large units such as a water recovery tank, a drilling derrick, prefabricated buildings, various machines with mud pumps, mud recycling units etc. These structures will have a significant impact on the visual

integrity of the landscape. The installations will be visible in that they will contrast in size and colour with the relatively homogeneous green forest background and will be visible by residents living in the elevated area of the community, by visitors trekking into the MTNPWHS as well by other trekkers using the road to the various sites.

To evaluate levels of potential and predict the significance, receptor viewpoints used by Jacobs that are relevant to this study were chosen based on its relevance to the AOI.

Impact Significance

The sensitivity of receptors of the area and magnitude of impact of the Project on visual amenity are categorised/classified using the criteria in in the tables below: (Jacobs EIA Volume 2)

Table 34: *Sensitivity of Visual Receptors*

Sensitivity	Typical character/use
High	Permanent occupiers of residential properties and associated outdoor areas (e.g. gardens). Users of nationally protected areas, recreational scenic trails or users of designated tourist routes.
Medium	Workers in predominantly outdoor professions (e.g. farmers) and any associated temporary accommodation. Users of secondary or minor roads in scenic areas, and outdoor recreational users (e.g. sports grounds).
Low	Users of main roads, passengers in public transport or tourists in minibuses using main arterial routes.

Table 35: *Magnitude of Impact*

Magnitude of Impact	Typical criteria
Major	Total loss or largescale damage to existing character or views, and/or the addition of new but uncharacteristic conspicuous features and elements.
Moderate	Partial loss or noticeable damage to existing character or views, and/or the addition of new but uncharacteristic noticeable features and elements.
Minor	Slight loss or damage to existing character or views, and/or the addition of new but uncharacteristic features and elements.
Negligible	Barely noticeable loss or damage to existing character or views/no noticeable loss, damage or alteration to character or views.

The site is not clearly visible from the core area of the village of Laudat. However, the site can be seen from viewing points in the upper part of the village and along the road above the village, leading to the Freshwater Lake. Although located at roughly one (1) kilometer distance from the Freshwater Lake Road, the site and installations can be seen from high up by residents in the elevated area of the village, by persons traversing the Freshwater Lake Road and by visitors to the Morne Trois Pitons National Park. Conversely, when viewed from a distance (e.g. Morne Nichols, Morne Prosper), the visibility of the installations will be limited.

Visually Sensitive Receptor (VSR)	Sensitivity of VSR	Magnitude of Change	Significance of Visual Impact	Comment
Permanent occupiers of residential properties in elevated areas	Medium	Minor	**Minor**	The site is not clearly visible by the core of the village but from several houses in the more elevated areas the view will be adverse. The view of the pipeline and the infrastructure of the well pad will be partially reduced over time through the planting of trees around the pipeline and the well pad.
Outdoor workers (farmers); and recreational users/ tourists	Medium	Moderate	**Moderate**	During operation there may be a number of workers in the vicinity of the reinjection pipeline that may experience adverse views of the pipe from their properties. However, it is anticipated that these adverse views will reduce over time through vegetation growing up around the pipe.
Users of main roads or passengers in public transport on main arterial routes above the village	Low	minor	**Negligible**	During operation, there is unlikely to be any view of the reinjection pipeline from the road for users of main arterial route

The impact will be negative, direct and long term and moderate. Overall, the sensitivity is moderate, and the significance is moderate.

Mitigation

Installation of the pipes underground could reverse any negative impact. However, if this is not considered, the following are being recommended:

- The first effective measure to limit the visual impact at the reinjection site is to preserve as much as possible the trees around the site. These trees already well-grown can serve as a visual screen but are insufficient to entirely integrate the site into the natural environment.
- Landscaping to integrate the site into the natural environment by planting seedlings of native trees and shrub species typically found within the habitat.
- Planting of vegetation must be scheduled as early as possible as they will take some time to grow to a sufficient height to perform their role as a screen.
- Line-of-sight measures implemented, such as planting tall trees to limit visibility of the geothermal infrastructure.
- The site's reinstatement phase would consist of replanting of native plant species so that the site is returned to its original state and level of functionality. This reinstatement would take place at the end of the reinjection platform's operation.
- Regular maintenance of the planted trees and shrubs will be necessary to ensure the survival and effectiveness of this screen of vegetation over time.
- The visual impact of the reinjection pipeline could be reduced by altering its colour. It is recommended that the pipeline be painted in natural colours such as brown or green. The visual impact will be less strong than with the metallic-coloured pipe which also reflects the sun. This will assist in the integration of this structure with the landscape

Monitoring

- Assess the acreage of area that has been landscaped and replanted with of native trees and level of maintenance of these trees and shrubs
- Replanting to be done within 4 months of clearing
- Pipeline is camouflaged through use of paint to reflect the natural colour of the environment

Residual Impact

With the implementation of the proposed mitigation measures, the residual visual impacts from the construction and operation of the pipeline and well pad will render the significance minor.

10.6 Impact on Soil

Soils can be negatively impacted by construction and operation activities through removal of topsoil, construction of drainage channels and soil contamination from accidental leakage of brine from the reinjection pipeline and through mud removal from the reinjection well.

During the construction period, soil and vegetation will be removed for the construction and rehabilitation of the access road, construction of the pipeline and well pad. For the pipeline (1200m) which is expected to be above ground, this will entail removal of surface soil and vegetation clearing for foundational work for support of the pipeline. Jacobs ESIA has estimated that this will amount to “(under 5 m2 each, every 50 m along the pipeline), to ensure they are on even ground to prevent settlement”.

The route may also need some localised earthworks as well as minimal excavation works in grading and construction of bridge/by-pass across a small waterway. As such, the volume and of soil removal from these activities is considered low and as such will have a minor impact on the geology and soil of the area.

There should be no contamination of the soils from hazardous waste or substances except through accidental spillage, improper storage or leaks from equipment. Without mitigation measures the significance of this can be moderate.

Drilling will have a mechanical impact on the soil and subsoil through the breakdown of the penetrated strata layers. However, this impact will be limited to the borehole and neighbouring rocks and the significance is expected to be negligible.

During the drilling phase, the mud will be in contact with the penetrated geological formations in particular, through fissures, faults or via under-pressurised permeable formations. Design technology for the mud will enable it to deposit a protective film called "mud cake" preventing major contamination of the formations penetrated and remaining very superficial. The cake and

the last remnants of mud will be flushed out prior to placing the cement using a "spacer" to clean the casing-formation interface.

Effluents from drilling, the mud and geothermal fluid will be recycled for use and then reinjected into the well thus there will be negligible impact. Coral Cuttings contained in the mud and the geothermal fluid extracted during the tests will be stored on the drilling rig in the watertight storage tanks provided. These effluents will therefore have no impact on the soil concerned.

The drilling area will be designed to prevent runoff and percolation. Water will be controlled through lined ponds and reused for drilling mud. The water will be sterilized prior to use to ensure no bacterial matter is introduced to ground water in all the drilling phase

Storage activities around the well-head primarily concern fuel, oils and lubricants (used to maintain the engines). Fuel will be stored in a watertight overhead tank. Engine oils and lubricants will be stored in a shed or building

Oils that have been used for turbine maintenance will be stored in tanks provided for this purpose. The handling of oils and fuel therefore has no impact on the soil or subsoil, apart from spillage

Construction of the access road will entail improvement to the existing road - basically road widening, grading, resurfacing and drainage and will not require major excavation. The significance of this is considered negligible.

At the operational phase, the potential impact will be contamination which could occur from accidental leakage of brine from the reinjection pipeline and geothermal liquid. Liquid geothermal effluent waste will have no impact on the soil or subsoil if they are treated on site.

There is a risk that soil will be adversely impacted by oils and stored chemicals through spillage, and improper handling and storage or through natural hazards. It is unlikely to occur if internationally standard operating procedures are in place.

The magnitude of this impact is moderate without mitigation measures, but the likelihood of impact is low based on project design.

Given proposed mitigation measures, the magnitude of the potential impact is considered as minor, and with a medium sensitivity, the significance is minor.

Table 36: *Rationale for Impact Evaluation*

Aspect	Size	Scoring	Assessment Rationale
Pollution of soil	Risks from spillage of petroleum products and other by-products from reinjection during construction and operation	Reliability level: High	Based on field observation, expert opinion and scientific data
		Impact: Negative	Soil quality will be adversely impacted by leachate of petroleum products oil or other solvents
		Type of Impact: Direct and indirect	The impact from construction or operations will be direct
		Magnitude: Moderate	Research has indicated that the potential pollutants can have a negative effect on the quality of soil
		Probability: Likely	Can occur during construction and operation
		Scope: restricted	Impacts will occur at project site
		Duration: short term	If recommended mitigation measures are implemented within the shortest period of time, overall, the duration can be short term
		Reversibility-reversible	With mitigation measures the impact will be minimized and the quality of the soil restored

Mitigation

- Contractor to develop procedures to reduce soil erosion, sedimentation and pollution
- All sediment and silt will be contained and prevented from getting into drains or surface water by barriers and any unused soil will be disposed of through licensed haulage truck, with suitable covering of waste, to a legally designated landfill.
- Proper use and storage of oils fuel solvents and petroleum products.
- Proper use and management of hazardous materials. Any use of hazardous materials shall conform to the proper use / recommendations of the product as well as the relevant national laws and policies governing the use of such products.
- Waste hazardous materials and their containers shall be disposed of in a manner approved by the relevant agency.
- In case of accidental spillage, contaminated soil should be excavated and replaced with clean fill to minimise (or prevent) groundwater contamination with treatment of any storm water runoff or process water prior to disposal
- All vehicles will be maintained off site and in garages

- Appropriate locations within the site should be identified for construction of surface water drainage systems to reduce flooding to adjacent properties
- Employees should be trained in proper use and storage of these pollutants so that spillage can be minimized.
- Reducing construction activities during the rainy season when flooding occurs
- Where excavated material is suitable to be used for construction purposes material will be transported to a designated area for storage

Monitoring

- In case of accidental spillage, soil should be tested to monitor level of contamination
- Ensure that training of employees in proper use and storage of pollutants has been have undertaken
- That construction schedule is in keeping with recommended mitigation measures

Residual Impacts

The assessment indicates that there is a risk of residual impacts on soils. However, the significance will be negligible and therefore not considered significant.

10.7 Impact of Noise

10.7.1 Introduction

This section deals with the potential impacts of noise during the construction of the reinjection pipeline and drilling of the reinjection well and the operation phase of reinjection of the geothermal wastewater.

The World Bank Group (WBG) recommends noise limits for residential locations in accordance with its Environmental, Health and Safety (EHS) Guidelines. These guidelines have been adopted from Guidelines for Community Noise, World Health Organization, 1999 and are values for noise levels measured outside a dwelling. The noise level guidelines from the WBG have been reproduced in the following table:

Table 37: *Noise Level Guidelines*

Noise Level Guidelines[54]		
	One Hour LAeq (dBA)	
Receptor	Daytime 07:00 - 22:00	Nighttime 22:00 - 07:00
Residential; institutional; educational[55]	55	45
Industrial; commercial	70	70

The background noise levels measured during the baseline is indicative of community noise generated from light traffic to rustling of trees.

Excessive noise levels have been known to lead to adverse health conditions including loss of sleep, annoyance and lead to cardiovascular and psychophysiological effects, reduce performance and provoke annoyance responses and changes in social behavior (WHO, 2018). Assessment of noise levels from construction and operation of the reinjection pipelines, well pad and well will be evaluated based on international standards of noise levels generated for relevant equipment and processes that will be used for this project.

Assessment of the impact of noise will be evaluated on the WB criteria for noise levels.

10.7.2 Evaluation of Impacts

Noise Sources

Construction phase

Noise levels are expected to increase during construction and drilling of the reinjection well however noise levels will differ over the various locations, the type of equipment being used and the time of day that works are being undertaken. Noise levels will increase from increased vehicular traffic and use of heavy equipment for the purpose of drilling and laying of the pipeline, and from construction of the well pad.

***Table 38**: Noise Levels for Equipment to be used during Construction Phase of the Project*

Construction stage	Noisiest equipment	Sound Power Level dB(A)
Reinjection pipeline		
Earthworks	Bobcat <10t Vibratory roller	111
Footings	Concrete truck and pump Concrete drill	109
Placement of pipe sections	100T Mobile crane Gas cutter Ratchet gun	107
Reinjection well		
Earthworks	Bobcat <10t Vibratory roller	111
Finishing works	100T Mobile crane Gas cutter Ratchet gun	107
Bridge		
Earthworks	Bobcat <10t Vibratory roller	111
Footings	Concrete truck and pump Concrete drill	109
Access Road		
Asphalting	Asphalt paving machine 30T Road dump truck	110
Earthworks	15t Road grader 30t Excavator 40t Road dump truck 2 x 20t Vibratory roller	116

Operation Phase

Valuation of noise from operations is based on the modelling methodology calculation of representative operational noise sources for reinjection well and pipelines used by Jacobs, 2019 as shown in the table below:

Table 39: *Valuation of Noise Levels from Operations*

Component	Equipment	Sound Power Levels SWL db(a)
Reinjection wells	Reinjection pumps	77
Commissioning of both power plant and reinjection wells	Steam pressure releases	118

Noise levels

Construction

The adverse impact of construction noise will be determined based on the extent of the noise levels above the existing background noise and the duration of the construction activity based on the proximity of the community from the noise generated.

Construction noise limits have been identified using the above impact criteria for noise sensitive locations in Laudat.

Table 40: *Impact Criteria for Noise Sensitive Locations in Laudat*

Location Residential Educational and Institutional receptors	Noise levels obtained dB(A)	Expected increase dB(A)	Maximum allowable increase dB(A)
N 15 33098 W 61 32580	60	15	75
N 153312 W 61 3356	45	15	60
N 15 3325 W 61 3331	45	15	60

Operations

The operation of the project has been assessed to determine the potential for noise impacts on residential and other noise sensitive receptors and factors taken into consideration to determine noise mitigation.

Noise levels from operation are expected from the pumps and based on sensitivity criteria are negligible.

Magnitude of impacts

Table 41:*Criteria for rating magnitude for noise levels*

Category	Description
Major	A Noise impact that is significant and mitigation must be considered.
Moderate	A Noise impact that is significant and mitigation should be considered.
Minor	A noise impact that is significant, but small enough that noise management practices would ensure noise levels are below significance criteria.
Negligible	No need to consider in decision making, no mitigation required.

Table 42: *Magnitude of Impact*

Magnitude of impact	Exceedance of operational noise criteria – dB(A)
Major	≥ 5
Moderate	3.0 – 4.9
Minor	0.1 – 2.9
Negligible	0

It is recommended that ambient noise levels do not exceed or result in a maximum increase of more than 3dB at the nearest receptor location.

Table 43: *Criteria for Sensitivity of Receiver*

Category	Description
High	Hospitals, medical centres, place of worship
Medium	Offices, schools, Zoos, botanical gardens Quiet areas for the preservation of habitat Residential areas
Low	Residential areas within commercial and/or industrial areas
Negligible	Commercial and industrial premises

The distances of public and private buildings from the source of the noise are as follows:

- Church (Catholic): 121 meters
- Former school building: 150 meters
- Roxy's Mountain Lodge: 215 meters
- Closest Residential Buildings: 122meters
- Closest Secondary Road: 150 meters

The majority of residential buildings are further away.

Evaluating the significance of the impacts

Construction

Noise levels are expected to increase during the construction phase of the project. These increases are expected during the drilling of the reinjection well, during the movement of heavy equipment and increase traffic as a result of the expected construction activities.

Works associated with the construction of the reinjection well, are predicted to comply with the noise limits at all other surrounding residential receivers. The nearest buildings to the reinjection site are the Catholic Church and former school building which is located east of the reinjection site 121 and 150 meters respectively.

Noise levels at these community buildings are not expected to increase significantly considering meteorological conditions, distance and drilling equipment which will be fitted with noise suppressing capabilities. Additionally, the school building is being used as a community center since students attend school in the neighboring community of Trafalgar and is only used

intermittently.

The maximum noise level of the reinjection pipeline construction activities is predicted to be as follows: Baseline noise levels obtained during the assessment revealed that noise levels at the nearest residential site from the proposed reinjection well site did not exceed 56 dB(A). Expected increase in background noise levels is not expected to exceed 3 dB (A) with maximum noise levels at the school and church buildings expected to be 59dB(A), a margin which is within the WHO and IFC standards for acceptable noise levels.

The magnitude of the noise impacts is therefore expected to be minor with noise levels being small enough to be manageable.

The sensitivity of the noise increases is also expected to be low since the nearest residential and receivers are over 120 meters away and community buildings within the limits are used intermittently.

Noise levels associated with laying of the pipeline is considered negligible and is not expected to exceed the ambient noise levels obtained during the assessment

***Table 44**: Rationale for Impact Evaluation*

Aspect	Size	Scoring	Assessment Rationale
PAP and environment/ wildlife	Generation of noise	Reliability level: High	Based noise measures, comparison with international standards, expert opinion, and scientific data
		Impact: Negative	Has a direct impact on receptors
		Type of Impact: Direct and indirect	The impact from construction or operations will be direct
		Magnitude: Minor	The PAP can adapt to noise.
		Probability: Likely	Can occur during construction and operation
		Scope: restricted	Impacts will occur at the project site and in areas adjacent to site
		Duration: short- term	Noise will occur during construction and is considered short term
		Reversibility- reversible	With mitigation measures the impact will be minimized

10.7.3 Mitigation and Monitoring

Mitigation

Predicted noise level increases should be considered during construction and worst-case scenarios must be considered when scheduling construction activities. The following must be considered when planning construction activities. Recommendations from DGDC EMS Manual on Noise and Vibration will be implemented. It includes among other activities the following:

1. A Construction Noise Management Plan should be formulated to provide a framework for addressing construction noise levels.
2. Construction works should adopt Best Management Practice (BMP) and Best Available Technology practices.
3. Use well maintained equipment to reduce noise emissions
4. No noise generating works can be undertaken at staging areas where works are not adjacent to residential receivers
5. Provide a summary of required construction noise management practices to all staff and contractors and be included during site inductions. The summary should include, as a minimum, the permitted hours of construction work, work site locations and site.

Monitoring

- Noise level measurements to be taken at the point of construction and at the nearest community receptor once during construction at daytime and nighttime
- Maintenance records kept of vehicles and equipment used on the project
- Ensure strict adherence to the time established for drilling
- Establish and review maintenance logs kept of drilling equipment to ensure regular maintenance.

10.7.4 Residual Impact

The impact assessment indicated that the impact of noise generated from construction on the community would be negligible. Mitigation measures would enable to keep the noise negligible.

10.8 Impact on Hydrology of the Area

10.8.1 Introduction

The project area falls within the Roseau River watershed. It also serves as a watershed for several ground water sources which spring out in the community of Trafalgar located about 500 meters downstream.

Surface runoff from the zone of influence is drained mainly via to (2) perennial watercourses and two (2) intermittent ravines, in addition to a network of natural and man-made ditches. All water courses within the study area are tributaries of the Roseau River.

This section outlines the potential impact on surface water including water quality from the construction and operation of the reinjection pipeline, and the reinjection well and access road.

10.8.2 Water use and consumption

During construction of the pipeline, water use will be restricted to construction of concrete foundation for the pipeline, the bridge crossing over the perennial stream, Ravine Fordy, and potable water for consumption. Discussion with technical staff of DGCD indicates that water will most likely come from adjacent streams. Water uptake for this will be minimal. Workers on the project will be expected to bring along their own supply of potable water.
Construction of the well pad and reinjection well and road access will require minimum use of water.

Pipeline and well operations will not require extraction of potable water.

The significance of extraction of water for use and consumption during construction and operation on the water resources is considered negligible.

10.8.3 Assessment of impact on Water Quality Resources

Introduction

The proposed reinjection site serves as the watersheds for two ground water sources feeding into rivers in Trafalgar. Drilling and disposal of geothermal wastewater at the project site could result in modifications of surface water.

Reinjection of geothermal waste water is generally high in salinity and contain pollutants such as Fluoride, Boron Arsenic, lead and mercury, (Huang , S. and Tian T, 2006) and is known to exceed the World Health Organizations standards and guidelines for water quality for drinking, recreation and agricultural irrigation (WHO, 2000). Wastewater re-injected into the ground could impact surface water through poor management of pipelines and could have a negative impact on users downstream.

Accelerated soil erosion resulting from earth excavation during construction activity i.e., access roads, well pads, re-injection pipeline and ancillary infrastructure), particularly during periods of heavy rainfall, leading to increased sediment and nutrient delivery into rivers and streams.

Surface and groundwater could also be impacted by high turbidity from soil removal and drilling for disposal. If mitigation measures are not implemented, the impact can be long term and moderate. There will be some cumulative effects from some pollution getting into the surface water from run-off from the community as well as from agricultural inputs. Overall, the magnitude can be considered moderate and the significance minor.

Activities of Construction and operations

During construction and operation, the proposed project will have a number of activities which could have potential impacts on the aquatic environment. This includes a number of disturbances during construction and the potential for leaks and spills of geothermal wastewater into the water courses. The following table developed by JACOBs 2018, identified the activities which could potentially affect the waterways.

Table 45: *Activities & Potential Impacts on Waterways*

Construction	
Reinjection pipeline construction: • Clearing of a 10 m wide corridor. • Provision of a road network to access the reinjection site. • Earthworks including excavation of foundation holes, drilling • Construction of the pipeline • Concrete use for foundation construction. • Possible excavation of sumps for draining line down and collecting condensate (Not confirmed by DGDC)	The main potential impact is from erosion of site soils then causing sedimentation impacts upon tributaries of the Roseau River and within the Blanc River. Direct physical disturbance could also occur at stream crossing locations within the tributaries of the Roseau River and within the Blanc River.
Water supply: • During construction, there will be a water demand for workers (potable and toiletry), equipment washed down, concrete mixing and potentially a reserve for firefighting. Raw water for construction works shall be drawn from the naturally occurring spring located within the site.	Although no flow rates are currently known for the stream, it is estimated that the stream has a flow rate of between 5 – 10 litres/s. Assuming this stream is 5 litres/s, if water is pumped to a 10 m^3 plastic tank and at an abstraction rate of one L/s (20% of flow rate) then it is estimated that it would take ~167 minutes to fill this tank daily.
Sewage and site amenity wastewater discharge: • Treatment by package plant then discharged to land via soakaway.	Limited potential discharge to the Roseau River.
Operation	
Storm water discharges from process areas: • Storm water from areas with oily process operations will be drained through oil interceptors before being discharged to watercourses.	Well pads plus reinjection site.
Treated sewage discharge: • Treatment by package plant then discharged to land via soakaway.	Limited potential discharge to the Roseau River.

Process wastewaters (condensate and brine): • These include condensate captured in sumps along pipeline route and on well pad. • Sumps will also be provided at the well pads to store brine or condensate that is discharged accidentally. • All brine and condensate wastewaters will be reinjected with no provision for discharge to the environment.	None envisaged as no discharge to the environment planned.
Water supply for showers, cleaning and firefighting: • Is expected to be delivered drinking water for 2-3 staff with rainwater collection for showers and cleaning. Firefighting water would be kept in a tank onsite. Bore maintenance is expected to use portable or tank water supplies when required.	None envisaged as no direct take from rivers.
Potential water supply for reinjection well stimulation: • This would require 51,840 m^3 of water to be pumped into WW-RV12 at a rate of 20 litres/s over a 1-month period. This is 0.6% of the base flow in the Roseau River at the point of take.	A large reduction in base flow could impact on the ecology. The low percent of base flow that is abstracted is considered unlikely to modify the available habitat within the watercourse and would be unlikely to impact on the ecology.
Hazardous Substances Storage: • Geothermal fluids which will be captured and re-injected. • Working fluid will be stored in bunded tanks. • Acid, caustic soda, biocide, dispersant and turbine lube oil will all be stored and used on site. These would be stored in bunded tanks with any residual material following use of products for cleaning collected.	None envisaged as all products bunded on site.

Impacts

<u>Construction of the pipeline and well pad</u>

This constitutes removal of vegetation along the pipeline corridor up to the reinjection well- a total length of 1.2 kilometers, slope stabilization, drainage, construction of a bridge construction

of service road along the pipeline and to some extent, excavation. The bridge will be constructed over the 'Ravine Fordy" which is located some fifty feet below. This is expected to generate increased erosion and sedimentation of the river which will have direct and indirect impacts from sedimentation. Earthworks and construction of a stream crossing phases of the pipeline construction as well as the movement of construction vehicles on bare soils will generate loose soil and pose some risk to the existing water quality and ecology. The impact on water quality will be direct.

Removal of trees reduces rainfall interception and increases volume and flow of water which increases soil erosion and sedimentation of surface water and turbidity. Additionally, small amounts of lubricants from vehicles and machinery on site can leach into the soil and wash down into streams and rivers during heavy rains.

Road construction to the reinjection well pad will not require clear felling of trees since it is a previously established road and will require upgrading to include widening and resurfacing. It is assumed that proper drainage will be constructed for surface water discharge. Small amounts of lubricants from vehicles and machinery on site can wash down temporary waterways during heavy rains. However, the overall impact will be moderate. Overall, the sensitivity is considered medium.

The significance of this is considered to be minor.

<u>Liquid drilling effluents</u>

The effluents are the geothermal fluids and the river water used for cooling mixed with the mud. The geothermal fluid will be stored in impermeable basins then re-injected into the well.

Drilling mud constitutes the main source of the potential pollution of surface water, groundwater, soil and subsoil. The mud will be recovered and recycled into the drilling well throughout the drilling operation. Mud waiting to be recycled will be stored in watertight pits to avoid polluting the outside environment.

Based on project design, the potential impact is considered to be of minor significance.

Operations of pipeline and reinjection well

The used geothermal fluid will be disposed of into reinjection wells RV I 2 via a 25-45 cm diameter pipeline of approximately 1.2 km in length.

Reinjection of the geothermal wastewater could cause contamination of ground and surface water through surface spills and leaking pipelines.

Wastewater re-injected into the ground could impact surface water through poor management of pipelines and could have a negative impact on users downstream. Surface and groundwater could also be impacted by high turbidity through soil removal and drilling for disposal.

The proposed impact on the water resources is negative. The magnitude can be considered moderate and the significance minor.

***Table 46**: Matrix Table and Rationale for Surface Water Quality*

Aspect	Size	Scoring	Assessment Rationale
Surface water	Water Pollution	Reliability level; High	Assessment was based on evaluation of scientific data, expert opinion, previous reports
		Impact Balance: Negative	Drilling and construction process, potential spills and leachates can cause pollution of surface water
		Type of Impact: Direct	Impact will be both direct and indirect
		Magnitude: Moderate	Impact can cause changes to water quality, but it will not be permanent
		Probability: Unlikely	There is a risk of occurrence accidentally, or through lack of experience or standard operating procedures, SOPs
		Scope: restricted	Point sources of pollution will be from the site, However, the impacts can be felt along the watershed serving several communities
		Duration: Short term	Short to Medium term from construction to operation
		Reversibility	Water quality will recover if mitigation measures are applied

10.8.4 Mitigation Measures and Monitoring

The following are mitigation measures for reduction of water contamination.

- Trees should not be cut unless necessary
- Gravel should be placed over area where vegetation is stripped
- Chemicals, lubricants and fuel should be stored above ground in sealed containers with concrete embankments built to hold potential spills.
- Vehicles and machinery should be regularly maintained, and all fuel and lubricant leaks should be immediately repaired.
- Absorbent material should be stored onsite for cleanup of spills
- A spill monitoring program should be established
- The project contractor shall prepare a water quality plan that will highlight the quality of the on-site environmental management. This monitoring concerns compliance monitoring which will be required at all points where liquid effluents (wastewater, drainage) leave the confines of the project sites concerned for the natural environment.

Monitoring

- Monitoring points should be established at the Trafalgar and Providence river to monitor water pollution and chemical contaminants
- Samples should be taken at six-month intervals at establish sample points and immediately after each spill, incident or leak to analyses water for potential contaminants
- Flow measurements should be undertaken at springs located downstream during drilling of the reinjection well and samples analyzed after drilling to assess impact of drilling on the aquifers.

10.8.5 Residual Impacts

Implementation of mitigation measures will greatly reduce the impact of water pollution from construction and operation. However, the significance will remain minor.

10 .9 Ground Water Resources

Drilling and disposal of geothermal wastewater at the project site could result in modifications of potential ground water sources or aquifers located beneath the surface of the site.

Reinjection of geothermal waste water is generally high in salinity and contain pollutants such as Fluoride, Boron Arsenic, lead and mercury, (Huang , S. and Tian T, 2006) and is known to exceed the World Health Organizations standards and guidelines for water quality for drinking, recreation and agricultural irrigation (WHO, 2000). Wastewater re-injected into the ground could impact groundwater through poor management of pipelines.

During the drilling phase, the mud will be in contact with the penetrated geological formations in particular, through fissures, faults or via under-pressurised permeable formations.

There is a risk that groundwater resources, if present, can be negatively impacted from drilling phase through penetration into geological formations particularly through fissures, faults tor via under- pressurized permeable formations. Mud from geothermal fluid leaks and over time, through leachate from discharge of fluids can also affect groundwater. This will depend on the general characteristics of the rock in the area and hydrogeology of the area as well as the watershed. The impact of this would be negative, and direct. Impact magnitude would be major and sensitivity high.

The design technology allows for cemented surface to protect shallow groundwater aquifers. However, the proposed design technology for the mud will enable it to deposit a protective film called "mud cake" preventing major contamination of the formations penetrated and remaining very superficial. As such the impact magnitude would be minor.

Mitigation Measures and Monitoring

- Proper well control is important to prevent blow outs
- A hydro-geological survey of the entire area inclusive of the hill overlooking Trafalgar should be conducted to assess the presence of aquifers within the AOI and any potential impacts that could accrue from this project so as to augment the baseline information and to provide the necessary data for future planning.

10.10 Impact on Air Quality

10.10.1 Introduction

Because geothermal electricity production does not burn fuel, they emit very little air pollutants. Of concern however in these power plants is the release of non-condensable gases, NCG hydrogen sulphide (H_2S) with its distinct rotten egg odour at very low quantities.

Mercury if present in a geothermal resource, using that resource for power production could result in mercury emissions, depending upon the technology used.

Air Quality was not measured since there is limited capacity in the country to monitor ambient air quality. JACOBs (2018) used predictive modeling techniques to predict ground level.

10.10.2 Impact of Construction and Operation

Construction

During project construction, there will be an increase of vehicles plying the road causing increased traffic and generation of vehicular emissions. Air quality is expected to be affected by fumes from vehicles and from machinery used on the project site. Emission from exhaust such as NOx, CO and particulate matter are expected to increase as a result of fossil fuel combustion in vehicles and machinery and equipment. There will also be generation of dust from construction and excavation. The dispersion of dust to the community will be hindered as a result of the direction of the wind. The area is affected by the trade winds. The direction of the wind is from east to west and will be blowing away from the community. Dust can also affect the biodiversity of the species. However, the impact is expected to be minor. Sensitivity to biodiversity will be low.

Inhalation of dust and fumes from vehicles will directly affect road users and residents along the roadside, as well as employees on the project site. The impact will be minor, and the sensitivity will be medium.

The significance of the impact of construction is expected to be minor given the fact that onsite workers will be given personal protective equipment.

Operation

There will be no release of steam from the pipeline and reinject well because of the technology used- binary system. However, the possibility exists for air quality to be impacted during operation by unplanned and intermittent release of steam from the pipeline and reinjection well. The likelihood of this happening is low.

Matrix Assessment Table

Table 47: *Rationale for air quality & dust emissions from construction of reinjection line & well pad.*

Aspect	Size	Scoring	Assessment Rationale
Air Quality	Dust Emission	Reliability level; High	Scientific surveys, past reports. expert opinion
		Impact Balance: Negative	Generated from dust, fumes from vehicles and from machinery used on the project site and exhaust emission.
		Type of Impact: Direct	Dust emissions have a direct impact on air quality
		Magnitude: Minor	There will be no noticeable change resulting from air emissions
		Probability: Likely	Dust emissions will be generated during construction phase from excavation and from increase vehicular traffic
		Scope: restricted	Distance from which impact will be visible
		Duration: Short term	Emissions will occur during construction
		Reversibility	Air quality will recover if mitigation measures are applied

10.10.3 Mitigation and Monitoring Measures

Mitigation Measures

- Speed breaks should be introduced at specific junctions to reduce the travel speed of motorists to curb dust and particulate matter
- Wetting of the surface land and roads is also encouraged at the construction phase to reduce migration of particulates from dust
- Road users should be encouraged to utilize environmentally safe vehicles via proper maintenance of vehicles
- All vehicles carrying waste from excavation should be properly covered

Monitoring

- Measurement of dust levels
- Measurements of air quality every six months for mercury and Hydrogen sulphide
- Workers to be fitted with H_2S monitors at all times during operation

10.10.4 Residual Impacts

With the implementation of recommended mitigation measures, the residual impacts from both construction and operation will be reduced to negligible significance.

10.11 Waste Generation

10.11.1 Introduction

The proposed project is expected to produce significant quantities of waste. Effective waste management is an important safety feature and an effective environmental protection tool. The project will generate both hazardous and non- hazardous waste including construction waste, oils and other lubricants, chemicals used in drilling and pipe laying and other human waste which needs to be managed to reduce the potential for environmental pollution and reduce the potential negative impact of the project on humans and the environment.

10.11.2 Impacts during construction

This includes waste from general construction activities like rock, metal, cement. steel and metal pipes, paints as well as excavated soils as well as waste generated from paper cardboard etc. while there may be some chemical that will be utilized. The containers from these- chemical will be disposed of utilizing acceptable national and international standards. It is expected that these will be re-used, re- cycled and disposed into a landfill. The magnitude of waste will be moderate, sensitivity will be minor and the significance of this will be considered minor.

With respect to operational waste, most of it – condensate, brine, drilling mud, NCG's and cooling sludge will be reinjected and with respect to the mud will be re-used. As such the impact will be negligible.

10.11.3 Impact during operations

Waste is expected to create aesthetic problems with potential concerns of accumulation on site. There is a risk that hazardous material could leach into the nearby waterways and contaminate recreational and drinking water being used downstream. However, this is unlike to occur given the standard operating procedures that will guide the handling and storage of hazardous waste.

Chemical waste could contaminate soils and surrounding lands. Waste accumulation could increase the potential for disease causing rodents, flies and mosquitoes and improper waste

management can contribute to air and environmental pollution leading to air and environmental contamination. However, design measures are in place to contain most of the waste generated during operation. Waste generated from construction will be disposed of based on local and international standards.

Hazardous waste will be controlled according to the proposed hazardous Substances Management Plan for construction and operation both by the contractor and in line with the DGDC ESMS associated procedure (DGDC-ENV-004: Management of hazardous substances, waste and wastewater).

With respect to non-hazardous waste, the impact is direct and negative, reversible and magnitude can be considered moderate, the sensitivity is low, and the significance is considered minor.

The impact from hazardous waste is direct and negative. Sensitivity is high and magnitude is moderate, and the significance is moderate.

10.11.2 Mitigation Measures and Monitoring

Mitigation Measures

- Project management should adopt and implement the 3 R of waste management - reduce, re-use and recycle
- A waste management plan should be developed to realize the various principles of waste management including
    - Waste re-use where applicable
    - Waste reduction
    - Waste minimization and disposal in approved ways
- DGDC will activate its Hazardous substances, waste and wastewater, ESMS procedures
- All waste management practices shall be in accordance with local regulations and shall conform to Good Management Practices (GMPs)
- Hazardous waste shall be separated from non- hazardous waste at point of generation
- Roles and responsibilities shall be clearly defined and a management responsibility for waste management shall be determined

- Hazardous waste shall be so labeled and disposed accordingly
- Non-Hazardous waste shall be packaged and disposed at the Fond Cole landfill
- All waste oil and water contaminated with oil will be collected and stored in sealed non - porous containers such as plastic tanks
- All waste associated with the project should be managed and disposed of effectively
- The contractor is responsible for providing an adequate system for the collection, transportation and disposal of garbage and other solid waste generated at the sites**.**
- Adequate garbage bins will be provided for workers to store waste.
- Storage bins will be transferred to appropriately identified collection point to ensure regular pickups by licensed haulers or persons designated by the Contractors
- All sediment and silt will be contained and prevented from getting into drains or surface water by barriers and any unused soil will be disposed of through licensed haulage truck, with suitable covering of waste, to a legally designated landfill.

Liquid waste

- All human waste shall be disposed in septic tanks and soakaway systems constructed for the purpose of human waste disposal
- Wastewater shall be disposed via collection tanks
- Wastewater from the drilling process shall be collected in sumps.
- Training programme to be developed and implemented on waste management and disposal

Monitoring

- Monitoring shall be done of the project site by an environmental and social safeguards specialist to ensure that containment, collection, transportation, and disposal systems are in keeping with national and international standards
- Waste types and quantities shall be recorded and be available for review by the authorised personnel

10.11.3 Residual Impacts

The implementation of mitigation measures with respect to proper use, storage management, and disposal of hazardous waste as well as well as non-hazardous will

translate into negligible impact on the environment and hence negligible impact significance.

10.12 Cumulative Impacts

Cumulative impacts are defined as impacts accruing from other projects within the existing geographic space or projects located alongside other existing facilities with similar discharges. There are no proposed development projects planned for this area that will incur cumulative impacts.

11.0 ENVIRONMENTAL & SOCIAL MANAGEMENT PLAN

This section provides a summary framework for assessing the social and environmental impact of the project, to review the mitigation measures required to significantly reduce the impacts, as well as to monitor these impacts. It provides a time frame for monitoring as well as the organizations, persons and institutions expected to undertake these functions.

The objectives of an environmental and social monitoring plan are to ensure that effective measures and controls, in compliance with environmental and social requirements, are implemented to mitigate the potential for environmental degradation and negative social, economic and gender impacts on communities and the general public during construction and operation of the project.

Negative impacts resulting from the proposed activity can be reduced or rendered negligible through implementation of proposed mitigation measures which include the implementation of sound environmental and construction management practices, and effective design.

The monitoring tool will constitute clearly defined action plans and procedures that will serve as a yardstick for the Contractor and other personnel for the planning and implementation of the project. This will include measuring, evaluating, assessment and reporting on all activities related to the construction phase of the project in keeping with the ESIA.

The following impacts will be monitored:

- Aesthetic Amenity and Landscape
- Biodiversity
- Geology and Soils
- Waste management
- Water quality
- Air quality
- Noise
- Community Health and safety
- Occupational Health & Safety
- Employment
- Traffic
- Land Acquisition

11.1 Responsibility for Mitigation Measures

Assumptions were made with respect to responsibility.

Table 48: *Responsible Entities & Activities*

Activity	Responsibility
Geology & soils- testing and monitoring plan	EPC
Landscape management Plan	EPC
Biodiversity / Habitat Management and Monitoring Plan	DGDC
Proper maintenance of vehicles and equipment	EPC
Water quality monitoring at six points on the nearby rivers	EPC
Capacity Building and Training/ annual basis	DGDC/EPC
Development of a Traffic & Transportation Management procedures implementation	DGDC/Traffic Department of the Dominica Police Force
Noise Monitoring – Once during construction)	EPC
Air Quality Monitoring, H_2S emissions, dust – half yearly	EPC Quarterly
Environmental monitoring to include noise measurements and air quality measurements	EPC
Occupational Health and Safety Management Plan	DGDC
Preparation of a Grievance Redress Mechanism	DGDC
Establishment of a transparent recruitment process	EPC Contractor
Number of local persons employed	DGDC
Community Health and Safety	DGDC
Hazardous Substances, Waste and Wastewater Management Plan	EPC contract
Stakeholder consultation programme	DGDC
COVID-19 Management	EPC Contract
Development of a register of skilled and or semi-skilled persons in the	DGDC

community	
Land Acquisition	GoCD

11.2 Monitoring and Reporting

The section details the main elements of the Environmental and Social Monitoring Plan indicating the critical locations for monitoring adverse effects of the project, the reporting protocol and the responsible agencies.

***Table 49**: Main Monitoring Locations*

Impacts	Locations for monitoring
Noise Levels	Sensitive receptors – community, close to schools, health centres.
Air Quality	Sensitive receptors within communities
Water Quality and Aquatic Biodiversity	Roseau River, River Fordy, Trafalgar River, Providence River, Boeri River
Biodiversity	AOI utilizing the established quadrats
Pedestrian and traffic safety	In communities adjacent to project roads and active construction sites

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Documentation

It is expected that all monitoring activities are documented and all plans relevant to mitigation and monitoring that are not yet developed, will be developed as follows:

- Landscaping through re-planting of native trees
- Establishment of tree barriers
- Implementation of MTNP Mitigation Plan
- Traffic and Transportation Management Procedures
- Habitat Assessment and monitoring plan
- Procedures to reduce Soil erosion, sedimentation and Pollution from hazardous substances
- Community Health and Safety Procedures

- Occupational Health and Safety Plan
- Environment Compliance standards for noise
- Development of a water quality plan
- Development of a register of skilled and or semi-skilled persons in the community
- Establishment of a transparent recruitment process
- Hazardous Substances, Waste and Wastewater Management Plan

All monitoring activities are expected to be documented and reviewed with other relevant authorities and stakeholders so as to allow for continuous assessment and feed-back, as well as possible adjustments to the plan, so as to achieve the mitigation objectives.

Reporting Protocols

A number of reports must be prepared at various stages of the project as follows:

Construction Commencement Report

This will document sensitive, socio-economic, environmental impacts prior to the commencement of the project so that mitigation measures can be implemented during project implementation. This task should be undertaken by the DGDC and the Contractor and should constitute part of the progress report.

Routine Reports

This will be the function of an Environmental Health and Safety coordinator and will entail the following:

- Compliance with contractual obligations
- Implementation of environmental recommendations and procedures including legal and environmental protocols
- Random inspection of construction and operation works to evaluate environmental compliance and implementation of outlined mitigation measures with respect to identified negative impacts

11.3 Emergency/ Environmental Response

This will be undertaken by the Community Health and Safety Coordinator in collaboration with the Disaster Preparedness Office and Specialist. This will entail monitoring of ongoing activities for non-compliance with the environmental mitigation plan and environmental specifications that could lead to stoppage of activities if recommendations are routinely not adhered to if there is an occurrence of an environmental emergency.

11.4 Environment Social and Management Plan

There are a number of mitigation measures and/ or support mechanisms that should be implemented at the pre-construction stage in preparation for construction and operation. The table below outlines these measures:

Table 50: *Mitigation Measures/Support Mechanisms*

Pre- Construction Phase						
Impact	***Potential receptors***	***Mitigation Measures***	***Monitoring***	***Responsible Agency***	***Performance Indicators***	***Relevant Project Document***
Land Acquisition	Landowners	• DGDC activates its "Abbreviated Resettlement Action Plan (ARAP)" • " Undertake land acquisition and compensation process in keeping with existing laws and regulations • DGDC will sensitize landowners to the "Grievance Redress Mechanism" and execute the mechanism • Encourage speedy and timely payment process for landowners	• Resettlement Action Plan is activated. • Landowners are aware of the "Grievance Redress Mechanism" and complaints filed have been attended to • Relevant Stakeholders are engaged.	GoCD/ DGDC	Landowners compensation process completion Grievances are recorded and addressed	Abbreviated Resettlement Action Plan (ARAP) Grievance Redress Mechanism Stakeholder Engagement Plan
Employment and income generation	Community	• DGDC to activate its related procedure "Local Labour and Opportunities Development Plan" • Inform community of employment opportunities • Contractors should be required to employ residents who have the requisite skills. • A register of persons with relevant skills should be prepared to expedite the employment process • Inform the community on the number of residents employed	• "Local Labour and Opportunities Development Plan is implemented • Number of persons trained • Number of skilled and unskilled persons recruited including women	DGDC/ Contractor	No of persons employed by the project based on gender and geographical origin	"Local Labour and Opportunities Development Plan"

		• Attempts made to employ women				
Community Health & /safety	Community	• Develop Health and Safety Procedures in collaboration with relevant authorities • Erection of signage to alert residence of dangerous areas including construction sites and safety measures to be undertaken • Speed bumps to be erected to reduce the speed of vehicles moving through the community • Continue training of the community on emergency response procedures • Sensitization & Public Awareness Programme on Safety, Health & Environmental issues	• Signs are erected • Speed bumps are installed • Number of persons trained • Number of Sensitization / public awareness programmes conducted	DGDC/ Traffic Department of the Dominica Police Force	Community Health and safety measures are in place	Community Health and Safety Management procedure Emergency Response Plan
Occupational Health & Safety	Project Work force	• DGDC to sensitize employees and contractors of existing mitigation measures as outlined in document • The Contractor should adopt the ESF/ Safeguard Interim Note: COVID-19 Considerations in Construction & Civil Works Project and develop a health and safety plan to safeguard employees • Health and safety registers to be developed and in place	• Review Management procedures, policies and proposed programmes • Inspection by the Environmental Health Department of all health and safety plans for workers • Employ a health and Safety Officer to train employees and to monitor safety	DGDC/ Contractor/ Environmental health & Safety Department	All environmental Health and safety protocols are in place and employees are trained on these protocols Health and Safety Officer employed Number of employees trained	Environmental, Social Health & Safety Policy A health and Safety Management plan

		• Conduct training/ sensitization of employees				
Increased Traffic	Community	• Develop Traffic and Transportation Management Procedures to reduce the risks of accidents and pollution • Establish operation time for which haulage trucks ply the routes so that it is not done during peak traffic hours. • Construction of a speed bump at a strategic area to reduce speed. • Erection of a pedestrian crossing in the location of the bus-stop. • Ensuring that vehicle hired for transportation are maintained to reduce exhaust emission	• Traffic & Transportation Management Procedures are endorsed by management authorities • Assess traffic accidents in the community and complaints filed by residents for baseline information	Collaborate with the Traffic Dept./Contractor/ GoCD / DGDC	Traffic Management procedures are finalized for implementation Collaboration with the Traffic Department of the Dominica Police Force is established.	Traffic Management Procedures
Waste generation	Soil, surface and groundwater	• DGDC will activate and inform all relevant stakeholders on its Hazardous substances, Waste and Wastewater, ESMS Procedures • Develop a waste management plan • Adequate garbage bins will be provided for workers to store waste. • Storage bins will be transferred to appropriately identified collection point to ensure regular pickups by licensed haulers or persons designated by the Contractors • Training / sensitization Programmes will be implemented to deal with proper waste management and disposal	• Waste Management Plan is developed • Training programmes have been implemented • Soil containment site has been identified • Containment /storage bins are in place • Training/ sensitization	Contractor	Complied with national policy on hazardous waste management Complied with waste Management plan and national standards and policies	Waste management Plan DGDC-Hazardous substances, waste and wastewater, ESMS procedures

		• Roles and responsibilities shall be clearly defined and a management responsibility for waste management shall be determined.	programmes is implemented			
Biodiversity	Fauna and flora	• Liaise with local specialists and the Forestry & Wildlife Division and stakeholders to develop a Habitat Management and Monitoring Plan (HMP) to include: management and control of weeds and invasive species and the establishment of a biodiversity off set plan to achieve no net loss of natural habitat • Sensitize employees on Dominica Wildlife Laws • Identify wildlife corridors	• Management plan for control of weeds and a Habitat Management Plan to establish biodiversity offset is developed • Sensitization workshop for employees completed	DGDC / Contractor	Management Plan developed No. of employees sensitized Wildlife corridor established	Habitat Management and Monitoring Plan
Alteration of existing landscape	Aesthetic Amenity	• Develop a landscape management plan • Identify and label which trees should be retained so as to preserve as much as possible, trees within the AoI • Identify source of native trees for replanting	• Landscape Management Plan is developed • Sources of trees for landscaping have been identified	Contractor/ In collaboration with the Forestry, Wildlife & Parks Division	Landscape plan is prepared and approved Sources for trees/ plant identified	Landscape management Plan
Erosion sedimentatio	Soils	• Develop and implement procedures to reduce soil erosion, sedimentation and pollution from hazardous substances	• Procedures are developed • Spill kits are	Contractor /DGDC	Mechanisms to reduce soil erosion,	Procedures to reduce soil

n and pollution of Soils		• Spill kits available for use in case of emergency	purchased		sedimentation, and pollution are in place for implementation	erosion, sedimentation, and control from hazardous substances
Surface Water	Users of recreational water	• Development of a water quality monitoring plan to ensure compliance monitoring at all points where liquid effluent leave the confines of the project site • Ensure proper storage facilities for hazardous and non-hazardous chemicals and fuel • A maintenance schedule in place for all vehicles and equipment • Absorbent material is available for on-site clean-up of spills • Monitoring programme for rivers are in place and sample points are established	• Water quality and monitoring Plan developed • Sealed containers with concrete embankments are built above ground on site to store chemical, lubricants, and fuel • Maintenance schedule in place	Contractor	All monitoring and safety standard procedures are in place to monitor water quality and reduce negative impacts on water quality	Water Quality Plan
Ground Water	Potable water	• Ensure equipment is available for well control to prevent blow outs • Ascertain through a hydrogeological survey the presence of aquifers within the AoI to reduce the risk of pollution	• Equipment available for use	Contractor	Risk of ground water pollution is minimized	Research Results
Noise	Employees/ Community	• DGDC Manual on Noise and Vibration should be made available to relevant parties for information • Contractor should develop a Construction Noise Management Plan to provide a framework to address construction noise levels and adopt Best Management	• Information disseminated to relevant parties • Contractor has in place a construction management Plan	Contractor / DGDC	Noise levels do not exceed IFC Standards for residential area	DGDC Manual on Noise and Vibration Construction Noise Management

		Practice (BMP) and Best Available Technology practices. ● Establish a maintenance schedule for all equipment ● Personal protective equipment (PPE) is available for all employees.	● Provide a summary of required construction noise management practices to all staff during site inductions. ● PPE is in stock and available ● Maintenance logs are established for vehicles and all equipment used on the project. .			Plan Occupational Health & Safety Standards Stakeholder Engagement Plan
Air Quality Emission	Employees Community	● Speed breaks should be introduced at specific junctions to reduce the travel speed of motorists to curb dust and particulate matter ● Road users should be encouraged to utilize environmentally safe vehicles via proper maintenance of vehicles	● Speed brakes are constructed ● Equipment and resources are in place for measuring air quality against baseline information ● H_2S monitors are in stock and available for use by employees ● Stakeholder sensitization programmes	Traffic Department of the Dominica Police Force Contractor Contractor DGDC	Facilities and services are in place to reduce emissions and maintain air quality standards	Air Quality Management Plan

CONSTRUCTION PHASE						
Impact	**Potential receptors**	**Mitigation Measures**	**Monitoring**	**Responsible Agency**	**Performance Indicators**	**Relevant Project Document**
Land Acquisition	Landowners	• DGDC continue to implement "Abbreviated Resettlement Action Plan (ARAP)" • DGDC to continue to implement the existing "Grievance Redress Mechanism"	• Ongoing meetings with landowners • Maintenance of grievance logs • Evaluate grievance logs to determine whether complaints are being addressed.	DGDC/ GoCD	Landowners compensation process completion. Grievances are recorded and addressed	Abbreviated Resettlement Action Plan (ARAP) Grievance Redress Mechanism Stakeholder Engagement Plan
Employment and income generation	Resident employed	• Recruit skilled and unskilled workers. • Community Informed on number of residents employed • Prior to construction completion, assist employees who would no longer be employed, into transitioning to other employment opportunities	• Number of skilled and unskilled persons recruited including women. • Obtain a list of residents who will become redundant and liaise with local government authorities to provide assistance and/ or job opportunities.	Contractor DGDC	Number of persons employed by the project based on gender and geographical origin Number of residents transitioned and employed	"Local Labour and Opportunities Development Plan"

Community Health &Safety	Residents and employees from the community	• Ensure that the Community Health and Safety Procedures are implemented • Continue to monitor traffic accidents and complaints from the community • Continue sensitization of community on the status of the project and on Emergency Safety Routes and procedures • Establish fencing around mud pond • Install no entry signs on project site to inform residents	• Number of grievances logged by the community on health and safety. • Fence is erected and persons restricted from site • Number of sensitization / public awareness programmes	Ministry of Health/DGDC/ Traffic Department of the Dominica Police Force Contractor DGDC	No Increase in health-related diseases Number of grievances filed by the community regarding health and safety	Community Health & Safety Procedures Emergency Response Plan Stakeholder Engagement Plan
Occupational Health & Safety	Employees and on-site staff	• Mitigation measures developed by DGDC and the Contractor are implemented. • Develop and utilize the Occupational Health & Safety Plan as outlined in the report and develop Standard Operating Procedures for adoption. • Train staff on SOPS and safety guideline and emergency procedures • Provide protective gear to all employees • Ongoing evaluation of site activities by the Health & Safety Officer to reduce hazards to employees	• Daily records should be kept of all injuries and accidents on site • A health and safety officer should be employed to train workers in proper use of PPEs and to monitor workers safety daily • Inspection by the Environmental Health Department of all health and safety plans.	Contractor/ DGDC	No increased impacts on the health and safety of workforce / number of on-site accidents	Environmental, Social Health & Safety Policy Health and Safety Management plan

		• Health and safety registers are being utilized and monitored				
Increased Traffic	Community	• Implement Traffic & Transportation Management Procedures. • Signs shall be erected at strategic locations to provide information to the public on project activities being undertaken, to alert them to the use of heavy vehicles and to encourage them to exercise caution and to co-operate with project management. • Ensure that only vehicles that meet maintenance requirements are utilized on the project • Ensure that haulage trucks operate within the stipulated time schedule to reduce the impact on peak traffic hours of the communities	• Traffic Management Procedures are implemented • Number of stakeholder meetings convened • In collaboration with the Traffic Department, monitor traffic accidents in the community and complaints filed by residents	Contractor DGDC in collaboration with the Traffic Department of the Dominica Police Force	No increase in traffic accidents Complaints filed by community members are minimal	Traffic & Transportation Management Procedure
Waste generation	Community Employees	• The Waste management plan is implemented to include reduce, reuse and recycle • DGDC will activate its Hazardous substances, waste and wastewater, ESMS procedures • All waste management practices shall be in accordance with local regulations and shall conform to Good Management Practices (GMPs) • Hazardous waste shall be separated	• Collection transportation and disposal system are in keeping with national and international standards • Containment measures for sediment and silt are operational • All haulage vehicles have adequate covering of disposal	Contractor DGDC	All waste management practices conform to national and international waste management Laws and policies	Waste Management Plan DCDG - Hazardous substances, waste and wastewater, ESMS procedures

		from non- hazardous waste at point of generation and labelled • Recycle bins are effectively utilized • Storage bins will be transferred to appropriately identified collection point to ensure regular pickups by licensed haulers or persons designated by the Contractors • All sediment and silt will be contained and prevented from getting into drains or surface water by barriers and any unused soil will be disposed of through licensed haulage truck, with suitable covering for waste, to a legally designated landfill • Wastewater shall be disposed of via collection tanks • Wastewater from drilling shall be collected in sumps and disposed of • Roles and responsibilities shall be clearly defined and a management responsibility for waste management shall be determined • Waste shall be packaged and disposed at the Fond Cole landfill • All waste oil and water contaminated with oil will be collected and stored in sealed non -porous containers such as plastic tanks	material ● Waste types and quantities are recorded and available for review by authorized personnel ● Train persons responsible in waste management techniques and standards ● Monitor method of storage of waste for recycling			

Destruction of existing habitat as a result of excavation and felling of trees	Fauna and flora	• Noise levels from construction activity should be minimized where possible • No herbicides or pesticides used on site • Construction workers should be oriented not to engage in any illegal hunting or poaching in the project area and made aware of Dominica's Wildlife Laws. • Hunting of game species should be prohibited on the project site and the hunting Regulations adhered to. • Observe the breeding season of the key threatened species and minimize vegetation clearance during this period. • Sedimentation of aquatic ecosystems should be minimized to reduce impact on aquatic species • Create a wildlife corridor under pipelines if constructed above ground to allow movement of wildlife • Pipeline to be thermally insulated to reduce the risk of burns • Endemic faunal species should be caught and relocated to similar habitats • Implement habitat Management Plan	• Noise reduction strategies are being implemented • Dominica wildlife laws are being respected • Sedimentation barriers are established and maintained • The ban on use of pesticide or herbicides on site is observed • Monitoring of endemic and endangered species • Wildlife Corridor maintained • Pipelines are thermally insulated • Excavated soil is removed to reduce sedimentation • Machinery and vehicles are cleaned to reduce the establishment of invasive species or plant pathogens	Contractor/ DGDC Forestry Wildlife & Parks Division	Collaboration established with the Forestry Division to relocate endemic species All employees are sensitized to wildlife laws Habitat management and monitoring plan are implemented	Habitat Management Plan

Alteration of existing landscape	Aesthetic Amenity	• Reduce clear felling by retaining the recommended identified trees. • Paint pipeline with natural colour of the environment to reduce the visual impact • Plant tall trees to limit visibility of the geothermal structure • Assess acreage of area for landscaping and source native trees for replanting	• Acreage of area for landscaping has been assessed • Pipelines are camouflaged through use of paint	Contractor Forestry, Wildlife & Parks Division	Improved landscape	Landscape management Plan/ Procedure
Erosion sedimentation and pollution of Soils	Soils	• Develop and implement procedures to reduce soil erosion and sedimentation and pollution • All sediment and silt will be contained and prevented from getting into drains or surface water by barriers and any unused soil will be disposed of through licensed haulage truck, with suitable covering of waste, to a legally designated landfill. • Ensure proper use and storage of oils and chemicals • Ensure regular maintenance of all equipment as per schedule. • Proper use and management of hazardous materials. Any use of hazardous materials shall conform to the proper use / recommendations of the product as well as the relevant national laws and policies governing the use of such products.	• Ensure testing of soil to monitor level of contamination in case of spillage • That construction schedule should adhere to recommended mitigation measures	Contractor /DGDC	Loss of topsoil is reduced, and soil pollution is avoided	Procedures to reduce soil, sediment control and pollution

		• Spill kits should be located on site. In case of accidental spillage, and any contaminated soil should be excavated disposed of and replaced with clean fill • Reduce construction activities during the rainy season to reduce soil erosion from run -off • Proper use and storage of oils fuel solvents and petroleum products. • In case of accidental spillage, contaminated soil should be excavated and replaced with clean fill to minimise (or prevent) groundwater contamination with treatment of any storm water runoff or process water prior to disposal • All vehicles will be maintained off site and in garages • Appropriate locations within the site should be identified for construction of surface water drainage systems to reduce flooding to adjacent properties • Employees should be trained in proper use and storage of these pollutants so that spillage can be minimized. • Reducing construction activities during the rainy season when flooding occurs • Where excavated material is suitable				

		to be used for construction purposes material will be transported to a designated area for storage				
Reduction of air quality from emissions	Employees Community	• Wetting of the surface land and roads is also encouraged at the construction phase to reduce migration of particulates from dust • Continue to sensitize road users to utilize environmentally safe vehicles via proper maintenance of vehicles. • All vehicles carrying waste from excavation should be properly covered	• Measurement of dust levels to be assessed • Measurement of air quality every six months for Mercury and Hydrogen sulphide	Contractor/ Environmental Health Department	Air quality does not exceed internationally accepted standards	Measurement records are available
Noise	Employees Community	• Implement recommendations from DGDC EMS Manual on Noise and Vibration and Contractor's Construction Noise Management Plan • Construction works will adopt Best Management Practice (BMP) and Best Available Technology practices • Use well maintained equipment to reduce noise emissions • Employees wear protective hearing equipment • Initiate noise monitoring and document results	• Maintenance records kept of vehicles and equipment used on the project • Noise level measurements to be taken at the point of construction and at the nearest community receptor once during construction during the day and night • Establish and review maintenance logs kept of drilling equipment to ensure regular	DGDC / Contractor	Noise levels kept to IFC standards	DGDC Manual on Noise and Vibration Construction Noise Management Plan Occupational Health & Safety Standards

		• Residents are informed of noise generating activities	maintenance. • Employees are wearing protective gear • Information disseminated to communities			
OPERATIONS						
Impact	**Potential receptors**	**Mitigation Measures**	**Monitoring**	**Responsible Agency**	**Performance Indicators**	**Relevant Project Document**
Land Acquisition	Landowners	• DGDC continue to implement "Abbreviated Resettlement Action Plan (ARAP)" • DGDC to continue to implement the existing "Grievance Redress Mechanism"	• Ongoing meetings with landowners • Maintenance of grievance logs • Evaluate grievance logs to determine whether complaints are being addressed.	DGDC/ GoCD	Landowners compensation process completion.	"Abbreviated Resettlement Action Plan"
Employment and income generation	Resident employed	• Recruit skilled and unskilled workers. • Provide skills training programme relevant to the proposed employment opportunities • Assist employees who would no longer be employed after the operational phase into transitioning to other employment opportunities	• Number of skilled and unskilled persons recruited including women. • Number of persons receiving training • No of residents transitioned to other employment opportunities	DGDC	Number of residents employed and transitioned	"Local Labour and Opportunities Development Plan"

Community Health, Safety and Security Plan	Community residents	• Continue with implementation of Community Health procedures and Safety and Security Plan to include COVID -1 • Water quality monitoring to include potable and recreational waters for disease organisms and chemicals • Alerting community residents when unusual activities are to be undertaken such as drilling • Undertake public awareness programmes to educate the community on safety, health, and environmental issues. • Continue to train community on emergency procedures.	• Review management Plan on an annual basis to evaluate its efficacy and to upgrade if necessary • Grievance filled by the community regarding health and safety should be tracked specifically and carefully responded. • All monitoring data should be recorded.	Contractor / DGDC	No Increase in health- related diseases	Community Health & Safety Procedures Emergency Response Plan Stakeholder Public Awareness Programme
Occupational Health & Safety	Workforce	• Continue to implement the "Environmental, Social Health & Safety Policy and Plan and Occupational Health and Safety Plan • Activation the employee grievance mechanism and record and address grievances in a timely manner. • Site activities must be evaluated to reduce hazards and protect workers health and safety in accordance with World Bank Group Environmental Health and safety guidelines. • Site managers should develop health and safety registers as mandated by the Accident and Disease Notification	• Daily records should be kept of all injuries and accidents on site • Monitor grievances to ensure that they are addressed • A health and safety officer should monitor on a daily basis, the safety of workers • All worker safety plans should be available for inspections by the	Contractor / DGDC	No increased impacts on the health and safety of workforce / number of on-site accidents	DGDC "Environmental, Social Health & Safety Policy Environmental Health & Safety Risk Assessment Mechanism Hazardous substance, waste and wastewater manual Occupational Health and Safety Management plan

		Act and establish procedures for assessment.	Environmental Health Department inspectors			
Waste Generation	Community Employees	• An adequate system for the collection, transportation and disposal of garbage and other solid waste is in place at the sites. • Storage bins will be transferred to appropriately identified collection point to ensure regular pickups by licensed haulers or persons designated by the Contractors • Hazardous substances will be separated from non-hazardous substances, labelled and disposed of based on national and IFC standards. • Waste shall be packaged and disposed at the Fond Cole landfill • All waste oil and water contaminated with oil will be collected and stored in sealed non -porous containers such as plastic tanks	• Evaluate collection transportation and disposal system to ensure that they are in keeping with national and international standards • Containment measures for sediment and silt are installed and operational • Examine hazardous substance storage and operations to ensure that they meet internationally accepted standards	Contractor DGDC Dept. Of Environmental Health	Conforms to national waste management Laws and policies	DCDG - Hazardous substances, waste and wastewater, ESMS procedures Waste Management Plan

Biodiversity	Fauna and flora	• Continue to implement the Habitat Management and Monitoring Plan (HMP), with input from local specialists and stakeholders as appropriate. • The use of herbicides or pesticides should be avoided • Workers should be oriented not to engage in any illegal hunting or poaching in the project area and made aware of Dominica's Wildlife Laws. • Hunting of game species should be prohibited on the project site and the hunting Regulations adhered to. • Sedimentation of aquatic ecosystems should be minimized • Wildlife corridor maintained under pipelines, if constructed, above ground • Any planting will use native species	• Noise reduction strategies are being implemented • Dominica wildlife laws are being respected • Sedimentation barriers are established and maintained • Monitoring of endemic and endangered species • Wildlife Corridor maintained • Monitor possible implementation of the Plan	Contractor/ DGDC DGDC/ contractor	Collaboration established with the Forestry Division to Monitor endemic and endangered fauna Habitat management and monitoring plan is implemented Forestry Division/ Community	Environmental Management and Monitoring Plan Habitat Management & Monitoring Plan
Landscape	Aesthetic Amenity	• Continue to implement the Landscape Development Plan • Equipment retrofitted and maintained to reduce noise	• Areas re-vegetated will be nurtured and maintained • Noise reduction facilities are fitted and operational	Contractor	Improved landscape	Landscape management Plan

Air Quality/ Emission	Employees Community	• Continue to implement the Air Quality Management Plan • All geothermal waste material should be disposed via the reinjection well • Road users should be encouraged to utilize environmentally safe vehicles via proper maintenance of vehicles. • All vehicles carrying waste from excavation should be properly covered	• Vehicles hired to transport waste have proper coverings • Workers are fitted with H_2S monitors at all times during operation	Contractor	Air quality does not exceed standards	Community Health & Safety Plan
Water Quality		• Continue to implement the water quality and monitoring Plan • A spill monitoring program put in place • Chemicals, lubricants, and fuel should be stored above ground in sealed containers with concrete embankments built to hold potential spills. • Vehicles and machinery should be regularly maintained, and all fuel and lubricant leaks should be immediately repaired. • Water quality monitoring program established at points identified during assessment • Water quality plan is implemented	• Ensure maintenance of all equipment to reduce accidents • Ensure that mud is properly stored for recycling • Water quality monitoring to be undertaken at established points Monitoring of sumps to ensure there are no spills	Contractor/ Dept of Environmental Health/ DOWASCO	No pollution of surface waters	Water Quality Management Plan

Ground water resources	Potable water	• Ensure proper well control to prevent blowouts • Effective treatment of liquid geothermal waste	• Maintenance checks on well heads and blowout equipment is undertaken • Undertake hydrogeological survey to ascertain the presence of aquifers and to augment baseline survey	DGDC/Contractor	Well is operational and efficient	Operational Manual
Erosion sedimentation and pollution of Soils	Soil	• Continue to implement procedures to negate soil pollution • Ensure proper use and storage of oils and chemicals to prevent soil pollution • Ensure regular maintenance of all equipment • Proper disposal of hazardous materials and their containers	• Ensure testing of soil to monitor level of contamination in case of spillage	Contractor /DGDC	Soil Pollution is avoided	Procedures to reduce soil pollution

12. SUMMARY OF STAKEHOLDER ENGAGEMENT /CONSULTATION

DGDC has in place and established stakeholder engagement plan and programme which will be utilized.

One-on-one interaction with potential affected persons and landowners was undertaken so as to cover a wide range of stakeholders in the AoI, . Community consultations were undertaken prior to and during the evaluation of baseline information with the overall community and with special interest groups – women, youth and unemployed persons. The objectives of the consultations were as follows:

- To engage the community and affected persons in the ESIA process and to provide an opportunity to provide input and suggestions.
- To benefit from local knowledge with respect to biodiversity and the identification of resources that are economically and socially important to the community
- To get the views of the community on what they view as the major issues of the proposed project and proposed mitigation measures
- To share information with all interested and affected persons on the project.

Public Consultations/ Focus Group Discussions

Overall project features, social safeguards, issues related to women's safety and security, environmental safeguards were discussed as well as the impact of Hurricane Maria and COVID-19, on the livelihood of the community.

Discussions were also held with landowners on land acquisition, and the impact of hurricane Maria and COVID-19 on livelihoods and other relevant issues

Focus group discussions and interviews were held over a period of 3 weeks with a cross section of members of the community as well as targeted special interest groups – women and youth- to provide information on the project, the process and elements of undertaking and environmental and social impact assessment, to obtain baseline information and to get their views with respect to their perspective on the positive and negative impacts of the project.

A socio-economic survey of the community was undertaken to gather baseline information on the socio-economic aspects of the community and to solicit information from residents on possible concerns with respect to the drilling of a reinjection well and the construction of a reinjection pipeline.

A similar exercise was undertaken with affected landowners to get their perspectives on the geothermal project, to obtain a better understanding of the extent of displacement- socially, physically or economically on them so as to assist the developers in mitigating any negative consequences which may be brought about as a result.

Public Meetings

Four public meetings were held with stakeholders as follows:

Saturday, August 08, 2020

Monday, August 10, 2020

Wednesday, August 12, 2020.

Tuesday, October 20, 2020

The objectives of the meetings were:

- To share information on ESIA project objectives, plans, activities, impact
- To provide updates or briefings on project developments
- To generate ideas for ESIA
- To get feedback on the Draft report and to seek recommendations for mitigation and monitoring
- To dialogue on other relevant key issue
- To obtain advice on plans or implementation issues
- To address specific risks, grievances or conflicts
- To plan for ongoing consultations

Reports on meeting are in Appendix 6.

13.0 APPENDICES 1 – 8

Appendix 1: Terrestrial Survey Methodology

Table 51: Detailed Terrestrial Survey Methodology

Discipline	Survey topics	Methodology
Biodiversity Survey – -	Habitats and flora	Undertake ground truthing/ecological surveys. Surveys will involve a combination of transects and quadrats, which will be taken to cover all habitats in the study area (stratified random sampling) and all project components as per the habitat map. Study area: For the purposes of conducting the biodiversity assessment of the proposed Geothermal Reinjection Well and Re-injection Pipeline Route, a designated geographical area was established as the potential "zone of influence". The study area comprised a 300meter - wide corridor (150m each side) along the proposed reinjection pipeline route and new access road, in addition to a 500m buffer around other major project infrastructure. . Nine (9) quadrats/sample plots measuring 20m x 50m (100m2) were established alternately at 150meter intervals on either side of the transect line. GPS co-ordinates and elevation above sea level were recorded for each quadrat. A complete list of plant species was recorded along each transect and a DAFOR score (D=dominants, A=abundant, F=frequent, O=occasional, R=rare) will be recorded for each species. Species cover (%) will be recorded within each quadrat.
	Flora uses	Information on the use of flora to include interviews with the local population to validate the data.
	Mammals	Baseline surveys for large and small terrestrial mammals included observation of field signs (faecal pellets, footprints, tracks, feeding signs, hair, and calls) along line transects. Other surveys methods to be used for mammals include spotlighting,

		All animal species observed within the quadrats and within a 25m radius of the transect line were identified and recorded. Identification of animal species in the field was done primarily through visual and auditory observation. The survey shall be completed between 6-10am and repeated between 6-10pm using spotlight method to record both diurnal and nocturnal species. The survey should aim to cover a combination of habitat types and locations within the area of project infrastructure.
	Birds	Baseline surveys for birds will be undertaken by involving line transects, point counts, general observations, and call recognition. Point counts and line transects should be set up within each main habitat type within the study area. Sound recording will be an integral part of the methodology. A rapid assessment of nocturnal birds based on their calls will be also undertaken during the nocturnal transect surveys, including spot lighting. During point count surveys, on arriving at each survey point, a one- minute settling period will be observed to allow for any disturbance caused by the surveyor arriving at the survey point. Following the settling period, all bird species identified by sight or sound within 50m of the observation point will be recorded for 20 minutes. Nests and important food source/trees for any protected and species of conservation importance will be recorded with GPS. Surveys will be undertaken during the periods when birds are typically most active and vocal (early morning and evening). Study area: - A 300m -wide corridor (150m each side) along the reinjection pipeline and re-injection site and a 500m buffer around each of them.
	Reptiles	Timed, diurnal active searches will be undertaken along transects, which involve a 30-minute search effort per stratification unit up to 100 hectares in size. Searches will focus on rocky outcrops, logs, and leaf litter. The same active

		search shall be repeated at night to survey for nocturnal reptiles. Any reptiles killed on the road will be also recorded. The presence/abundance (sex and approximate size where possible) of observed animals and any field signs will be recorded using a GPS. The time of day and temperature will be also recorded at each survey site. Study area: - A 150m -wide corridor (75m each side) along the reinjection pipeline and
	Amphibians	Surveys will be based on systematic searches and observations along transects and quadrats (at least one hour per transect with quadrats). The presence/abundance of observed animals and any field signs will be recorded during the day but avoiding the highest temperatures. Some transects/quadrats are also to be surveyed at night and will include listening, spot lighting and call recording. The time of day and temperature will be also recorded at each survey site. The watercourses likely to be affected by the project (pipeline crossing and polluted runoff) and adjacent areas will be searched, including under logs and rocks, under bark and in litter. These watercourses will be surveyed at night using a fixed time search involving two person hours of searching per 100m section of the stream at 2 sites
	Fish and other aquatic species	Standard surveys will involve the use of nets. Data recorded will include the number of fish and length of the individuals captured. The habitat characteristics (river habitat type, substrate, water depth and flow) of the location of the netting sites will also be recorded. Fish will be released into the river immediately, with the exception when lab identification is required. Each survey location will be photographed and mapped, with GPS coordinates of the location recorded and included in the project's geographic information database. Local fishers and villagers will be interviewed to identify fish species, patterns

		and extent of local use The data collection for fish will be undertaken in conjunction. Two or three sites for fish surveys. Data on water quality To be undertaken by an environmental health specialist – samples will be collected at 2 sites and analyzed by the national lab Study Area: - 20m river section each side of the pipeline crossing, water abstraction and potential polluted runoff input
	Interviews with local people	The aim will be to identify and assess the priority ecosystem services in the study area, including the use and dependency of local people on flora and fauna. This will include economically or culturally important species, and others which play important ecosystem regulatory functions. The baseline data on ecosystem services will be collected using the World Resources Institute method and will involve dedicated workshops between the social and environmental teams. This activity will be undertaken in conjunction with the social surveys and focus group meetings.
Stakeholder engagement	Stakeholder engagement	1 public consultation event to disclose draft updated supplementary ESIA findings

***Table 52**: Schedule of field investigations – fauna / floraTable:*

Team Members - David Williams, Stephen Durand, Marie-José Edwards, Gary Shillingford

	Date	Research Activity	Habitat type
1	July 07, 2020	Familiarization field visit with DGDP technical staff to proposed site of alternate Reinjection Well and Reinjection Pipeline Route	Modified /Secondary Rainforest/ and active / abandoned agriculture
2	July 14/15/16,2020	Establishment and demarcation of quadrats/sample plots #1,2,3,4,5,7, 8,9 along transect line on preferred pipeline corridor and reinjection well	Modified /Secondary Rainforest/ and active /abandoned Agriculture
3	July 21/22/23, 2020	Assessment of flora - research quadrats #1, 2, 3, 4, 5, 7, 8, 9	Modified /Secondary Rainforest/ and active /abandoned agricultural lands
4	July 28, 2020	Bird surveys-Quadrats #1, 2, 3, 4, 5	Modified /Secondary Rainforest/ and active /abandoned agricultural lands
5	July 29/30, 2020	Faunal survey of research quadrats #7, 8, 9	Modified /Secondary Rainforest/ and active / abandoned agricultural lands
6	July 30, 2020	Establishment / demarcation & assessment of Quadrat #6 & visit to preferred re-injection well site	Modified /Secondary Rainforest/ and active abandoned agricultural lands
7	August 06, 2020	Bird surveys Quadrats #1, 2, 3,	Modified /Secondary Rainforest/ and active/ abandoned agricultural lands
8	August 03/04, 2020	Bird surveys Quadrats #5, 6,7,8,9	Modified /Secondary Rainforest/ and active /abandoned agricultural lands
9	August 06, 2020	Nocturnal fauna survey- Quadrats #1, 2, 3, 4,	Modified /Secondary Rainforest/ and active abandoned agricultural lands
10	August 10, 2020	Nocturnal fauna survey- Quadrats #1, 2, 3, 4,	Modified /Secondary Rainforest/ and active abandoned agricultural lands
11	August 11, 2020	Aquatic life survey – Roseau River at Titou, & Providence River	River
12	August13, 2020	Aquatic life survey - Boeri River/Canefield & Trafalgar River	River

Appendix 2: Description of Quadrats

Location	Geothermal Power Station Site
Location ID#	Q#1
UTM Coordinates:	N15° 19.849' W61°19.535'
Elevation:	576m (1,890ft) ASL
Habitat Type:	Secondary Rainforest/Abandoned Cultivation/Pasture

***Figure 59**: Quadrat 1*

Site Description: Quadrat Q#1 is situated on private land at the proposed construction site for the Geothermal Power Station. The site is accessed via a secondary road, east of the main the access road to the Titou Gorge. The study area is relatively flat and traversed by a small intermittent watercourse. The vegetation type comprises a mixture of secondary rainforest and pasture. Roughly 80% of the quadrat is covered by secondary forest. Historically, the area has been utilized for subsistence agriculture; however, current land use is limited to livestock rearing (rabbit and sheep). Human activity has modified this habitat.

Location	**Geothermal Power Station Layout Area**
Location ID#	Q#2
UTM Coordinates:	N15° 19.841’ W61°19.619’
Elevation:	570m (1889ft) ASL
Habitat Type:	Abandoned Citrus Orchard/Secondary Forest

Figure 60: *Quadrat 2*

Site Description: Quadrat # 2 is located on an abandoned citrus orchard, approx. 150 meters west of the proposed site of the Geothermal Plant. The study area is bounded on its southern side by a secondary access road. Access into the plot was somewhat limited due to several huge boulders lined up along its southern perimeter. The study area being a former citrus orchard has been severely modified and is partially overtaken by pioneer plant species and trailing vines. Several aged grapefruit trees, *Citrus paradisi* were recorded within the quadrat.

Location	**Production Well**
Location ID#	Q#3
UTM Coordinates:	N15° 19.879’ W61°19.680’
Elevation:	573m (1,88O) ASL
Habitat Type:	Secondary Rainforest

Figure 61: *Quadrat 3*

Site Description: Quadrat Q#3 is situated between the Production Well’s northern perimeter fence and the access road leading to the proposed power plant site. Most of the study area is relatively flat with a steep incline on its northern side. Secondary rainforest is the main forest type. Uprooted canopy trees are also evident in the understory. Dense clusters of *Heliconi*a *caribea* are present in the understory. One residential home is approx. 50 meters north of the quadrat.

Location	Hydro Power Station Site
Location ID#	Q#4
UTM Coordinates:	N15° 19.916’ W061°19.754’
Elevation:	556m (1,824ft) ASL
Habitat Type:	Secondary Rainforest

***Figure 62**: Quadrat 4*

Site Description: Quadrat # 4 is located adjacent to the Laudat Hydro Power Station and the pipeline corridor from the Hydro-Power Station to the Balancing Tank. One residential home is also situated in proximity to the study area. The quadrat is traversed by a steep-sided perennial ravine. The spillway from the hydropower plant drains into the stream at a point just before it passes through the study site. Access through this site is made difficult due to steepness of the ravine. Secondary rainforest makes up 95% canopy coverage.

Location	**Daway's Garden**
Location ID#	Q#5
UTM Coordinates:	N15° 19.895' W61°19.831'
Elevation:	534m (1,752ft) ASL
Habitat Type:	Active Agriculture / Secondary Forest

Figure 63: *Quadrat 5*

Site Description: The site is located south of DOMLEC's decommissioned balancing tank. Most of the terrain is relatively flat. The area is drained by a narrow drainage ditch. Approx. 70% of this quadrat is actively cultivated, 20% is under secondary forest and the other 10% is occupied by invasive lemon grass. Cultivated agricultural crops include root crops, banana, and vegetables. The site can be reached via an unpaved farm access road.

Quadrat Location	**Park á Bas 1**
Location ID#	Q#6
UTM Coordinates:	N15° 19.849’ W61°19.535’
Elevation:	576m (1889ft) ASL
Habitat Type:	Secondary Rainforest

Figure 64: *Quadrat 6*

Site Description: Located on gently sloping terrain along the southern side of hydroelectric pipeline corridor, this quadrat is occupied by secondary rainforest. The site is traversed by a small dry ravine and a foot path which leads to the Roseau River. The predominant plant community within the area is the secondary rainforest which has been heavily degraded by hurricanes. Evidence of active timber extraction exists.

Quadrat Location	**Park á Bas 2**
Location ID#	Q#7
UTM Coordinates:	N15° 19.815’ W61°20.000’
Elevation:	502m (1,647ft) ASL
Habitat Type:	Secondary Rainforest/Abandoned Agriculture

***Figure 65**: Quadrat 7*

Site Description: Located on the northern side of the hydro pipeline corridor, Quadrat #7 sits just outside the preferred site for the Re-injection Well. The terrain near the hydro-pipeline is flat but gets relatively steep with a 30-40º slope. The predominant vegetation type is secondary rainforest. Residual agricultural crops indicate past subsistence farming activity.

Location	**Park á Bas 3**
Location ID#	Q#8
UTM Coordinates:	N15° 19.791’ W61°20.080’
Elevation:	501m (1,643ft) ASL
Habitat Type:	Secondary Rainforest/Abandoned Agriculture

Figure 66: *Quadrat 8*

Site Description: Quadrat #8 is located roughly 50 meters north of the hydro pipeline corridor. The terrain is flat and bounded by a dry ravine on its northern flank. A relatively small area of secondary forest exists; however, invasive grasses and herbaceous vines are the predominant vegetation type. The area is privately owned. There is evidence of abandoned subsistence agriculture. One citrus tree was recorded.

Quadrat Location	**Alternate Reinjection Well Pad**
Location ID#	Q#9
UTM Coordinates:	N15° 19.837’ W61°20.146’
Elevation:	594m (1,948ft) ASL
Habitat Type:	Farmland /Secondary Forest

Figure 67: *Quadrat 9*

Site Description: Quadrat # 9 is located on the alternate site chosen for the construction of the Reinjection Well. The study area is flat and bordered by a dry ravine on its southern side and a farm access road leading on its northern side. Land use comprises subsistence farming and livestock rearing. A piggery exists on the site. The natural vegetation comprises a variety of secondary forest tree species and herbaceous plants.

Appendix 3: Fauna of the Zone of Influence

FAUNA OF THE ZONE OF INFLUENCE				
BIRDS RECORDED WITHIN THE ZONE OF INFLUENCE				
Common Name	Scientific Name	Total	IUCN Conservation Status	On-Site Status
Red–necked Parrot, Jaco Parrot	*Amazona arausiaca*	13	IUCN - VU 3.1	Dominican Endemic/Common
Antillean-Crested Hummingbird, Ti-kap	*Orthorhyncus cristatus*	29	Least concern	Lesser-Antillean Endemic Common Resident Breeder
Bananaquit, Sikiyé, Sikwiyé	*Coereba flaveola*	88	Least concern	Abundant Resident Breeder
Black-faced Grassquit, Sisi-zèb	*Tiaris bicolor*	73	Least Concern	Common/Resident Breeder
Black Swift Hiwondèl	*Cypseloides niger*	22	Least Concern	Common/Visitor
Lesser-Antillean Swift, Jiwondèl, Zyozyo lapi	*Chaetura martinica*	77	Least Concern	Lesser-Antillean Endemic/Common Resident Breeder
Black-whiskered Vireo, Chwèk, Chwèk annglé	*Vireo altiloquus*,	31	Least Concern	Common / Resident Breeder
Blue-headed Hummingbird, Foufou Tèt-blé, Madam béké	*Cyanophaia bicolor*	01	Least Concern	Endemic to Dominica and Martinique- Common/Resident Breeder
Broad-winged Hawk, Chicken Hawk, Malfini	*Buteo platypterus*	02	Least Concern	Common/Resident Breeder
Osprey, Malfini Lamès	*Pandion haliaetus*	01	Least Concern	Common Regular Winter Visitor
Caribbean Elaenia, Siflé, Chwèk Patwa	*Elaenia martinica*	139	Least Concern	Caribbean Endemic /Abundant Resident Breeder
Lesser-Antillean Flycatcher, Gwo-tèt, Labèl	*Myiarchus oberi*	02	Least Concern	Lesser-Antillean endemic/Common Resident Breeder
Zenaida Dove, Toutwel	*Zenaida aurita*	02	Least Concern	Common Resident Breeder
Green Heron, Kalali, Kayali	*Butorides virescens*	02	Least Concern	Common Resident Breeder
Green-throated Carib, Foufou vèt	*Eulampis holosericeus*	33	Least Concern	Caribbean Endemic/Common Resident Breeder
Scaly-naped Pigeon, Rammier	*Columba squamosa*	20	Least Concern	Common Resident Breeder
BIRDS RECORDED WITHIN THE ZONE OF INFLUENCE (CONT'D)				

Common Name	*Scientific Name*	*Total*	*IUCN Conservation Status*	*On-Site Status*
Grey Kingbird, Pipirit	*Tyrannus dominicensis*	61	Least Concern	Common Resident Breeder
Lesser Antillean Bullfinch, Pennwè, Mwéson	*Loxigilla noctis*	51	Least Concern	Lesser Antillean Endemic/Common Resident Breeder
Lesser Antillean Saltator, Gwo-bèk	*Saltator albicollis*	63	Least Concern	Lesser Antillean Endemic/Common Resident Breeder
Little Blue Heron, Kwabyé (Juvenile)	*Egretta caerulea*	01	Least Concern	Common Resident Breeder
Great Blue Heron	*Ardea herodias*	02	Least Concern	Common/Visitor
Purple-throated Carib, Foufou made	*Eulampis jugularis*	42	Least Concern	Caribbean Endemic/Common/ Resident Breeder
Scaly-breasted Thrasher, Gwiv	*Margarops fuscus*	06	Least Concern	Caribbean Endemic/Common Resident Breeder
Brown Trembler, Twamblé	*Cinclocerthia rauficauda*	10	Least Concern	Lesser Antillean Endemic/Common Resident Breeder
Mangrove Cuckoo, Cuckoo Manioc	*Coccyzus minor*	05	Least Concern	Fairly Common Resident Breeder
Rufous-throated Solitaire, Siflé moutayn, Mountain Whistler	*Myadestes genibarbis*	01	Least Concern (population decreasing)	Common Resident Breeder
Yellow Warbler Titin	*Dendroica petechial*	04	Least Concern	Common Resident Breeder
Plumbeous Warbler, Chik-chik, Papya	*Dendroica plumbea*	31	Least Concern	Endemic/ to Gaudeloupe, Dominica and Marie-Galante Common Resident Breeder

MAMMALS RECORDED WITHIN THE ZONE OF INFLUENCE				
Common Name	*Scientific Name*	*Total*	*IUCN Conservation Status*	*On-Site Status*
Agouti*	*Dasyprocta leporinus*	-----	Least Concern	Common/not encountered during field survey. Field confirmation through tracks and droppings
Opossum Manicou	*Didelphys marsupialis insularis*	1	Least Concern	Common/recorded one (1) adult female with young
Big Brown Bat	*Eptesicus fuscus*	18	Least Concern	Common

AMPHIBIANS RECORDED WITHIN THE ZONE OF INFLUENCE				
Common Name	*Scientific Name*	*Total*	*IUCN Conservation Status*	*On-Site Status*
Whistling Tree Frog, Tink Frog /Gounouj	*Eleutherodactylus martinicensis*	>70	Least Concern	Abundant

REPTILES RECORDED WITHIN THE ZONE OF INFLUENCE				
Common Name	*Scientific Name*	*Total*	*IUCN Conservation Status*	*On-Site Status*
Puerto Rican - Crested Anole	*Anolis cristatellus*	>50		Abundant /Invasive/Numerous juveniles
Dominica Skink, Zanndoli kléwan	*Mabuya dominicana*	2		Common
Ground Lizard, Abòlò / Dominica ameiva	*Pholidoscelis fuscatus*	1		Endemic/One (1) individual encountered in quadrat #9
AQUATIC SPECIES RECORDED WITHIN THE ZONE OF INFLUENCE (RAVINE FORDY / RAVINE BOUK)				
Common Name	*Scientific Name*	*Total*	*IUCN Conservation Status*	*On-Site Status*
Kakador	*Atya innocous*	6	Least Concern	Common
Goby, Loshe	*Sicydium punctatum*	2	Not evaluated	Two (2) specimens recorded downstream of Ti Tou Gorge
Guppy or Million Fish/Rainbow Fish	*Poecilia reticulata*	>25	Not evaluated	Common/Introduced, naturalized species

River Crab/Ciwik	*Guinotia dentata*	2	Least concern	Common crustacean

AQUATIC SPECIES RECORDED WITHIN THE ZONE OF INFLUENCE (ROSEAU RIVER/LIVIERE MYWAL)				
Common Name	***Scientific Name***	***Total***	***IUCN Conservation Status***	***On-Site Status***
Kakador	*Atya innocous*	> 60	Least Concern	Common
Goby, Loshe	*Sicydium punctatum*	2	Not evaluated	Two (2) specimens recorded downstream of Ti Tou Gorge
Guppy or Million Fish/Rainbow Fish	*Poecilia reticulata*	> 100	Not evaluated	Common/Introduced, naturalized species
River Crab/Ciwik	*Guinotia dentata*	6	Least concern	Common crustacean

AQUATIC SPECIES RECORDED IN MORNE PAIX BOUCHE RIVER (AT PROVIDENCE)				
Common Name	***Scientific Name***	***Total***	***IUCN Conservation Status***	***On-Site Status***
Kakador	*Atya innocous*	8	Least Concern	Common
River Crab/Ciwik	*Guinotia dentata*	2	Least concern	Common

AQUATIC SPECIES RECORDED IN DUBIQUE RIVER AT TRAFALGAR				
Common Name	***Scientific Name***	***Total***	***IUCN Conservation Status***	***On-Site Status***
Kakador	*Atya innocous*	6	Least Concern	Common
River Crab/Ciwik	*Guinotia dentata*	4	Least concern	Common

AQUATIC SPECIES RECORDED FOR BOERI RIVER (RIVER ESTATE/CANEFIELD)				
Common Name	***Scientific Name***	***Total***	***IUCN Conservation Status***	***On-Site Status***
Kakador	*Atya innocous*	8	Least Concern	Common
Goby Losh	*Sicydium punctatum*	13	Not evaluated	Common
Mountain Mullet	*Agonustomus monicola*	15	Least Concern	Common
River Crab/Ciwik	*Guinotia dentata*	2	Least Concern	Common

BUTTERFLIES AND MOTHS RECORDED WITHIN THE ZONE OF INFLUENCE				
Common Name	*Scientific Name*	*Total*	*IUCN Conservation Status*	*On-Site Status*
Great Southern White	*Ascia monuste*	6		Common
Little Yellow	*Eurema venusta*	10		Common
Caribbean Buckeye	*Junonia evarete*	8		Common
White Peacock	*Anartia jatrophae*	4		Common
Cloudless Sulphur	*Phoebis sennae*	7		Common
Gulf Fritillary	*Agraulis vanillae*	2		Fairly common
Flambeau	*Dryas iulia*	2		Common
Broken Dash Skipper	*Wallengrenia ophites*	1		Lesser Antillean Endemic/ Fairly common /Cultivations and forest edge
Stub-tailed Skipper	*Urbanus obscurus*	2		Lesser Antillean Endemic/ Fairly common in secondary forest edge
Polydamas Swallowtail	*Battus polydamas*	1		Rare
Monarch	*Danaus plexipus*	5		Common
Black Witch Moth	*Acalpha odorata*	3		Common
UID Moth Species	*UID*	6		Common
UID Moth Species	*UID*	4		Common

MISC. INSECTS RECORDED WITHIN THE ZONE OF INFLUENCE				
Common Name	*Scientific Name*	*Total*	*IUCN Conservation Status*	*On-Site Status*
Stick Insect	*Bostra sp.*	6		Common along the reinjection line corridor
Stick Insect	*Lamponius guerini*	4		Common in the reinjection line corridor
Bess bug Beetle	*Odontotaenius disjunctus*	2		Recorded in leaf litter in Quadrat #6
Click Beetle	*Chalcolepidius porcatus*	2		Recorded in Quadrat #9
Unidentified Weevil	*UID*	2		Recorded in Quadrat # 6
Unidentified Locust	*UID*	13		Common
Unidentified Grasshopper	*UID*	5		Recorded in Quadrat # 5 and #7

Unidentified Katydid species	*UID*	7		Recorded in Quadrat #7
Unidentified Cricket Species	*UID*	4		Recorded along the reinjection line corridor

Appendix 4: Flora of the Zone of Influence

SHORT LIST OF PLANTS FOUND WITHIN THE STUDY AREA		
Trees		
Local Name	**Common Name**	**Scientific Name**
Pipiri, Bwa Sisserou		*Pithecellobium jupunba*
Lagli , Bwa Lèt		*Sapium caribaeum*
Bwa Rivière		*Chimarrhis cymosa*
Pwa Doux Mawon		*Inga ingoides*
Pwa Doux		*Inga lauriana*
Chatanye Bab Chat		*Slonea beteriana*
Graine Blé, Kaka-wat		*Symplococus martinicensis*
Bwa Masse		*Trichilla simplifolia*
Kaklen		*Clusia sp.*
Gomyé		*Dacryodes excelsa*
Fougère	Tree Fern	*Cyathea arborea*
Fougère	Tree Fern	*Hemitelia muricata*
Bwa Kano	Trumpet Tree	*Cecropia schreberiana*
Bwa Bandé		*Richeria grandis*
Bwa Blan		*Simarouba amara*
Lowye Kaka		*Besleria sp.*
Lowye Bordmèr		*Nectranda membranacea*
Koko Poule		*Cordia elliptica*
Maho Kochon		*Sterculia caribaea*
Kakonyé Blan		*Ormosia krugii*
Bwa Flo	Balsa	*Ochroma pyramidale*
Fijyé		*Ficus sp*

SHORT LIST OF PLANTS FOUND WITHIN THE STUDY AREA (Cont'd)		
(a)Trees		
Local Name	**Common Name**	***Scientific Name***
Palmist	Mountain Palm	*Euterpe broadwayi*
Mapou		*Pisonia fragrans*
Pomme Woz	Rose Apple	*Syzygium jambos*
Bwa Léza		*Vitex divaricata*
Mille Bwanch		*Magaritaria nobilis*
Koko Poule		*Cordia reticulata*
Cré Cré		*Miconia/Conostegia spp.*
Bwa Masse		*Bonchosia polystachia*
Bwa mal-èstomac		*Siparuna glabrescens*
Yanga		*Geonoma interrupta*
Bwa Pèdrix		*Heisteria coccinea*

Karapit		*Amanoa caribea*
Mauricif		*Brysonima trinitensis*
	Screw Pine	Pandanus sp.
(b) **Shrubs, Herbaceous Plants**		
Pawasol Agouti	Selaginella	*Selaginella flabellata*
	Blue Wax Flower	*Psychotria urbaniana*
Zailles Mouches		*Aspludia insignis/ A. rigida*
Balizé	Heliconia	*Heliconia caribaea*
Bamboo	Bamboo	*Bambusa vulgaris*
Elephant Grass	Elephant Grass	*Pinnesetum purpurem*
Mulch	Lemon Grass	*Cymbopogon citratus*
Zeb Kouto	Razor Grass	*Scleria sp.*
	Pangola Grass	*Pennisetum pupureum*
SHORT LIST OF PLANTS FOUND WITHIN THE STUDY AREA (Cont'd)		
Local Name	**Common Name**	***Scientific Name***
White Mulch		*Andropogon bicornis*
Mamizou	Sage, Lantana	*Lantana camara*
Bata Belanjen	Wild Eggplant	*Solanum torvum*
	Elephants Ear	*Anthurium acaule*
Zanana Bwa		*Guzmania megastachya*
Kapi		*Ipomeas sp.*
David' Orchid		*Spathoglotttis plicata*
Man-Better Man		*Acyranthes aspera*
La Ché Wat	Vervaine	*Stachyarpheta urticifolia*
	Spiral Ginger	*Costus speciosus*
(c) Agricultural Crops		
	Dasheen	*Colocasia esculenta*
	Banana	*Musa sp.*
	Tannia	*Xanthosoma sagittifolium*
	Passion Fruit	*Passiflora edulis*
	Grapefruit	*Citrus paradisii*
	Coconut	*Cocos nucifera*
	Coffee	*Coffea arabica*
	Cocoa	*Theobroma cacao*
	Avocado	*Persea americana*
	Guava	*Psidium guajava*
	Papaya	*Carica papaya*
	Pumpkin	*Cucurbit asp.*
	Yam	*Dioscorea spp.*
	Sweet Potato	*Ipomea batats*

Appendix 5: Photographs of Fauna of Area of Influence

Figure 68: *Red-necked Parrot Amazona Arausiaca*

Dominican Endemic: one of three critically concerned species noted within the Zone of Influence.

Figure 69: *Grey King Bird (pipiwi or pipiri) Tyrannus dominicensis*

One (1) of the more common species recorded.

Figure 70: *Caribbean Elaenia (sifle) Elaenia martinica*

The most abundant avian species observed & recorded within the study area.

Figure 71: *Plumbeous Warbler (papya) Dendroica plumbea*

Dominican Endemic

Figure 72: *Purple-throated Carib (fal wouj) Eulampis jugularis*

The most common of the four hummingbird species recorded.

Figure 73*: Blue-headed Hummingbird (fou-fou ble) Cyanophaia bicolor*

Lesser Antillean endemic (Dominica & Martinique) Resident breeder in Rainforest

Figure 74:*Lesser Antillean Flycatcher (gob-mouch) Myiarcus oberi*

Common throughout the Zone of Influence

Figure 75*: Imperial Parrot (Sisserou) Amazona Imperialis*

Dominican Endemic; not seen but one of the species that's of critical concern.

***Figure 76**: Black-capped Petrel (Diablotin) Pterodoma hasitata*

An Endangered species utilizing the Laudat region as flight path to from nesting sites on Morne Micotrin and nearby summits

***Figure 77:** Opossum (manicou) Didelphis marsupialis – female with young*

Figure 78: *Agouti Track*

Figure 79: *Animal droppings (Agouti)*

Figure 80: *Whistling Frog Gounouj – Diurnal*

Figure 81: *Whistling Frog – Nocturna*

***Figure 82**: Invasive Puerto Rican Crested Anole Anolis cristatellus*

***Figure 83**: Skink (zannodli Klewan) Mabuya mabouya*

Figure 84: *Unidentified Moth – observed during nocturnal survey*

Figure 85*: Unidentified Moth – Recorded in quadrat #3 during nocturnal survey*

Figure 86: *Hercules Beetle Dynastes Hercules*

Figure 87*: Stick Insect Lamponius guerini – Common species within study area*

Figure 88: *Butterfly - Gulf Fritillary Agraulis vanillae*

Appendix 6: Stakeholder Consultation Report

STAKEHOLDER CONSULTATION-Environmental and SocialImpact Assessment, ESIA Drilling of Geothermal Well RV-I2 & Reinjection Route

AGENDA

Opening Prayers

- Introduction
- Introduction of participants
- Overview of proposed ESIA currently being undertaken
- Questions and Answers
- Open Discussion on specific topics
- Closing remarks

Objective

To sensitize and inform the community of Laudat of the project and to generate feedback on the key issues of environmental and socio-economic concerns of the community with respect to the project.

Components of the project discussed are as follows

- For the construction and operation of a new reinjection well and well pad
- The drilling of a geothermal reinjection well
- Development and or improvement of the access road
- The construction of a reinjection pipeline.

Public Meeting – Saturday 8th August 2020
Venue: Laudat Primary School

Held Saturday 8th August in the community of Laudat, to discuss the proposed injection well and a well pad for the geothermal project. To sensitize the community and receive their views on what would make the community feel comfortable in having that kind of development within the community.

This report provides the comments and recommendations from the community from the meeting.

COMMENTS

Questions	**Response**
Will there be any effects on the immediate people in the area due to the route being located so close to the school?	If you look at the route, it is pretty straight, the rest of the road exists, and the houses are not so close per say between the point of the school and the well.
The plant is proposed to be a 10-megawatt plant. However, will it be increased in the future or it is going to remain at 10 megawatts?	The 10 megawatt is proposed for domestic use in Dominica; however, the export projects will go up to 80 megawatts for exports and if needs be, it will be increased to suit developments.
Will the additional wattage power come from the same wells?	The reinjection well that is just outside the map can produce just about 17 MW or so, but 10 MW will be used, and it is not going to be used for export. There will be other injection wells drilled for export purposes. Some will be in the Laudat area and around Titou Gorge on the way to the lake.
Is this just the beginning phase of the wells being drilled?	Yes, for the export project, there will be other wells that will be drilled in other locations, but they will be reinjection wells.
Are you really suggesting that you will have to combine the water table and all of that?	For the water tables, in regard to the reinjection, we will have to look at the water table of that to see.
How are you able to see the difference if you don't have the baseline data?	That's why we are collecting that data through the analysis right now to be able to identify any pollutants in the water or the quality parameters in the water.
Are you looking at only pollutants?	Yes, only pollutants and water tables for now at the water injection site.
What about the springs we drink from all over the area?	For that, some soil analysis will be done. The quality of the water that is being run through the watershed is being determined by the soil, what the water runs through. So we are again doing an analysis to identify any pollutants or impurities that may be in the soil, so that we could have that baseline, in the event that there is spillage- the recommendations will be made to do periodic monitoring when the project/plant is

	established to ensure that parameters do not deviate from the baseline that was established.
Drilling has affected water tables in the past. Looking at the volume of water that was put out long before they started, they were able to identify some of the problems in the process and some they were able to mitigate whilst others were beyond mitigation.	Initially, some water flow of the two rivers have already been undertaken- that being the Queen's River and the Roseau River- there are also two streams that are on either side of where the reinjection well is going to be. So, we are also looking at the quality of water of that.
The weather has a major part to play in the village and the lack of other members present at the meeting does not voice in entirety the village's take on this whole project. The first EIA mentioned an acquisition of 2000 acres of land. How much of that has changed in regard to that? It appears that this is the 3rd EIA being presented, and based on the other EIA's presented, all plants on site were able to be identified and there is no representation of 'Morphotypes' in this one- some species were not recorded or identified, however it was listed on the chart and the disinclusion of such is not right. Mentioning this to other persons, it was found that there was a big issue with it because everything the EIA has accounted for, a lot of things listed for Laudat is not fully and truly represented in the EIA. Also, how much of a baseline data can compare sometime in the future?	We are not expected to identify every plant, because what we are doing is a biodiversity of the area and we are looking at the different types of vegetation and the distribution of plants and the frequency. However, to do a plant and biodiversity, we are not expected to identify every plant or not everything will be represented. For example, in some areas, most of it is secondary vegetation and agricultural land because most of the forest has been cut down before. In fact, what is being looked at are the major plans in each of the areas that can give a general idea of the biodiversity in the area, so we are looking at the plants and the wildlife. Even at the level of the floor of the area, we are not expected to identify all the plants because the forest there is so modified that in terms of biodiversity, it is not that important in regards to the floor level.
Based on the testing, we have already started noticing significant changes in water quality and water levels and I think you are going to miss that because it is missing the data before the initial testing. The testing has already compromised some springs. Are you aware of that? Because some water levels have significantly dropped in the village and vanished in some areas. Some springs have popped up in places that never existed before.	Well if there was no baseline information for this initially then we would not have noted these changes but it is certain that for sure, the past EIA's that were done, there was baseline information in some areas.
Do you trust that? Considering that the company which did the first EIA, done by a Guadeloupe company, their only experience was in ground water management, nothing close to geothermal and I do not feel that they are qualified to conduct the project here in Dominica. Also stating that the baseline done by them is quite questionable due to their lack of experience. But they did an EIA suggesting that it is appropriate to build a 12- megawatt system which was suspected to have downscaled. In spite of that, the past EIA had a lot of failures from their capacity or not.	"I beg to defer on that because I've met quite a few of the consultants who came in to do that. The company was contracted to do the ESIA and they had a lot of experience, their lack thereof would not have permitted them to acquire the contract in the first place. They were hired to do specific things for example water quality, and they are consultants who are highly trained on these areas".
It was stated that the first consultant failed for many reasons and they admitted to their shortcomings in many areas.	The EIA is supposed to be on the Physical Planning website, and it would make more sense if you would look at the ESIA done by them. It was very technical, and all information is there. There is another one that was done in 2018.

The reinjection well was never included in the initial EIA; therefore, a new EIA should be done to cover the new areas.	Yes, with every change and new information acquired, it is added and input into the new EIA being done.
Who owns that geothermal company?	The Government of Dominica.
Who is funding the project? "I heard the prime minister said in parliament that he has secured the full funding for that project- who backing it up?"	The World Bank has now joined with The French Consortium and DGDC and some Government funding.
So, is it true that World Bank has pulled out because the government is not willing to comply with guidelines of the EIA?	The safeguards manager noted no, not at all and that the World Bank component of the project is over due to a failed procurement. The bids were two times higher than the estimate and so procurement was cancelled due to lack of funding available.
Directly below the reinjection plant is the parking lot to the Trafalgar Falls. Looking up from the parking lot, the pipeline is visible. Directly after installation, a landslide occurred at the Falls in 1995. How much is the EIA taking into consideration to not alter the adjacent and present sites because we know that the production well is right in the Valley of Desolation. We know the elevation there is 544 meters and they drilled 1669 meters, and referencing from the top of Morne Diablotin, they went below sea level, interfering with a lot of the water systems and other things. Would the World Bank withdrawn, can the Government of Dominica fund the project long term? In spite of all the locked valves that they claim to have in the event of an earthquake and natural disasters to prevent shattering of the pipes. When spills occur, is there a mitigation plan that the community should respond to? "Because I noticed that one of our evacuation routes on the Freshwater Lake road is almost compromised with the tarish taking, so soon from now there is no evacuation place to run to".	In terms of the ESIA, quite apart from the area where the pad is going to be, we are also evaluation up to 500 meters external to it so we will be looking at this entire buffer in its entirety. The new reinjection well does not go into Trafalgar Falls, noting that it is very close to the edge of the falls, we are doing 500 meters outside of that. The analysis that is being done of water will include the Trafalgar River and up to the bridge in Wotten Waven- monitoring of the water quality- to ascertain the baseline. Going up to the bridge that crosses from TR to WW and then the Providence River, and the Boeri River up to Canefield.
Does geothermal pose as a risk if not done properly to affect the water table in Laudat?	There is a risk to everything. As explained previously, geothermal is supposed to be a closed system, which is the type of system proposed for Dominica where the steam is taken from the earth, the turbine is turned and then it is sent out and so on- just to oversimplify how it works. But the whole idea for the geothermal and whether it could contaminate our water falls under whether it is not managed properly. It is considered one of the safest ways of generating energy because of reduced forms of pollution and so on.
How will future drilling and vibrations affect the cliff at Trafalgar and erosion? Noting that part of the route is so close to the cliff, the composition of rock is molten rock, and it is very easy to crack. So how will that affect its stability?	Based on responses from the experts, the actual drilling process does not emit that kind of vibration to affect the rocks in that type of way. They have very sharp bits and the size of the hole to be dug up keeps vibrations very low.
How many acres are intended to be used for the	Unsure.

reinjection?	

Additional comments:

- Sylvester St. Ville: The water table at the reinjection site- the idea is to have a soil analysis done to identify the soil type, the geology and the water table to see how high it is in that area. It looks at the rivers that surround the areas, the water quality in and around Laudat. Some samples were taken for analysis the day before at the Center for Testing Excellence; a benchmark is to be taken to identify what type of pollutants may be present in the water. There are two sites on each of the major rivers in the area.
- Marie Jose - we have established all the GIS points in the areas that we are going to do all the research and that in itself will serve as a baseline so for example, 2-3 years from now, we can go back to the same area and evaluate whether there are changes in the baseline information.
- Marie Jose -What was asked about the up streams, there is not part of our TOR. Noting that one of the villagers asked that if it should not be an area where it should be included in the TOR. However, that research was supposed to have been done before under the ESIA. We are simply looking at the reinjection line, the pads and the road and everything else around it.
- The previous drilling caused vibrations throughout the community and could be felt by a number of persons.
- Whilst there are streams located higher, streams that were in close proximity of the area or closest to where the plant is going to be, were evaluated through a monitoring area. These streams have been monitored especially in the area where there may be possible pollution, and so we expect pollution to be moving down and not up the streams.
- Land acquisition process is dealt with by the Government of Dominica. The landowners and the Land and Survey Department will meet; they will agree on terms and they will get compensated.

Questions directed to community members.

Question	**Response**
Are there plants or trees in this area that are important to your livelihood?	Yes, the villagers want to use the area to develop one of the best botanical gardens in Dominica.
What do you utilize the rivers and streams in this area for?	Yes, crayfish and fish are caught, and they want to look in to exporting water. Many areas within the community use the water for drinking and domestic purposes. There are concerns of the 500-meter buffer being too close to the river- seepage and erosion poses as potential threats.
What are the issues of importance to you with respect	The reinjection well drills into the Valley of

to the Geothermal Development Project?	Desolation, how is it going to impact that area long term and there is a lot more erosion in the community. The acquisition of land still poses as a major issue to the persons being affected and those who would rather keep their land, there is no ultimatum for them- where else would be made available for persons. Could there be a possible land exchange of land with the Government of Dominica and the persons affected? Persons are living in fear of expansion and uncertainty. Also, that more land will have to be acquired from persons. Will the relocation of persons provide equal value in the relocation? How much commitment is the government making to block back the test wells that were abandoned? And how well is it going to be maintained because the lack thereof is a concern to the community. Noted that regular maintenance is being done.
What additional information would you like to have on the project?	Will the project create additional jobs for the persons in the community? A liaison from community is needed to represent the company and the community. Someone who is known by the community.
What are your most pressing needs following the impact of Hurricane Maria on you and your family?	Employment/jobs, homes, money
How has COVID -19 impacted you and your family?	Due to tourism being the main source of income, they are not able to provide for their families. No social security funds distributed as promised. General livelihoods being affected.
Do you think you will be better off without this project?	Yes and no. Because if something goes wrong with the project, it is the Laudat people being affected first, however, it should bring some positives to the community such as employment and others.
What are the benefits of the project on your community?	The community is in hope that it provides employment opportunities for the community. Hopes that the persons being directly affected will be rightfully compensated. Low electricity rates. Enhancing tourism by using the energy
What worries you most about the project?	Some members feel that the initial information may have been misleading and used as a tactic to get persons from the community to agree with project and now, different information is given and persons feel that there is less benefit to the community. The steam can no longer be used to produce avenues for other

	opportunities due to it being a binary selection.
What is the History of domestic violence in your community?	Negative. Although every home has its issues, the level of domestic violence is not significant to note.
What can you share about alcoholism in the community?	Is it rampant in the community? It is a little too much and raises a bit of concern.
How do you take care of the physically challenged in your community?	The families take care of them if needs be but there is no provision for such persons.

RECOMMENDATIONS

1. Establish monitoring stations at the sites when the plant comes into effect.
2. Try accessing the land from the south of Papillote Hotel to identify where the other sources of water are located. (There is an underwater spring just passed Laudat and coming down to Papillote.)
3. Train persons from the community in order to be able to undertake employment opportunities on the project and not just for the phases of construction.
4. Provide scholarships to students to study Geothermal.
5. Try advertising future meetings through Mat Peltier's program on Q95 FM for increased numbers at next meeting.
6. Recommendation to have meetings every 3 months post final presentation for updates to the community or to keep them in the loop.
7. Conduct periodic monitoring when the project/plant is established to ensure that parameters do not deviate from the baseline that was established.

LIST OF ATTENDEES
8TH August 2020

Name	Organization	Occupation			Gender
Sylvester St. Ville	Eclipse Inc.				M
David Williams	Eclipse Inc.	Env Consultant			M
Lennox St. Aimee	Eclipse Inc.	Social Planner			M
George Daway					M
Philbert Daway		Police Officer			M
Fabiana Moses					F
Shane Reid					M
Clem Stedman		Unemployed			
Elvis Brown					M
Garry Shillingford	DGDC				M
Allan Toussaint	DGDC				M
Lyn Fontenelle	DGDC				F
Marie-Jose Edwards	Eclipse Inc				F

Stakeholder Consultation

Environmental and Social Impact Assessment, ESIA

- **Drilling of Geothermal Well RV-I2 & Reinjection Route**

Meeting with Women
Monday 10th August 2020
Venue – Laudat Primary School

Aim:
To assess the environmental and social impacts

- For the construction and operation of a new reinjection well and well pad
- The drilling of a geothermal reinjection well
- Development and or improvement of the access road
- The construction of a reinjection pipeline.
- To sensitize the community and receive their views on what would make the community feel comfortable in having that kind of development within the community.

This report provides the comments and recommendations from the community from the meeting.
Focus group: Women

COMMENTS

Questions	**Response**
Why are we building a reinjection well?	The first tender process was cancelled due to the proposed prices being too high, noting that geothermal is to reduce the cost in electricity and first tenders did not accommodate that. The chief reason for the high prices was because the reinjection site being too far away. So, reconfiguring the project was to shorten the route by putting the reinjection well closer to the production well.
Why do we want to reinject?	In order to prevent pollution from the extraction of the steam, solvents and heavy metal from the earth, the reinjection process is to inject all these materials back into the ground, thus maintaining a clean and green production. Also, reinjecting too close to the source can cool the source, so we need to go as far away from the production well to reinject.
How deep down is the well going to be?	The reinjection well at Trafalgar Lilly Valley is 1900 meters down. The production well is about 1500-1600 meters.
Where do you go for health care services?	The doctor usually comes up to the village. So, there is a need for proper healthcare in the community.
- *What is going to be done with the soil that is drilled up from the wells?*	No affirmative response was given.
How will electricity be cheaper for us in retrospect to the amount spent to implement this project? Some of the villagers do not believe that it will reduce the cost of electricity for the community.	A lot of the money spent was grant money, therefore it is not to be paid back by the government.
Why weren't other forms of electricity production used such as wind, solar and or water, seeing as Dominica has a lot of that?	We should try to develop them yes, but it does not eliminate the avenue to try geothermal. Also, geothermal was chosen because with the other options, there needs to be a stable base load such as diesel to run the operation and we are trying to replace the need to use diesel and geothermal gives steady power.
How far will these pipes be from DOMLEC pipes?	There will be at least a 10 to 30-meter corridor between them.
Will the pipelines be on anchor blocks to allow person to pass under to access their farmlands?	Yes, bridges will also be implemented just as the DOMLEC pipelines so it will not affect these persons.
Will the community get electricity on a cheaper scale than the rest of the country? Will the community get additional benefits such as employment and cheaper electricity?	This is the reason why we are doing the surveys and having the meetings to know what sort of benefits you would require. Furthermore, due to the nature of this entire project, there will be many opportunities for training and for maintenance of the plant.
How long will the project take to commence?	We expect to have electricity on the grid by the 3rd quarter of 2022 and to your question about whether Laudat will benefit, the power will be sold on to the national grid. As of now DOMLEC is the only company with a transmission and distribution license

	by law so we will generate, and the power will be sold to the national grid so everyone in Dominica will benefit.
What will become of the national park? It's not going to be impacted	We have been looking at that to ensure that we do not go outside that buffer zone.

Additional comments:

- To look at the likely impacts of utilizing the access route to the well pad area.
- A biodiversity survey is being done to map the trees of the area, all the wildlife
- The meeting also sought to find out from the women in the village, the level of use of resources- whether it is used for the livelihood of the community and what and how much.
- The water quality of the river is paid close attention to ensure that the geothermal plant does not pollute the river. Therefore, baseline information is being collected to be able to compare and contrast data newly acquired in the future.
- Members of the community need to comply with the persons administering the socioeconomic survey and land ownership survey which are being done to ensure that no one suffers because of the project.
- The consultants are looking at a general overview of public and private facilities and services in the community to have an idea on the impacts on the community.
- There are concerns of Laudat not benefitting directly from any of the projects being implemented in the community. The community should receive electricity on a cheaper scale and work should not only be for the youth in the village. There are persons of age who need a source of income as well. There also needs to be safety for the persons of the community. A simulation plan was done with the fire and ambulance to test their mode of response and response time in case of any future mishaps. An important part of every bid put out is the need to use local labour as much as possible.
- The GDC is looking to partner with the Dominica State College to get the skills up to par so that more locals can be used for labour when the project has begun to be implemented.

Questions directed to women of the community.

Question	**Response**
Are there plants or trees in this area that are important to your livelihood?	No.
What do you utilize the rivers and streams in this area for?	Yes, crayfish and fish are caught. Many areas within the community use the water for drinking and domestic purposes.
What are the issues of importance to you with respect to the Geothermal Development Project?	One member mentioned that it should not be in Laudat and should be away from persons- there are other areas in Dominica where it can be. So, the noise would not have an effect on the persons. Fearful of increased potential of volcanic activity in the area. Fearful of increased health issues. If a member is impacted by the GDC and possibly needs to fly out of the country, the GDC should absorb the expenses incurred. Concerns about the route and the space needed for the road.
What are your most pressing needs following the impact of Hurricane Maria on you and your family?	Employment/jobs, homes, money, there was no market to sell crops.
How has COVID -19 impacted you and your family?	Unemployment. Fear of contracting the virus, and children have limited areas to which they can go. General livelihoods being affected. Unfair distribution of goods in the community.
What are the benefits of the project on your community?	The community is in hope that it provides employment opportunities for the community. Hopes that the persons being directly affected will be rightfully compensated. Low electricity rates.
What worries you most about the project?	Will there be another simulation exercise?
What is the History of domestic violence in your community?	Very little cases. One member noted that there is a pervert in the community.
What can you share about alcoholism in the community?	It is a little too much and raises a bit of concern. Smoking and other uses of illicit drugs is another issue as well.
How do you take care of the physically challenged in your community?	The families take care of them if needs be but there are not many persons with disabilities in the community.

LIST OF ATTENDEES

10TH August 2020

Name	Organization	Occupation	Email Address	Phone #	Gender
H. Bertrand		Storekeeper (PMH)			F
Emily Rolle		Unemployed			F
Jacqueline C.		Housewife			F
Violet Young		Housewife			F
Fabiana Moses					F
Hanalla Magloire					F
Michell Richards					F
Lyn	DGDC				F
Allan	DGDC				M

Stakeholder Consultation

Meeting with Youths & the Unemployed
Wednesday 12th August 2020
Venue: Laudat Primary School

Aim:
To assess the environmental and social impacts

- For the construction and operation of a new reinjection well and well pad
- The drilling of a geothermal reinjection well
- Development and or improvement of the access road
- The construction of a reinjection pipeline.

To sensitize the community and receive their views on what would make the community feel comfortable in having that kind of development within the community.

This report provides the comments and recommendations from the community from the meeting.
Focus group: Youth and Unemployed

COMMENTS

Questions	**Response**
Will the consultants be returning to ensure that their recommendations are being adhered to by the project?	The participants were advised of a Monitoring Plan for the project
Is there was a group in the village liaising with the Company.	Mr. Toussaint noted that there was not a Village Council, as is the case in Trafalgar or the existence of a Village Improvement Committee. He suggested the formation of such a committee.
Will the Trails be affected as they are not being taken into consideration and what would the long-term impact be?	The participant was re-assured that all evaluations were being done.
A question was asked as to the Employment Status of community residents in the project.	There are: Six (6) directly employed and Four (4) temporarily employed.
Will there be noise pollution from the drilling and operations?	Not outside of normal operational hours.
How will the operations of the project benefit the unemployed in the community?	The World Bank has insisted on using local labour where possible. Priority will be given to persons from the community.

Additional comments:

- Ongoing operations:
  - Nets were being placed in the rivers
  - Nocturnal surveys were being done
  - Water quality assessments were being made
  - GIS Points are being plotted (for future monitoring)
- -A question was asked as to whether drilling would affect the lakes.
- -Participants also wanted to know whether there were plans in place, in the event of a negative outcome of the project.
- -The health center has clinic once a week; however, the nurses do not reside in the community.
- -The playing field is partly abandoned and in need of attention.
- -Concerns of:
  - Grievance Procedure for lodging complaints/concerns.
  - Unregistered Lands

-Members should be able to purchase shares in the company as villagers, as part of land negotiation- It was advised that the Company was not involved in land negotiation.

Questions directed to youth and unemployed of the community.

Question	**Response**
Are there plants or trees in this area that are important to your livelihood?	No.
What do you utilize the rivers and streams in this area for?	Yes, crayfish and fish are caught but not so much right now.
What are your most pressing needs following the impact of Hurricane Maria on you and your family?	Jobs and money.
What are the benefits of the project on your community?	The community is in hope that it provides employment opportunities for the community. Hopes that the persons being directly affected will be rightfully compensated. Low electricity rates.
What is the History of domestic violence in your community?	None; merely Crime of Passion
What can you share about alcoholism in the community?	Plenty
Are there any social problems in the community?	Land dispute among families

Recommendations:

- Establish a fund by the company for the medical expenses of community residents.
- Printed material about the project should be made available to the community.
- A participant recommended that residents should be given money and shares in the company, as part of the land acquisition deal.

LIST OF ATTENDEES

12th August 2020

Name	Organisation	Occupation	Gender
McNeil Stedman			M
George Daway			
Harrision Hodge			M
Thomas D.			
Marcus Philbert			M
Arnold Corriette			M
Aaron Rolle		Fireman	M
Deshawn Ralph		NEP	M

Joshua Bernard			M
Jason Bernard Jr.			
Jeanette Bernard			F
Dahlia JnoBaptiste			F
Mackelma JnoBaptiste			F
Eustache Bertrand			
Clem Stedman		Unemployed	

Stakeholder Consultation

Meeting with stakeholders
Tuesday October 20, 2020
Venue: Laudat Primary School

Objective
To present the finding of the ESIA Report and to get feed-back from stakeholders

CONCERNS AND COMMENTS

Questions	**Response**
Concerns of trespassing on private property and what is the compensation for acquiring and occupying land before the transaction is done?	Concerns will be relayed to the respective organisations.
Concerns of inadequacy of impact area proposed, that there may be underwater waterbodies below the intended impact area and also the seismic consideration of the broader study area was not specified. The impact area of the reinjected material may as well produce toxic material from beneath the earth's surface. The surface of the area of the caldera is unstable and as well the assessment of the impact is bothersome and also inadequately defined. The concern is mainly of the valley that there may be considerable contamination of the entire reservoir once tapped into.	Suggestions of more research of the aquifers in the area have been recommended. Taking into consideration that this is a consolidated study, based on the gap analysis we were able to see where we should have done the study so it can complement what has been done. Water quality analysis studies were done, and monitoring mechanisms were developed for the reinjection at a number of rivers, as far as River Estate, Canfield. This was to identify a point which must be monitored during the implementation phase of the project. We have established a 6-month timeline period, in which samples will be collected at these points to be monitored for a number of the parameters mentioned. Including additional parameters of PH and salinity, which are good measures of geothermal spillage. The studies were done by the French which included baseline studies for the entire Queens River (beginning at Titou Gorge), and so our report referenced the studies and highlighted some of the parameters and their concerns, which can be seen in the broader report.

With regards to the water quality, we spoke about the international standards but what are the Dominican standards and how are we going to build our capacity to monitor all the properties in the water quality? Are we going to build that capacity in our island?	We are building that capacity in Dominica to undertake that kind of analysis including all the parameters that were discussed. That capacity is being built by the Bureau of Standards. During the baseline study, there was some equipment issues and so we were not able to complete the assessment at the time, hoping that by now that it should have been completed- the development and the building of that capacity to undertake the analysis. Dominica has adopted the WHO standard for drinking water quality and not necessarily the water quality standards for aquatic life and plant life. We rely on the international standards, and the International Finance Corporation (World Bank Group) has published standards which are supposed to be adhered to when approaching the World Bank for financing for any project within any country.
Concerns of future expansion of the village and how much land will be acquired for the power station area and that no one is coming forward to speak on the truth of what is really going on. What will become of the persons who are directly affected by this project?	The reinjection line and well will acquire 4.9 acres. The owners have also agreed to sell their land. Land and water are two important aspects of this project. We as a company cannot address your concern of future expansion of the village. However, in terms of future direction of this project, for the domestic aspect, all the lands have been identified and these persons have been contacted.
Although we have been notified of land, we have not been informed about the total amount of land. Laudat is not flat and some of the areas where the line is to be extended will cause spillage of land. Human access is another concern. How do persons access the land in the east from the west and vice versa?	A walk-through was done using the presentation to explain this concern of land acquisition and access, pipeline extension and the service road. A decision to put a bridge over the ravine is to be made. Otherwise access issues have been addressed. Small details of inaccessible areas need to be pointed out so we could address it.
In regard to some of the hazards of geothermal, in the initial stages some trees in the area of the fumes got burnt (the area by the balancing tank). What caused the trees and the area to get burnt? What caused that	We are not aware of that because our area of study was specifically the at the pipeline and the well pad. What you are referring to, is during the

sort of destruction?	testing of the well, when it was opened to test the pressure and the flow from the well, and so the heat and steam burnt the trees around it. This was not normal operation- it was a one-time test done in 2019. In normal operations, nothing comes out.
Will more land be acquired in the future for additional injection wells?	No. Everything is fixated in that area.
To what extent will the noise of the ongoing operation of the plant be managed and mitigated to ensure that the residents will not be negatively impacted?	There is no definite response in regard to the noise, however, in regards to the design of the plant, the ESIA was already done and so that is specified in the specifications that was sent to the vendors. The standards were with the contractor and monitoring is a big part of this project.
With the acquired knowledge from the team, if they were to have immediate family living in Laudat, what would be your immediate concerns?	Ensuring that we do not disturb what we came into. The binary decision made was a direct and strategic decision made, that was costly, but it is effective and reliable. Water is a major concern for us as well, and so we have done everything that we could to ensure minimal interference with the water supply because the drilling operations is literally lined. In regard to the reservoir, distance is the most important thing and so everything that happens there is captured. The important thing for us is to plunge through the ground water and not contaminate it and once we get through that safely, we are going down to 1500 meters.
What is your estimate total expenditure for the testing and the digging of the well?	All project costs should be made available at the end of the year. As it relates to the RFP of lands, two procurements are in process right now, one for the reinjection well and another for all the civil works of the plant. In a few months, these figures will be made known to us.
Concerns of accessing private owners land to the roads.	It will be addressed with the surveyor.

List of Attendees
20th September 2020

Name	Organization	Occupation	Email	Gender
Charles McClean	Villager	Supervisor	Manfromlaudat@hotmail.com	M
Margaux LaRocque	DCA	Artist/Activist		F
Wilfred Role				M
Nickisha Phikbert		Artist	Nicki.philbert@gmail.com	F
Marshall Matthew				M
Hanson Hodge				
Gregor Nassief				M
Phillip Cadet				M
Glenda Irish				F
Nathan Rolle				M
Alrick Irish				M
Alice Matthew				F
Marvin Philbert				M
Yohannah Desiree				F
Michelle Richards				F
Fabiana Moses				F
Shane Reid				M
Eugenia Richards	Education	Principal (Ret)	Mayene0558@hotmail.com	F
Polly Pattulo			pollypattullo@gmail.com	F
Anne Jno Baptiste	Papillote	Hotelier	papillote@dwdom.dm	F
Jeri Oesterreich	Resident		chicagolivereggaemusic@gmail.com	F
Valentina Futac	UNDP	Consultant	vfutac@gmail.com	M
Albert Noel		Field Officer	Noelalbert69@gmail.com	M
Jacqueline Dupigny	DCA		Kai.kboutique@gmail.com	F
Athie Martin		Hotelier	athiemartine@gmail.com	M
Phillip Rock		Musician	Gizzae123@yahoo.com	M
Nahjie Laflouf			Nahjie.Laflouf@hotmail.com	F
Catherine Yager				F
Eugene Rolle				F
Joel Lambert			Joellambert32@gmail.com	M
Martin Yager			thewildginger@gmail.com	M
George Daway				M
Clem Steadman				M
Emmanuel Rock				M
Frances Jolly				F

Appendix 7: Community & Landowner Surveys

COMMUNITY SURVEY:

THE DRILLING OF GEOTHERMAL WELL RV-12 & CONSTRUCTION OF REINJECTION PIPELINE AT LAUDAT:

OBJECTIVE OF QUESTIONNAIRE: THE OBJECTIVE OF THIS QUESTIONNAIRE IS TO GATHER INFORMATION ON THE SOCIO-ECONOMIC ASPECTS OF THE COMMUNITY AND TO SOLICIT INFORMATION OF RESIDENTS, AS TO THE POSSIBLE CONCERNS FACING THE COMMUNITY, AS TO THE DRILLING OF A REINJECTION WELL AND THE CONSTRUCTION OF A REINJECTION PIPELINE.

Section of Community:

.....

Location of House:

.....

Name of Interviewer:

.....

Name of Interviewee:

……

Date of Interview:

……

Time of Interview:

Start: … End: …

Interview Status:

1st Visit ☐ 2nd Visit ☐ 3rd Visit ☐ Refused ☐

Reason for Refusal: ……

Questionnaire #: ……

QUESTIONNAIRE:

SECTION A - HOUSEHOLD

1. Is the head of this household - Male ☐ Female? ☐

2. Is your family the owner of this house or is the family renting?

   Owner Occupied: ☐ Tenant: ☐ Other: ☐

   Other, Specify: ……

3. Is there an insurance policy on your house?

   Yes: ☐ No: ☐

4. How many persons live in this household? …….

5. What is the age grouping of this household?

   0 – 10: ☐ 10 – 20: ☐ 21 – 30: ☐ 31 – 40: ☐

   41 – 50: ☐ 51 – 60: ☐ 61 – 70: ☐ 0+: ☐

6. Does any member of this household suffer from illnesses?

   Yes: ☐ No: ☐

   If Yes, Specify: …….

7. Is the head of the household employed? Yes: ☐: ☐

   If Yes, is the employment: Fulltime: …

   Part-time: …

   Seasonal: …

8. Where is the usual place of employment for members of this household?

Community……. Town/City …… Other……

If Other, Specify: ……

9. What type of work are members of this household involved in?

Farming: ☐ Vendor: ☐ Construction: ☐ Tourism

Government ☐ Manufacturing: ☐ Other Services: ☐

Other: Specify …….

10. What is the estimated monthly income of this household?

Under $500 per month: ☐ $501 - $1,000 per month:

$1,001 - $1,500 per month: ☐ $1,501 - $2,000 per month: ☐

$2,001 - $3,000 per month: ☐ Above $3,001 per month: ☐

11. Where members of the household do most of their banking?

Credit Union ☐

Regular Bank ☐

12. Do you have a family vehicle?

Yes: ☐ No: ☐

13. Is your household or any of its members supported by an institutional social or development programs?

Yes: ☐ No: ☐

14. Is your family originally from this community?

Yes: ☐ No: ☐

If No, how long have you been living in this community?

……

15. Where did your family last reside?

……

16. Why did your family move to this community?

Owned Land: ☐ The Environment: ☐

Other: Specify …….

17. What are women in the household responsible for?

……

……

18. Is the family's residence close to the location of the proposed reinjection well?

Yes: ☐ No: ☐

19. Has your household been (or will be) directly affected by the geothermal project?

Yes: ☐ No: ☐

If Yes, how will your household be affected?

……

……

20. How has hurricane Maria affected your household?

……

21. How has the COVID-19 VIRUS affected your household?

……

SECTION B: RESPONDENT

1. Sex of Respondent: Male ☐ Female ☐
2. Are you: Married ☐ Single ☐ Widowed? ☐
3. To what ethnic group do you belong?

   ……..

4. What language is your mother tongue?

   ……

5. To which religious denomination do you belong?

   ……

6. What is the highest educational level that you have achieved?

   ……..

7. Which do you consider as major hazards facing the community?

   a. Landslides ……. e. High Winds ……
   b. Eruptions ……. f. Flooding …….
   c. Fumes …… g. Other …….
   d. Fire.……

8. Are there social problems facing this community?

Yes: ☐ No: ☐

If Yes, name them:

……. …….
……. …….
…… ……
…… ……

9. Are you in favour of a geothermal reinjection well?

Yes: ☐ No ☐

If No, list any concerns that you may have:

a…… b…….

c…… d…….

e…… f…….

10. How do you see the reinjection well affecting your community?

……

……

11. Are there any safeguards that you would like to see implemented by the project?

……

……

12. Would you like to make any other general comments and/or recommendations regarding the geothermal project in your community?

Yes: ☐ No: ☐

Comments/Recommendations:

……

……..

ECLIPSE INC. & THE TEAM OF CONSULTANTS WOULD LIKE TO THANK YOU FOR YOUR PARTICIPATION IN THIS SURVEY AND WISH TO ASSURE YOU THAT YOUR CONTRIBUTION WILL ASSIST IN THE SUCCESSFUL IMPLEMENTATION OF THIS PROJECT.

Landowner Survey
Directly Affected Parties Consultation

Introduction

(To be read to each participant prior to interview)

The Dominica Geothermal Company proposes to construct a reinjection facility for the proposed geothermal power plant in Laudat. Eclipse INC has been assigned to undertake an Environmental and Social Impact Assessment for the reinjection facility. The following questionnaire has been developed to obtain information from directly affected parties to determine the extent of the impact on those directly affected.

For any parties that will be displaced by the project or infrastructure associated with it either directly or economically, detailed socio-economic census data needs to be collected from each household/business to help in providing a better understanding of the social impact and to assist the developers to mitigate against any negative consequences which may be brought about as a result of the project.

The developers and Eclipse INC promise that all personal information collected in this questionnaire for the purpose of this development will be held in confidence and that no information collected will be disseminated without the consent of the respondent. The data collected will be held in a secured computer which can only be accessed by those authorised under the terms and conditions of this project.

We thank you for your participation and advice that you can refuse to provide any information which you do not wish to disclose.

We look forward to working with you to enhance the livelihoods of those affected by the implementation of this project.

(Procedure for engagement with affected households/businesses

Introduce the project and explain that this is an information gathering exercise to ensure that the project can be managed so that local people can benefit from the project and negative impacts to local people can be minimised. Be sure to get current contact details for the participant. Take a photo of each party (particularly important for parties where land is being acquired). After completing the survey ask if the party has any questions. Keep findings in an excel database.)

1.0 Identification details:

	Name of the Respondent	Male Female
	Address:	
	Was this your address prior to Hurricane Maria (September 18, 2017)? Yes/No	
	Is your property affected by the Project – note: Location, Acreage, and reference for cadastral map	Yes No
	How much of your property is affected by the project? Quantify?	
	What is this property currently being used for? Is it used for any informal purposes as well such as grazing, medicinal or tree harvesting, etc.?	
	How many households are directly affected by the acquisition of this property? How?	
	Take photo of respondent and property on all sides and note direction of any structures. Note on map if layout is correct.	

2.0 Household Details:

2.1	How many people occupy your household? Age Range 0-5 6-15 16-25 26-35 >35	
2.2	Are you married, single, widowed?	
2.3	Do you have children? How many and what ages are they?	
2.3	What is your main language	
2.5	What ethnic group(s) do you belong to? Carib Black White Mixed	

3.0 Household Structure

3.1	Do you own this house? If no is it rented? Does it belong to a relative? Other	
3.2	Do you have a family vehicle?	
3.3	What is the Average Family annual income $5-10000? $10-20000, $20-30000 >$30000	
3.4	Can you meet your basic needs? Food Clothing	
3.5	No of women in household	

4.0 Household Survey for Directly Affected Household (complete this section for property owner and/or land user)

Include members who are permanently resident at the address of the primary respondent.

Start with respondent.

Name	Head of the household (YES/NO)	Age	Sex	Marital Status		What is the highest education level have you achieved? None Primary Secondary College	Area of specilization	Occupation

5.0 Livelihood Details (for land users):

5.0		What type of work do you do?	
5.2		How long have you been doing this kind of work?	Months: Years:
5.3		Do you own your land?	
5.4		Why did you decide to locate in this spot?	
5.5		Do you own other property? Yes no If yes where is it located Could it be used for farming or your business	
5.6		Is there any other job you would like to start working in?	
5.7		How would moving your farming/ business operations affect you?	
5.8		What are your biggest challenges in business?	
5.9		What are your biggest challenges as a household?	
5.10		What are your biggest challenges since the hurricane?	

6. Asset inventory for physical structures (photograph the structure):

6.1	House description Concrete Wooden No of stories Average square feet	
6.2	Type of Floor (materials): (1) Earthen; (2) Cement; (3) Tile; (4) Marble; (5) Wood; (6) Others	
6.3	Type of outer wall (materials): (1) Earthen wall; (2) Brick wall; (3) Stone Wall; (4) Wood; (5) Others	
6.4	Type of Roof: (1) Thatched; (2) RCC; (3) Tile; (4) Asbestos; (5) Galvanise; (6) Others	
6.5	Condition of Structure: (good, average or poor)	
6.6	Electric connection (1. Yes 2. No)	
6.7	Off-grid energy devices (independent generators, solar PV panels etc.)	
6.8	Water connection: (1. Yes 2. No)	
6.9	Wastewater outlet (1. Yes 2. No)	
6.10	Separate Kitchen (i.e. outside of main dwelling structure) (1. Yes 2. No)	
6.11	Size of Area of plot (sq ft):	
6.12	Size/type of house (sq feet)	
6.13	Availability of Toilet	
6.14	Placement of Toilet (1. Inside, 2. Outside)	

6.15	Total rooms:	
6.16	List furniture and approximate costs	
6.17	List all furniture observed	
6.18	Any other physical assets associated with the property? Outdoor furniture?	
6.19	Any community assets that are relevant to you (e.g. water sources, trees, medicinal plants)?	
6.20	Do you access public transport? What type?	

7. Income and Business

7.1	What is your main source of income in the household?	
7.2	Do you own a business? What type? Where is it located?	
7.3	How do you get there?	
7.4	Do you have any other sources of income? Please list.	
7.5	What average income do these other sources generate per week, month, year?	
7.6	Are you engaged in farming?	
7.7	Do you cultivate any crops? Yes/No	
7.8	Where exactly	
7.9	What is the total acreage?	

7.10 Which crops do you grow (add to example)?

Crop	**Labour (family only, hired labour, both)**	**Used for household consumption**	**For Sale**
Cassava			
Plantains/Bananas			
Citrus			

Short term vegetables e.g. lettuce, cabbage, cucumbers			
Root crops e.g. dasheen, yams			
Herbs & Seasonings e.g. chives, celery, seasoning peppers, parsley			
How many hours do you usually spend per day on crop cultivation?			

Other activities:

7.11	Do you engage in any animal husbandry? Yes/No	
7.12	Which type and how many?	
	i) Dairy	
	ii) Poultry	
	iii) Goats	
	iv)Sheep	
	Others (Specify)	
7.13	Do you cultivate any trees or other forestry products near the site?	
7.14	What is the quality of the soil where you farm?	
7.15	Do you collect any wild foods like medicinal plants?	
	For use or to sell?	
	How much do you make from selling it?	Per Week: Per Month:
7.16	Do you collect timber for charcoal? To use for your house only or to sell?	

	How much do you collect?	Per Week: Per Month:
	How much do you make from selling it?	Per Week: Per Month:

8 Savings

8.1	Do you save money for future requirements? (1. Yes 2. No)	
8.2	How much do you save in a year?	
8.3	Where do you save? 1. Bank 2. Co-operative 3. Other (Specify)	

9 Indebtedness

9.1	Have you taken on any loan for your house? (1. Yes 2. No)	
9.2	From what source? (Bank, Family, Friend, Other)	
9.3	Amount	
9.4	Year	
9.5	How much do you still owe on the loan?	

10 Access to Credit

10.1	Do you have access to credit?	
10.2	If yes, from which institution?	
10.3	What is the interest rate?	

11 Source of drinking water

11.1	Type of sources:	
11.2	Details of source:	
11.3	Distance of source of water from house (m):	
11.4	Type of Source: (1) Community; (2) Own	
11.5	Details of Source: (1) Open Well; (2) Tube Well; (3) Tap; (4) Tank-Pond; (5) River; (6) Canal; (7) Any Other (Specify)	
11.6	What is the source of your water? 1. Dowasco 2. Spring 3. River 4. Rain	

12 Household Income (Include members who stay permanently)

12.1 Household income per person

Name	Age	Sex	Marital Status	Educational Qualification	Occupation 1	Occupation 2 and 3 if applicable	Monthly income	Annual income

12.2	Is any household member currently seeking a job? Yes/No	
12.3	What percentage of your annual income is generated by your primary occupation?	
12.4	What percentage of your annual income is generated by other sources	
	i) From own land cultivation	
	ii) From leased in land	
	iii) From leased out land	
	iv) By hiring agricultural assets	

12.5	What percentage of your annual income is generated by animal husbandry?	
12.6	What percentage is generated by other occupations? Please list.	
12.7	What is your total annual income?	

13 Household Spending

13.1	Which member(s) are responsible for spending?	
13.2	How much do you spend on food per week?	
13.3	How much do spend on electricity or other sources of power per month?	
13.4	How much do you spend on health care per month?	
13.6	How much do you spend on your children's education?	
13.7	Do you have any other investments that you spend money on?	
13.8	Have you borrowed money for business purposes?	
13.9	How much have you repaid?	
13.10	How much is outstanding?	
13.11	What was the purpose of your loan?	

14 Land Acquisition

14.1	Have you been approached about acquisition of your land?	
14.2	Has the land acquisition process been explained to you?	
14.3	Would you be willing to sell your parcel for purposes of the project?	
14.4	Have you agreed a price or engaged in any negotiations on this?	
14.5	Have you been compensated for your property?	

15 Beneficiary of Development Programmes

15.1	Are you a beneficiary of any development programme during last 10 years? 1. Yes 2. No	
15.2	If Yes, Name of the Programme:	
15.3	Source of Funding: 1. Government, 2. Voluntary Organization, 3. Charitable trust	
15.4	Details of benefit received:	Cash Component: Kind/asset:
15.5	Specify in detail, the improvements made through the programme:	
15.6	Do you currently use any services in the community? Counselling, health-related, or other?	

16 Migration

16.1	How long have you been living in your current location?	
16.2	Do you reside there seasonally or permanently?	
16.3	Birthplace	
16.4	Reasons for Migration:	
16.5	Had any of your relatives lived here before you came:	
16.6	Was it easy to settle here or did you experience any difficulties?	

17 Personal Perceptions

17.1	Are you familiar with the proposed geothermal project?	
17.2	How do you think it will affect you?	
17.3	What is your preferred means for addressing this?	
17.4	How do you think it will benefit you?	
17.5	What are your biggest challenges as a household?	
17.6	How has the hurricane affected relations in your household? Economically? Socially?	
17.7	Have you noticed an increase in domestic violence since the hurricane?	
17.8	What are your hopes for the future?	

18 Vulnerable populations

18.1	**Women/single moms** Do you have any children? Yes No Who is responsible for your children while you are working?	
18.2	Do the children ever miss school because you are working	
	How have things changed since you moved your business to your new location?	
18.3	Where do you travel for your business supplies?	
18.4	Has this changed since your move?	
18.5	Do you ever have safety concerns at your new location?	
18.6	Do you ever work by yourself at night?	
18.7	What are your biggest worries in business? At home	
18.8	What support would be most valuable to you?	
	Elderly	
18.9	Do you have access to healthcare?	
	How do you travel?	
	Does your family visit you regularly?	
	How do you get your food?	
	What support would be most valuable to you?	

Terms of Reference (TOR)

Environmental and Social Impact Assessment for

Drilling of Geothermal Well RV-I2 & Reinjection Route

Purpose of the Terms of Reference

These Terms of Reference describe the scope of works required for an Environmental and Social Impact Assessment, necessary for the construction of a well pad, the drilling of a geothermal reinjection well and the construction of a reinjection pipeline.

Introduction

Proposed well RV-I2 will be used as a reinjection well in the construction of a 10MW Domestic geothermal power plant in Laudat. The location is as a more cost-effective alternative to previous reinjection options. Groundwork for the small Domestic power plant is being facilitated by the Dominica Geothermal Development Company (DGDC).

This ESIA will provide the necessary compliance with the laws and regulations of Dominica for construction. This ESIA will meet the national requirements of the Physical Planning Division of the Government of Dominica and applicable international Standards including the IFC Performance Standards on Environmental and Social Sustainability, and the World Bank Group Environmental, Health and Safety Guidelines.

Background

The European Union and the Agence Française de Développement (AFD) funded the drilling of three geothermal slim-hole exploration wells in Wotten Waven (WW-01) and Laudat (WW-02, WW-03) in 2011 and 2012. This was followed by the drilling of one reinjection well in Trafalgar (WW-R1) and one production well in Laudat (WW-P1) in 2013 and 2014. In 2016, the Government of Dominica and the World Bank came to an agreement for the funding of the *Geothermal Energy Risk Mitigation Project* for the construction of a 7MW power plant for Domestic use, with the DGDC being the executing agency. The design included the use of production well (WW-P1) and power plant site in Laudat, with reinjection

wells in Wotten Waven (WW-01) and Trafalgar (WW-R1). Following a failed procurement in November 2019, that approach was abandoned.

DGDC commissioned reinjection studies from two independent consulting firms who recommended reinjection in Laudat in the area specified below. That approach would eliminate the pipeline from Laudat to Wotten Waven and Trafalgar and still maintain the integrity of the reservoir. In 2020, the DGDC and a French Consortium agreed to the construction of a 10MW Domestic Power plant in the same general area. The plant design output has been increased to produce 10MW of power and an alternative reinjection well pad location, designated RV-I2, was identified in Laudat.

A re-test of the production well P1 in October 2019 confirmed the viability of the resource and the ability to produced 10MW of power from well pad P1. The power plant location would be the same as in the previous project design. A differentiation in the project approach has been the designating the technology to be built (Organic Rankine Cycle) as opposed to letting the market decide.

Objectives

The purpose of this assignment is to develop an Environmental and Social Impact Assessment (ESIA) to determine the environmental and social impacts resulting from the construction and operation of new reinjection well including its associated access road, well pad and pipeline. The ESIA will supply the data relating to these impacts and give recommendations for their prevention or mitigation. These findings will form part of the Environmental and Social Management Plan (ESMP).

This focused ESIA should use as much as possible the existing information from the ESIAs conducted prior to drilling of the 3 exploration wells and the addendum for the production and reinjection wells between 2011 and 2013 as the defined Area of Influences are overlapping the current project location (see Figure 1) as well as from the 2016-2018 ESIA studies performed by JACOBS and covering the power plant site and former reinjection route (reference to these previous studies is provided in Annex A). Following the review and gap analysis of the available information, targeted additional data collection including field surveys are expected to be necessary complement and update the baseline data, especially (but not limited to) on biodiversity and social.

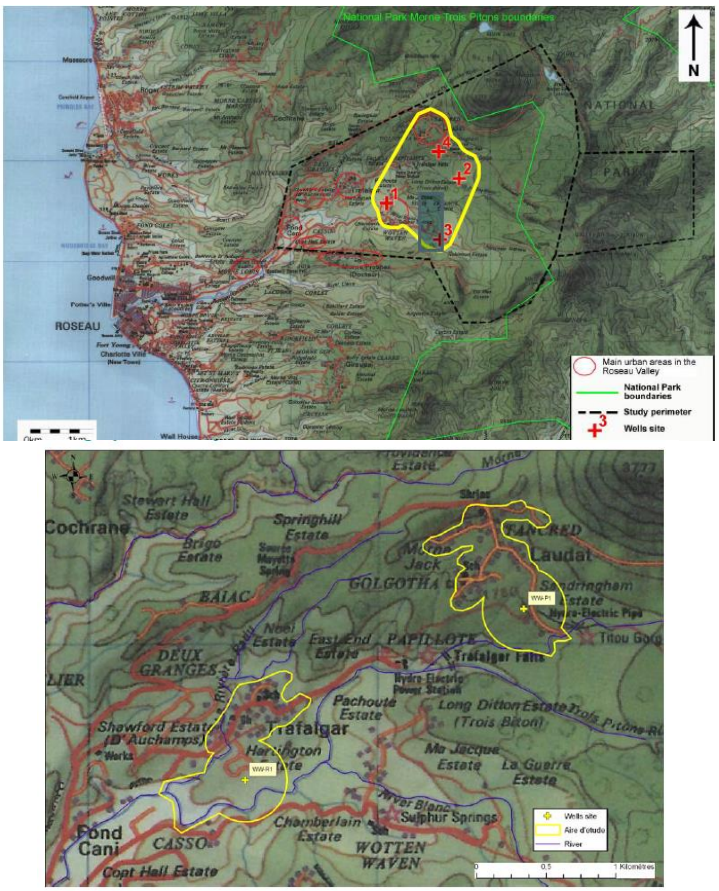


Figure 1 - ESIAs for the exploration and production wells

Study Area

The proposed project site is in the village of Laudat roughly 0.75km due west of WW-P1 well pad. Access to the area is through the village in an area known as Middle East. Some additional road construction will be required to access the proposed well pad. Figure 2 shows a map of the proposed project location and likely pipeline route.

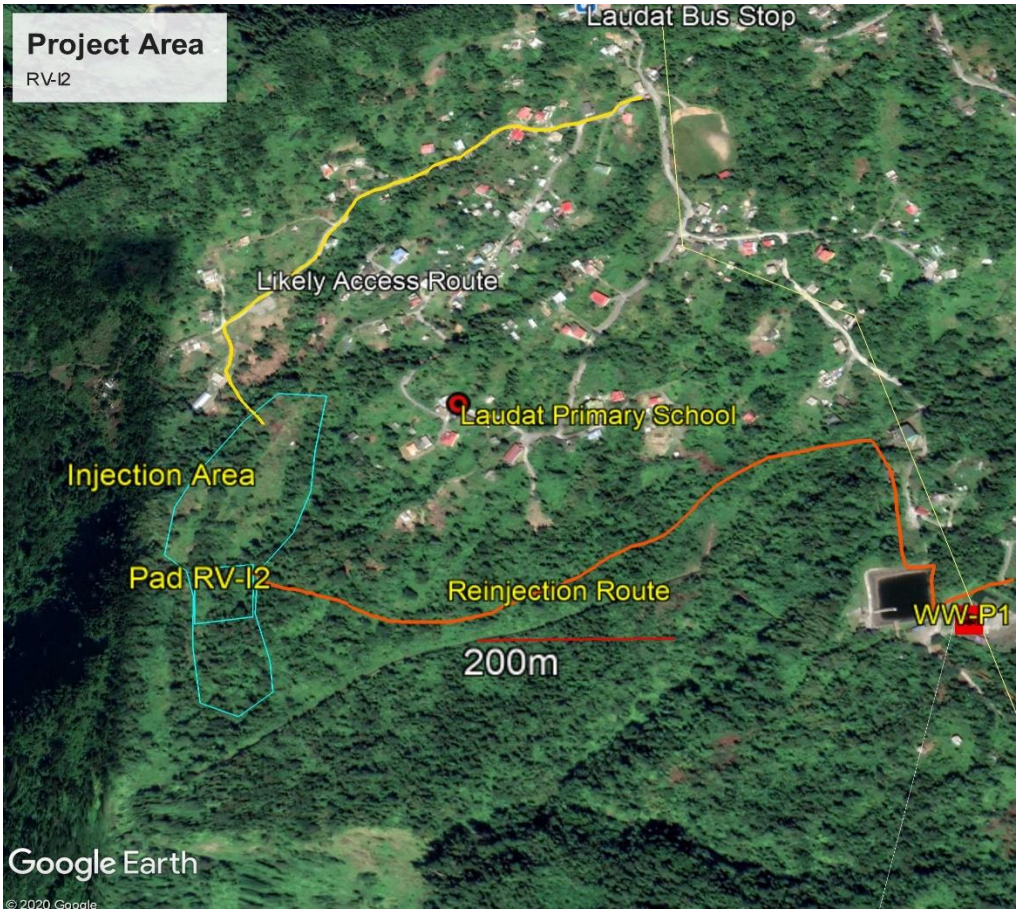


Figure 2 - Current project area location relative to Laudat Village

Scope of Work

The consultant shall:

1. Describe the proposed project using clear and illustrated presentation of the technical aspects of the construction and operations activities in the context of the larger future project (see some project description information in Annex B).
2. Prepare a detailed section on the social, environmental, and physical aspects of the project Area of Influence which should be defined at the beginning of the assignment:

Determine baseline conditions to establish prevailing biophysical and socio-economic conditions upon which the impacts will be assessed using a combination of desk research, on-site field assessment, stakeholder analysis, interviews, focus group meetings and possible community consultation as well as meetings with Dominica Geothermal Development Company Ltd, to collate baseline data on the following:

Physical and environmental parameters

- Geology, geomorphology, and hydrogeology
- Topography
- Soils
- Climate
- Air and noise
- Hydrology and aquatic biodiversity
- Flora including vegetation and habitat mapping
- Fauna
- Historical / archaeological features
- Aesthetic amenity
- Land use

Socio-economic parameters

- Socio-economic profile of the Laudat community to include *inter alia,* population, demographic, socio-cultural, main economic activities, infrastructure, social services, and labour force activities, disaggregated by gender and including the identification of vulnerable groups.
- Mapping of the local stakeholders comprising amongst others, landowners, land users, residents, local business, authorities, NGS, development partners, tourism service providers, etc.
- Description and documentation of the stakeholder engagement and land acquisition processes undertaken by Eclipse, DGDC and the authorities.

3. Review the policy, legal and institutional framework at the national level as well as the international guidelines to determine whether the project meets national laws, regulations, and policies as well as relevant international guidelines including the IFC Performance

Standards on Environmental and Social Sustainability, and the World Bank Group Environmental, Health and Safety Guidelines.

4. Present and analyse the alternatives to the project, especially on the well location and pipeline routes.
5. Identify all impacts of the processes of construction and operation of the project in relation with the area of influence under consideration. These impacts will be characterized – adverse or positive/ direct, indirect or cumulative/ short, medium, or long term/ local, regional, global/ low, medium and high probability of occurrence – and estimated as much as possible quantitatively rather than qualitatively to determine / as well as their respective magnitude in low, medium, high intensity. The significance of the impact will then be estimated and ranked through an impact significance matrix combining the intensity and the sensitivity/vulnerability of the receptors.

6. The mitigation strategies will be considered using the usual hierarchy: avoid/minimize/rectify/reduce/offset. Assess mitigation by further consideration of technical and social methods and alternatives, detailed consideration of the technology employed and in the social sphere by discussion with affected stakeholders so as to avoid, reduce or mitigate any adverse impact.
7. An Environmental and Social Management Plan, ESMP to allow for monitoring and evaluation based on previous project specification has been developed and will be updated by DGDC, as will the ESMS.
8. Identify and consult with all relevant stakeholder groups to provide information, determine their interest and to assess the impact of the project on these groups and to obtain feed-back from them This will be administered through questionnaires, meetings and consultations. The following safeguards instruments have already been developed and are in use at DGDC: stakeholder engagement plan, grievance mechanism and an abbreviated resettlement action plan. They will be updated based on recommendations of the report.

9. At finally, a list of the likely impacts will be issued and a meeting with all stakeholders will be arranged to discuss these impacts and the proposed mitigations.

Timeline

As the construction work are planned for October 2020 and the minimum delay for administrative processing is 60 days, this focused ESIA process is expected to be finalized by the end of July under the following timeline:

Month	June	June	June/July	July	July	July	July	August
Dates	15-19	22-26	29-3	6-10	13-17	20-24	27-31	3-7
Week	1	2	3	4	5	6	7	8
Kick-off								
Preliminary field visit								
Document review								
Baseline surveys								
Stakeholder engagement								
Reporting								
Submission								

Annex A:

The following environmental and social studies have been carried out to date:

1. Regulatory Impact Assessment on the Initial Environment (Environmental Feasibility Study, May 2009)

2. Stage 1: Exploration Drilling Process – Environmental Impact Assessment (2011)

3. Stage 2: Preliminary Environmental Impact Assessment of Geothermal Production and Re-Injection Drilling Wells in Dominica – Environmental Impact Assessment (2013).

4. To support the preparation of an ESIA for the Project baseline surveys of the social, physical and biological environment within the Roseau Valley were completed between December 2013 and June 2015.

5. Environmental and Social Impact Assessment 2018 (https://www.geodominica.dm/esia/)

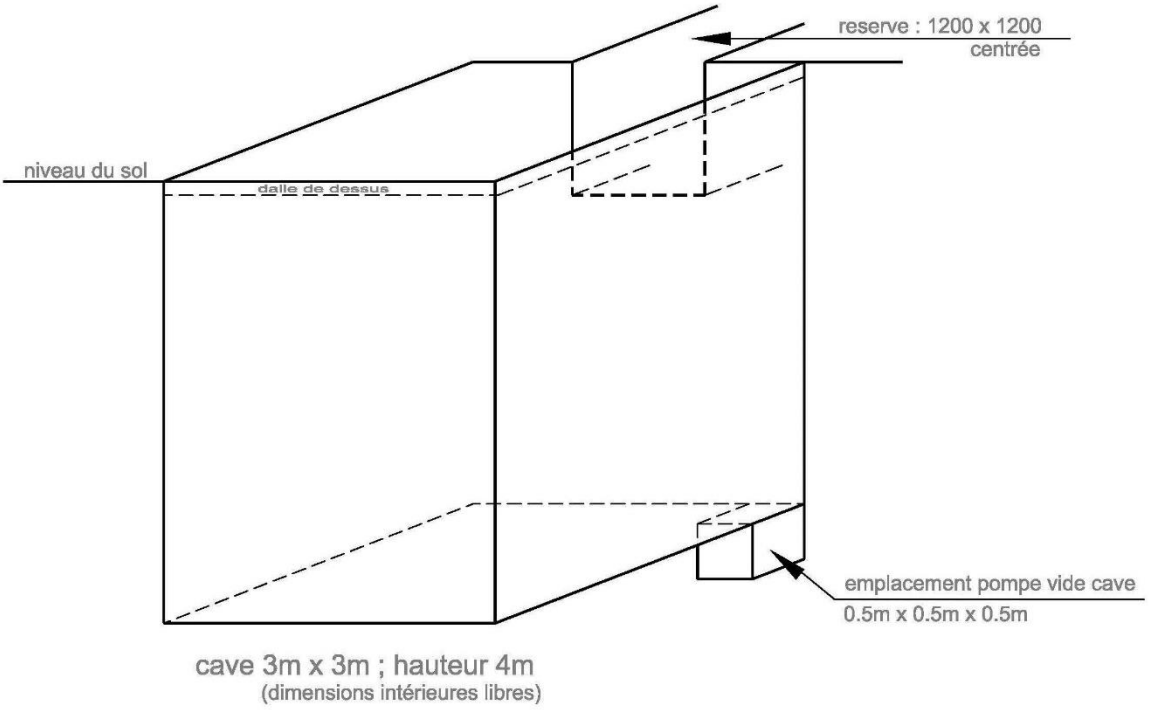
Annex B: Technical Specification of reinjection well

Well pad specifications:

- Forest clearing and the evacuation of cut plants

- Closure of the construction site if necessary

- The earthworks of the platform to allow the optimal installation of the equipment according to the constraints of the site defined in this document, the platform will have a slope of 1% allowing the collection and reprocessing of all platform water. average surface area of 6000 m². – 50 MPa minimum (100 MPa under the machine and substructure…)



- Creation of an access track to the well pad any tonnage

- The installation of a waterproof coating (coated type) under the machine, the sludge area, the product storage areas: sludge, lubricant, etc., under the diesel tanks and the effluent collection area (surface around 2000/2500 m²)

- The construction of the shaft head cellars by excavation around the conductor pipe, the cellars will have a dimension of 3 x 3 x 4 m.

Each cellar will be provided with a reservation for the installation of a cellar pump: each cellar will be equipped with a sump positioned in one of the lower corners (dimensions of the sump 0,50m x 0.50m x 0.50m).

One of the four walls of each cellar will have to have a reservation for the arrival of the production / injection pipes. The position and dimensioning of each of these reservations will be defined by mutual agreement with the project owner and the Prime Contractor.

- The construction of the cuttings corral with a volume of approximately 150 m^3, located under the vibrators (to be validated by the holder of Contract).

Its dimensions will be approximately 10 x 10 x 2 m, of which 1 m will be buried.

This element will be built with stepoc type blocks (cleaning of the corral with the use of an excavator during the drilling work).

The positioning of these elements and their final dimensioning will be carried out in consultation with the holder of drilling contract

- Cellar: Supply and installation of gratings, ladders, and intermediate levels at the end of drilling.

Well:

As the primary objective of this well is to reinject the remaining produced liquid fraction of the domestic plant, emphasis will be put in characterizing its injectivity index.
The well testing operations will then resume in a well monitored completion test with the following operations:

- 4 injection steps: 20, 40, 60 and 80 kg/s with a minimum duration of 4 hrs. each
- 1 PT and flowmeter profile during each step (up and down)
- Continuous P, T recording at the reference depth when no profile acquisition

First section	
Length	80 m
Diameter	24''
BOP	Diverter
Casing	18''5/8 87,5 lbs/ft K55 BTC
Cementation	Cement Class G + 40% silica
Second section	
Length	250 m MD
Diameter	17''1/2
BOP	Annulus 20''3/4
Casing	13''3/8 68 lbs/ft K55 BTC
Cementation	Cement Class G + 40% silica
Third section	
Length	750 m MD
Diameter	12''1/4
BOP	Stack 13''5/8
Casing	9''5/8 47 lbs/ft K55 BTC
Cementation	Cement Class G + 40% silica
KOP	300 m
GBU	3°/30 m
Inclination maximum	30°
Reservoir	
Length	750 to 1800 m MD maximum
	8''1/2
Diameter BOP	Stack 13''5/8
Casing	Slotted liner 7'' between 650
	m till TD

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