April 2017

State Party's Report on the State of Conservation of Morne Trois Pitons National Park

Executive Summary

In 1997 Morne Trois Pitons National Park was established as a UNESCO World Heritage Site - Inscribed on the World Heritage List under Natural 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 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".

In 2013 exploratory and well drilling and testing was completed at Wotten Waven and Laudat fields. These sites are located outside the boundaries of the Morne Trois Pitons National Park.

Since the conclusion of the exploratory phase there has been no activity by the project on the sites. The State party is now waiting on the Operational phase of the project. TOR for an Environmental and Social Impact Assessment (ESIA) is finalised and the ESIA is expected to be completed between June and August 2017.

In discussion with the UNESCO/ IUCN mission on island March 27-31, State Party has accepted the recommendation to include an assessment of the potential impact on the OUV of the property, namely on Biodiversity, and to consider mitigation actions for the project.

A recently approved project "Supporting Sustainable Ecosystem by strengthening the Effectiveness of Dominica's Protected Area System" Funded by GEF will use GEF incremental support to build Dominica's national capacity to manage its PA system with emphasis on the MTPNP and its buffer zone; to improve management effectiveness create sustainable livelihood activities and improve biodiversity conservation. This project will develop a protected areas management system in keeping with recommendations from previous initiatives like the OPAAL project and the National Parks Consortium Studies. Using the GEF funding this project will strengthen the sustainability of Dominica's PA system by developing a sustainable financial

management plan, site specific management plan for Morne Trois Piton National Park, ensure the legal establishment of a buffer zone for MTPN, among other things.

Responses from the State Party of Dominica to the World Heritage Decisions committee

State Party has noted paragraphs 1 & 2 of Decision 40 COM 7B 73

Regrets that the State Party did not submit a report on the state of conservation of the property, as requested by the Committee

In Response to paragraph #3 of the Decision State Party also has regrets and sincerely apologises for the non-submission which was due firstly to emergency situation linked to Tropical Storm Erika and then to transitional arrangements within the administration of the management of the park.

Urges again the State Party to suspend the geothermal project until the above mentioned EIA has been submitted to the World Heritage Centre, and reviewed by IUCN;

In response to paragraph #5 of the Decision, State Party would like to inform that the exploration phase is concluded and there is no ongoing works at the sites.

Terms of reference for a new Environmental and Social Impact Assessment (ESIA) for the operational phase is finalised thanks to the financial support of the World Bank and the ESIA should be completed between June and August 2017 and submitted then to the World Heritage Centre. A copy of the TOR is attached.

It must be noted that during the joint UNESCO IUCN mission it was requested to include an assessment of the potential impact on the OUV of the Park, namely on Biodiversity and consideration for mitigation in the Tor.

Also reiterates its request to the State Party to invite a joint World Heritage Centre/IUCN Reactive Monitoring mission to the property, to assess the impacts of existing geothermal infrastructure, and the current status of the geothermal project in the Roseau Valley and its potential impacts on the OUV of the property

In response to paragraph #6 of the Decision, State Party invited a joint World Heritage Centre/IUCN Reactive Monitoring mission to the property during the period March 27-31, 2017. A number of meetings were held with MTNP mangers, Stakeholders and site visits were conducted at the exploration areas in Laudat, Wotten Waven and Trafalgar.

The monitoring mission also had the opportunity to visit one of the highly visited eco tourism sites Emerald pool and Petite Savanne a community located along the southern boundary of the MTNP which was devastated during Tropical Storm Erika in 2015. State Party of Dominica will provide a copy of the programme of the meetings with the Monitoring mission.

Requests the State Party to submit to the World Heritage Centre, by 1 February 2017

This report is submitted in compliance with paragraph #7 of the Decision; as explained above, the delay in the submission is due firstly to an emergency situation linked to Tropical Storm Erika and then to transitional managerial and administrative arrangements. The State Party will submit timely updates and complementary information as available.

Other current conservation issues

As in all small insular states and everywhere in the Caribbean, the general issue of climate change is a matter of concern for the State Party of Dominica, as showed by the impact of Tropical Storm Erika. However, climate change effects represent a potential threat and not a current impact on the OUV of the Park. The State party is therefore working to integrate climate change into its conservation practices and management strategies.

Developments to describe in line with paragraph 172 of the Operational Guidelines

No proposed developments with possible impact on the OUV of the property need to be outlined at this stage, in terms of explorations, hunting/fishing, building or road constructions, and restorations. In conformity with para 172 of the OG, possible upcoming elements will be reported to the World Heritage Centre in a timely manner.

Public Access to the SOC report

Dominica has no objection to publish this report on the web site of the World Heritage Centre.

Date and signature

April 7, 2017

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April 7, 2017

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Dominica Geothermal Development – Environmental and Social Impact Assessment

Ministry of Foreign Affairs and Trade

Terms of Reference (ToR)

RZ020300-0000-NP-RPT-0001 | Version 3

January 2017

Dominica Geothermal Development – Environmental and Social Impact Assessment

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Document history and status

Revision	Date	Description	By	Review	Approved
1	7 Oct 2016	Draft for Submission to World Bank and GoCD	T Strange	B Clarke	A Brookes
2	23 Nov 2016	Changes following requests by World Bank	P Gabriel / Dorney Burgdorf	B Clarke	A Brookes
3	10 January 2017	Changes following further clarifications by World Bank	P Gabriel / Dorney Burgdorf	B Clarke	A Brookes

Contents

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs New Zealand Limited (Jacobs) is to provide a Terms of Reference for the Dominica Geothermal Power Plant Environmental and Social Impact Assessment in accordance with the scope of services set out in the contract between Jacobs and the Client (New Zealand Ministry of Foreign Affairs and Trade). That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

The report is based on information supplied by Jacobs' Client and from information held by Jacobs for the Environmental and Social Impact Assessment project.

The report is based on information supplied by Jacobs' Client and from information held by Jacobs for the ESIA. This report has been prepared on behalf of, and for the exclusive use of, Jacobs' Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

Glossary

ASL	Above Sea Level
DOMLEC	Dominica Electricity Services Limited
DOWASCO	Dominica Water and Sewerage Company Limited
EIA	Environmental Impact Assessment
EHS	Environmental Health and Safety
EP	Equator Principles III (2013)
EPC	Engineer, Procure and Construct
GoCD	Government of the Commonwealth of Dominica
ESMS	Environmental and Social Management System
EPFI	Equator Principle Financial Institutions
ESMP	Environmental and Social Management Plan
ESIA	Environmental and Social Impact Assessment
IFC	International Finance Corporation
IUCN	International Union for Conservation of Nature
kV	Kilovolt
kW	Kilowatt
MW	Mega Watt
MWe	Mega Watt Electric
NO_x	Oxides of Nitrogen
NO_2	Nitrogen Dioxide
ORC	Organic Rankine Cycle
OUV	Outstanding Universal Value
O_3	Ozone
$PM_{2.5}$	Ultra-fine Particulate Matter
PM_{10}	Fine Particulate Matter
PS	Performance Standard
SEP	Stakeholder Engagement Plan
SO_2	Sulphur Dioxide
ToR	Terms of Reference

1. Introduction

1.1 Background

The Commonwealth of Dominica is a small island developing state in the Caribbean Sea with a population of approximately 72,000 people and a land area of approximately 750 km^2. About 60% of the land is classified as a World Heritage site by UNESCO, due to its rich biodiversity. It is located near the centre of a string of islands known as the Lesser Antilles, between the neighbouring French territories of Martinique and Guadeloupe. The capital Roseau is located to the south-west of the island and has a population of around 15,000 people.

Dominica's power system relies heavily on diesel imports to generate electricity. Changing the power generation mix and reducing the cost and volatility of electricity prices have become development priorities for Dominica. To this end the Government of the Commonwealth of Dominica (GoCD) has pursued an exploration programme to evaluate the viability of geothermal resource in the Roseau Valley (Figure 1-1).

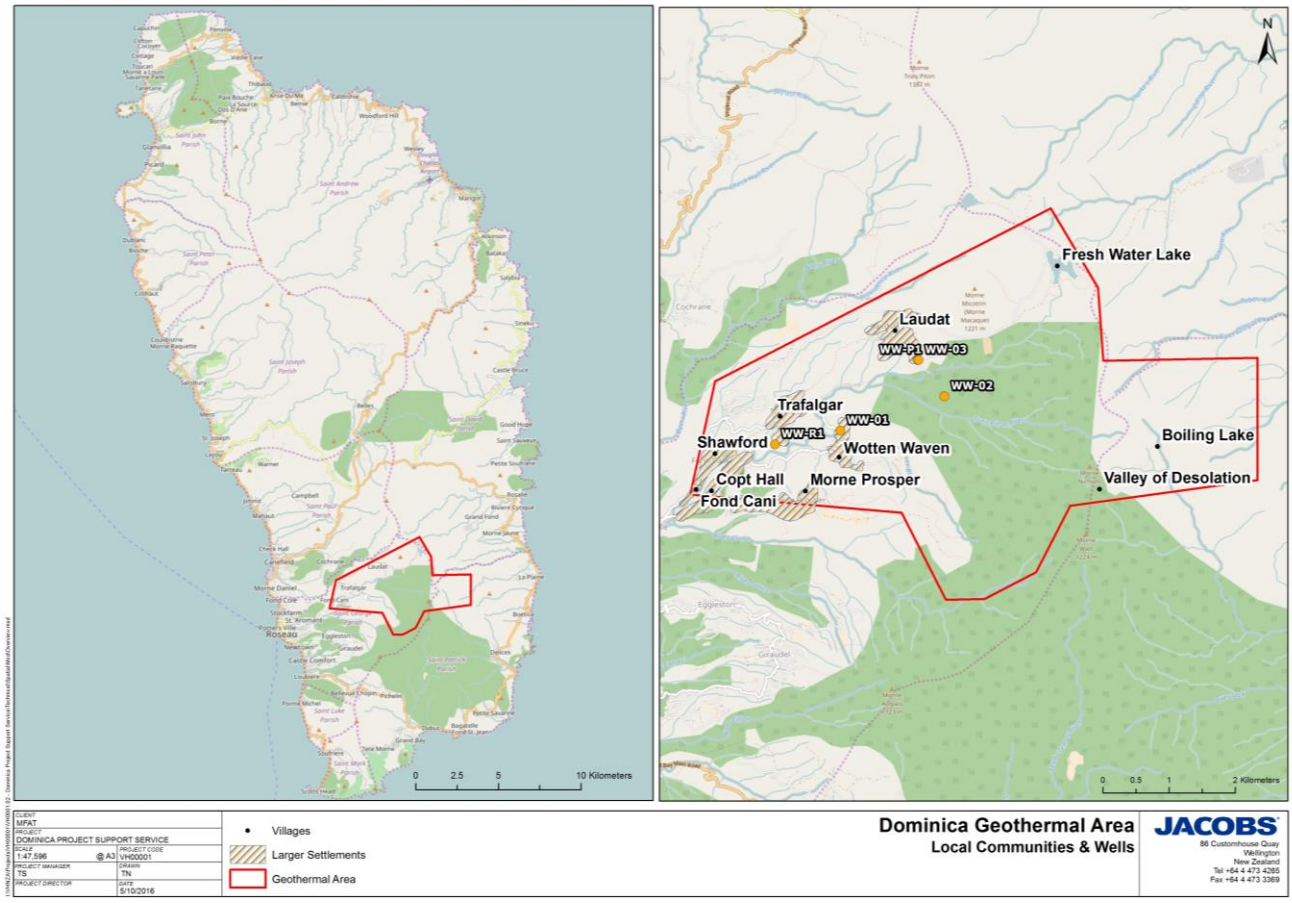


Figure 1-1: Location of Roseau Valley (Site of proposed Geothermal Power Plant)

The exploration programme has been conducted in a phased manner over the course of approximately 10 years:

No.	Phase Name	Activities
1	Preparation	Project establishment, geoscientific investigations
2	Exploration	Exploration drilling of 3 slim hole wells and resource assessment
3	Production	Production drilling of one full size well and one reinjection well
4	Construction	Present phase comprising power plant construction and start-up

The GoCD has previously taken the leadership to complete the successful drilling of exploration, production and injection wells in order to enable a geothermal power project in Dominica. The exploration campaign, which has been focussed in the Laudat-Wotten Waven-Trafalgar geothermal field, has proven the existence of a geothermal resource suitable for power generation.

The Government now wishes to complete the project by establishing the Dominica Geothermal Company to develop a 7MW geothermal power plant and sell electricity to DOMLEC. The project company will be 100%-owned by GoCD, being established as a private company under the laws of the Commonwealth of Dominica. Electricity will be sold to DOMLEC, under the regulatory framework established through the Electricity Supply Act 2006. The project will be financed using grant monies from international agencies and bilateral partners, the World Bank and with the Government's own resources.

Prior to the construction and commissioning of the Geothermal Power Plant an assessment of the potential environmental and social impacts of construction and operation of the power plant and associated infrastructure is required in accordance with local legislation and international lending institution safeguards.

1.2 Purpose of the Terms of Reference

The Terms of Reference (ToR) describe the scope of the Environmental and Social Impact Assessment (ESIA) that will be carried out to evaluate the potential positive and negative impacts of construction and operation of the project in accordance with the requirements identified in Section 2. In addition it describes the process of identifying and implementing appropriate controls to avoid, mitigate and/or offset potential environmental and social impacts.

1.3 Structure of Terms of Reference

The structure of the ToR is set out as follows:

- Section 1 – Introduction
- Section 2 – Legislative Requirements
- Section 3 – Project Description
- Section 4 – ESIA Scope of Works

2. Legislative Requirements

It is important that a geothermal development meets internationally accepted environmental and social safeguard standards in order to ensure that benefits to project affected people are maximised and that potential adverse environmental and social impacts are minimised.

2.1 Local Legislation

With sole responsibility for physical development of land in Dominica, the GoCD manages physical development through the Commonwealth of Dominica Physical Planning Act 2002. In accordance with this Act, development permission is required before the construction of the Project may commence. Clause 17 of the Act states:

'No person shall carry out any development of land except under and in accordance with the terms of a development permission granted in that behalf prior to the commencement of such development…'

Applications for development permission must be submitted to the Physical Planning Department within the Ministry of Agriculture and Environmental Protection along with an Environmental Impact Assessment (Clause 20(1)(b)). As defined in the Act an Environmental Impact Assessment (EIA) means:

- *'The environmental appraisal which will identify positive and negative impacts on the site, the immediate communities as well as on the wider regional context.*
- *The environmental assessment includes the direct impact of each project component as well as on the physical, socio-economic and socio-cultural features of the site, the immediate communities as well as the wider regional context.'*

Before carrying out an EIA a Terms of Reference should be submitted to the Ministry for review in order to confirm the scope of the EIA.

In accordance with Clause 22(1) the Chief Physical Planner may require the applicant to:

a) Publish details of his application at such times, in such places and in such manner as may be specified in the notice;

b) Give details of his application to such persons or authorities as may be specified in the notice.

Further, as specified in Clause 22(3), where an EIA is required, the Authority shall:

a) publish a notice in at least one daily newspaper and affix a notice on the land to which the application relates that an application to develop land has been received and will be determined on a date specified in the notice; and

b) *invite comments and representations either in writing or orally on such application.*

The Chief Physical Planner may also *'consult in writing any public officer or other person who appears to him to be able to provide information relevant to an application for development permission to enable the Chief Physical Planner to advise the Minister or the Authority , as appropriate, with regard to the application'* (Clause 24 (1)).

The ESIA will be approved by the Physical Planning Department of the GoCD in consultation with relevant Departments (i.e. the Environmental Coordinating Unit, Lands and Surveys Department, Environmental Heath and Safety Department). Monitoring of the implementation of Environmental and Social Management Systems will be conducted by the Environmental Health and Safety Department.

2.2 International Standards

As the World Bank has indicated its intention to provide funding to the development, the project is also required to demonstrate compliance with the World Bank Performance Standards for Private Sector Activities, OP 4.03,

(WBG, 2013) and the WBG Environmental, Health, and Safety Guidelines (hereafter referred to as the 'EHS Guidelines').

2.2.1 Categorising the Project

In accordance with the World Bank's Operational Policy, the World Bank undertakes environmental screening of each proposed project to determine the appropriate extent and type of Environmental Assessment (EA) needed. The Bank 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. The findings and results of EA for Category B projects are described in the project documentation (Project Appraisal Document and Project Information Document).
- **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 IFC 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) and Environmental and Social Management System (ESMS).

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. As Dominica is not a designated country[1] the assessment process shall also evaluate compliance with the IFC Performance Standards and EHS Guidelines.

Based on a description of the project (Section 3), a review of previous studies, summarised in Section 4.2 and a preliminary risk assessment (Section 4.4) carried out by Jacobs New Zealand Limited (Jacobs) it is considered the project should be given a preliminary classification of **Category A**. This is for the following reasons:

- Based on the initial preliminary risk assessment, most of the potential social and environmental impacts have been determined to be of low risk (i.e. to be managed by routine procedures) and would therefore not require any additional design mitigation.

[1] Designated Countries are those countries deemed to have robust environmental and social governance, legislation systems and institutional capacity designed to protect their people and the natural environment. The list of Designated Countries can be found on the Equator Principles Association website.

- The route injection line Option C (Figure 3-4) passes close to the residential area of Laudat and therefore there may be adverse impacts due to:
  - Potential physical relocation or infringement of land use for residents of Laudat. Such displacement is undesirable and also not expected to occur, but cannot be completely ruled out at this stage.
  - Potential disturbance of habitat (i.e. through vegetation removal) that has been classified as 'high' sensitivity by Caraibes Environment Development (2015a/b). High sensitivity areas were classified as those that contained the following:
    - A high number of protected species inside (IUCN, French and Dominican legislation);
    - An area with very few anthropic influences; or
    - A high number of endemic species (Dominican and Caribbean).
- Three of the potential power plant sites (Option 1A, 1 and 3 – see Figure 3-3)) fall within habitat that has been classified as 'high' sensitivity by Caraibes Environment Development (2015a/b).

It should be noted that the habitat classification carried out by Caraibes Environment Development in 2015 was done at a high level when the potential reinjection line routes and power plant sites were not known. Assigning the project as Category A is a precautionary approach at this stage based on the current level of uncertainty with site locations of reinjection lines and the power plant. This categorisation will be confirmed following site visits in December 2016 and by further studies through the ESIA process.

2.2.2 World Bank Performance Standards for Private Sector Activities., May 2013

As the project is considered a private sector led economic development project, the following World Bank Performance Standards would apply to the project (note that these standards are equivalent to the IFC Performance Standards – Appendix A (IFC, 2012):

- Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts;
- Performance Standard 2: Labor and Working Conditions;
- Performance Standard 3: Resource Efficiency and Pollution Prevention;
- Performance Standard 4: Community Health, Safety, and Security
- Performance Standard 5: Land Acquisition and Involuntary Resettlement;
- Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources;
- Performance Standard 7: Indigenous Peoples; and
- Performance Standard 8: Cultural Heritage.

2.2.3 General and Industry Specific EHS Guidelines

In addition to the performance standards, the WBG has developed Environmental, Health and Safety (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 EHS Guidelines became available for use in April 2007 and will be used in the preparation of the ESIA Report and supporting technical analysis. The industry specific guidelines are as follows:

- Geothermal Power Generation, and
- Electric Power Transmission and Distribution.

2.2.3.1 Environmental, Health and Safety General Guidelines (April, 2007)

The EHS Guidelines cover the following key areas:

Environmental

The general environmental guidelines are:

- Air Emissions and Ambient Air Quality
- Energy Conservation
- Wastewater and Ambient Water Quality
- Water Conservation
- Hazardous Materials Management
- Waste Management
- Noise

Occupational Health and Safety Guidelines

The general occupational health and safety guidelines are:

- General Facility and Design and Operation
- Communication and Training
- Physical Hazards
- Chemical Hazards
- Biological Hazards
- Radiological Hazards
- Personal Protective Equipment
- Special Hazard Environments
- Monitoring

Community Health and Safety Guidelines

The general community health and safety guidelines are:

- Water Quality and Availability
- Structural Safety of Project Infrastructure
- Life and Fire Safety
- Traffic Safety
- Transport of Hazardous Materials
- Disease Prevention
- Emergency Preparedness and Response

Construction and Demolition Guidelines

The general construction and demolition guidelines are:

- Environment
- Occupational Health and Safety
- Community Health and Safety

2.2.3.2 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 most 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.

2.2.3.3 Environmental, Health, and Safety Guidelines for Electric Power Transmission and Distribution

The EHS Guidelines for Electric Power Transmission and Distribution sets out relevant information that needs to be considered in the environmental and social impact assessment of transmission lines between a generation facility and a substation located within an electricity grid. Key issues covered include:

- construction and maintenance of Right of Way and impacts on terrestrial habitats;
- electric and magnetic fields (EMF);
- hazardous materials; and
- occupational health and safety.

2.2.4 Other Relevant Treaties and Legislation

International treaties that Dominica is signatory to and any local Dominican legislation will be listed and a summary of key requirements will be included in the Policy, Legal and Administrative Framework section of the ESIA.

3. Project Description

3.1 Overview

The Project comprises the construction, completion, testing, commissioning, ownership and operation of geothermal wells, steam gathering and reinjection system, power plant with nameplate capacity of 7MW and connection to electrical grid and associated infrastructure in the Roseau Valley, Dominica.

The preliminary design for the Project is ongoing with detailed design to be completed following a formal tender process for an Engineer, Procure and Construct contractor(s). Therefore some of the descriptions provided in this Section are high level and typical of a geothermal development in this setting.

Geothermal projects connect production wells through a steamfield facility to a power plant which is connected to an electricity grid. Geothermal fluids consist of steam, hot water (brine) and a small quantity of non-condensable gases (mostly carbon dioxide, but also some hydrogen sulphide). Used geothermal fluids produced by the project (separated brine and steam condensate) are returned to the geothermal reservoir via reinjection wells, which may be located some distance away (i.e. over 1 km) from the production wells to avoid short-circuiting or premature cooling of the production wells.

The key components of the proposed 7MW power plant include:

- Power plant comprising 2 x 3.5MW units or a single 7MW unit (either steam Rankine cycle or organic Rankine cycle units).
- Production well at WW-P1 - The existing geothermal production well, WW-P1 at Laudat, is indicated to have potential to generate 6 to 9MWe of geothermal electricity and will be the sole production well for the Project. In the event that there is a decline in production well output to a level that will no longer sustain the full operation of the power plant.a workover of WW-P1 may be required or it might be necessary to drill an additional make-up wellwhich would also be located on pad WW-P1
- Reinjection to wells WW-R1 and WW-01 - The used geothermal fluid (brine and possibly some steam condensate) produced from production well WW-P1 would be disposed of into reinjection wells WW-R1 and WW-01 in Trafalgar and Wotten Waven respectively via a 30cm diameter pipeline of up to 4km in length. WW-R1 will require injection of cold water for a period of up to three months to improve reinjection capacity prior to commissioning.
- Steamfield infrastructure including two phase piping, steam separators, atmospheric flash tank, steam gathering system, brine collection and disposal system, condensate collection and disposal system, pressure relief system and storage sump.
- Supporting Infrastructure including well pads, turbine building, primary and ancillary equipment, cooling system, road network and water/waste water supply.
- Substation and interconnection to the DOMLEC electricity grid via a transmission line to Laudat Power Plant.

Further description of the proposed technology and land requirements is provided below.

3.2 Power Conversion Technologies

Energy can be extracted from both brine and steam, or a mixture thereof, and turned into electric power. There is much more energy in steam than in hot water and even though the ratio of brine to steam produced by WW-P1 is about 5:1, most energy still lies in the steam phase. There are two main power plant technology options, steam Rankine cycle or organic Rankine cycle, either of which is suitable:

1) Steam Rankine Cycle

Geothermal steam is used directly in a steam turbine connected to a generator. After the steam passes through the steam turbine it can either be condensed or discharged directly to atmosphere. The atmospheric discharge option (sometimes called a back pressure turbine) is not recommended for the initial project development as

this can create a significant visual plume, it would only achieve ~3.5MW output and there would be substantial work required to retrofit and convert the turbine to a condensing option.

2) Organic Rankine Cycle (ORC)

The 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). Organic Rankine cycle plants may use brine, steam or two-phase fluids produced from the wells, with any of the options potentially providing a suitable solution.

3.3 Cooling System

A cooling system is required to reject heat which cannot be converted to electric power. This can either be air (dry) cooling or water (evaporative) cooling. The main differences between the two are: the land area required for the cooling towers; the visual impact of the equipment; overall efficiency; visual emissions, the reinjection load and the total installed cost.

- Organic Rankine cycle plants are usually configured with air coolers, but they can be specified to use water cooling. Air coolers do not have a visible plume of water vapour, but may exhibit a heat haze and typically have a larger land footprint than water coolers.
- Wet cooling towers are typically used with condensing steam Rankine cycle plants. They have the advantage that part of the steam condensate is evaporated, so the total amount of liquid to be injected is less than for air cooling. However, water cooling towers may have a visible plume of water vapour when the relative humidity of the atmosphere is high.

A hybrid cooling option (which includes a small amount of dry cooling) can provide an alternative which removes the visual plumes of water vapour from water cooling towers, but comes at a slightly increased cost. The cooling system will typically be closely integrated with the power plant and supplied as part of the overall power plant package.

Figure 3-1: Turbine Hall and Evaporative Cooling Tower (left). Air cooling for 20MW plant (right)

3.4 Steamfield

The steamfield will comprise of the following:

1) A single production well on WW-P1 located in Laudat. Separation of steam and brine will take place on the production pad, with steam being transferred via a pipeline to the power plant, which would be located adjacent to the production well pad. River water was utilised for drilling and it is expected that existing infrastructure may be used for the provision of water for the power plant.

2) Approximately 3 km of cross-country pipelines to take hot brine for reinjection into two wells, WW-R1 and WW-01. The specific route for the brine line has not yet been confirmed (refer Section 3.7.2).

3) Well WW-03 located adjacent to WWP1 or WW-02 may be used for condensate injection, although this requirement will depend on the technology selected.

The steamfield equipment plays several important roles in the safe and reliable operation of a geothermal plant:

- Handling variable multi-phase steam, brine and non-condensable gas flows while ensuring that neither production wells nor reinjection wells are adversely affected by its operation.
- Matching the supply of steam to the power plant with the demand for steam from power plant as it changes in response to fluctuations in electricity demand.
- Providing clean steam (or brine) to the steam turbine or the organic Rankine cycle heat exchangers.
- Disposing of spent fluids into reinjection wells.

The steamfield will take production of two-phase fluid from WW-P1. Although in the current project only one production well is envisaged, the addition of future wells will be considered in the layout and design of pad WW-P1. The two-phase fluid will be sent to a separator where it will be divided into steam and brine phases, before flowing to the power plant (depending on technology) or reinjection pipeline. It may be necessary to install two separators if a two-phase development approach is chosen.

Separators may be vertical or horizontal, with major differences being the space required, tolerance to changes in geothermal fluids and overall efficiency. The separator is best located close to the production well and so is likely to be installed on the WW-P1 well pad. Other key pieces of equipment to be housed on this pad will depend on the final technology selected, but may include an atmospheric flash tank, steam venting and pressure control system, and storage sumps.

If a steam condensing turbine option is selected there is a requirement to inject the condensate produced. This is normally done via a dedicated pipeline to a different well than that used for brine injection because condensate has different chemistry to that of the separated brine. However, this is not necessarily the case and in some instances there can be advantages in combining the flows to prevent silica deposition, depending on the chemistry. This will be addressed during the detailed design process. The volume of condensate produced is low compared with brine produced and, if required, it is recommended that condensate be injected into well WW-03, located on pad WW-P1 or to WW-02. Organic Rankine Cycle technology enables condensate to be recombined and reinjected with the brine.

The steamfield takes the used geothermal fluids to reinjection wells WW-R1 and WW-01. The steamfield pipeline will be insulated to reduce heat loss, which is necessary to avoid deposition of silica. It will be clad in aluminium or other appropriate material and may be coloured or camouflaged to reduce visual impacts. The reinjection pipeline must operate at high temperature and pressure and needs to 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.

3.5 Civil Works

Three existing well pads will be used for the development WW-P1, WW-01 and WW-R1. All sites will require remedial works to bring them up to standard, with an initial indication of the work required as follows:

- Site WW-P1: Site improvement, slope stabilization, drainage works, fencing, security lighting.
- Site WW-01: Site fencing, slope stabilization, improve road access.
- Site WW-R1: Site fencing, security lighting, disposal of material/ general cleanup.

WW-P1 will contain the majority of fluid production and separation equipment, with power generation equipment to be located on a newly created pad adjacent to WW-P1. The Government currently owns the well pads. However, additional land will be required for the power plant site and for the injection line piping system. The land required for the power plant, and hence civil works required to prepare the site, will depend on the power plant technology selected. Figure 3-2 provides nominal land area required for 2 x 3.5MW power plants, with binary plant requiring an area of approximately 115m x 60m (plus laydown area) and steam condensing plant

requiring approximately 50m x 40m (plus laydown area). A larger scale version of this Figure is provided in Appendix B.

Land requirements are discussed in more detail in Section 3.7.

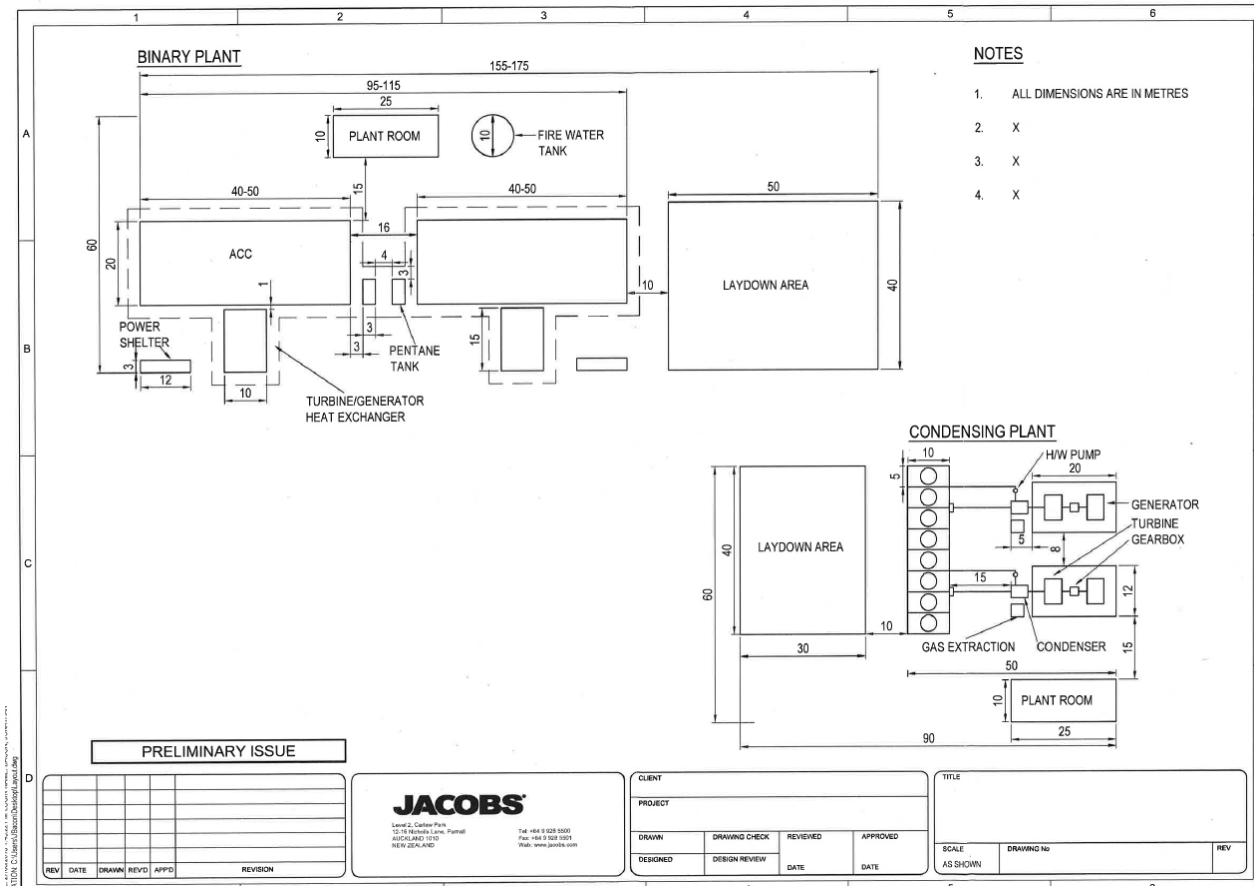


Figure 3-2: Nominal land area required for 2 x 3.5MW binary and steam condensing technologies

The power plant will be constructed on a concrete pad designed to withstand the weight and movement of large pieces of mechanical equipment.

As the dominant power source for the island, it is recommended that the main components of the power plant be housed in a fully enclosed building designed to withstand heavy rainfall and hurricane conditions. This should be constructed to accommodate 2 x 3.5MW turbines. Some elements of the balance of plant equipment, including circulating water cooling systems and gas extraction systems may be outside but under appropriate cover.

Access to the well pads is the responsibility of the Government and an evaluation of the roads and public infrastructure is required to ensure that the power plant can be safely delivered.

3.6 Land Requirements

In line with International Standards, the project will seek to avoid involuntary resettlement, economic displacement and minimise compulsory land acquisition. The Roseau Valley is relatively sparsely populated and the Government has already carried out numerous consultations and outreach with local landowners. As part of the ESIA process any additional land acquisition, including potential resettlement or economic displacement, will be completed in accordance with WB Performance Standard 5. The process will consist of the following steps:

1) An Audit of the land acquisition completed to date to ensure compliance with World Bank Performance Standard 5;
2) For new sites required for the project, where land acquisition will result in physical or economic displacement, a Resettlement Action Plan (RAP) and/or Livelihood Restoration Plan (LRP) will be completed prior to project construction; and
3) Any additional sites required during project implementation, which could result in in physical or economic displacement, a Resettlement and/or Livelihood Restoration Framework will be prepared.

3.6.1 Land Acquisition

The Government has acquired the land for the existing well pads, although payment remains pending. Of the three sites which were purchased (WW-P1, WW-01, WW-R1), two were purchased through negotiated agreement and WW-P1 was purchased by Compulsory Acquisition under the Land Acquisition Act 1946, as the owner of the land is deceased.

Construction and operation of the plant may require the acquisition of up to three or more adjacent properties currently in private ownership, which may total approximately 6.5 acres. The final reinjection route is still being determined and will require a land corridor approximately 15 - 30 foot wide. An estimated 4 acres of lands will be required to establish the right of way for the reinjection pipeline and associated infrastructure. Future land acquisition will be completed in accordance with the requirements of WB Performance Standard 5 including the completion of compensation payments, along with involuntary resettlement and economic displacement requirements described below.

3.6.2 Involuntary Resettlement

As the Roseau Valley is relatively sparsely populated, it is considered unlikely that involuntary resettlement will be required. However, until the final requirements and locations have been finalised it cannot be ruled out. The Government has carried out numerous consultations and outreach with local landowners over the past six years as is documented in the previous two EIAs (2009 and 2011), a Gap Analysis (2013) and the ESIA Baseline Study (2015). For the areas where project related civil works will be undertaken and people are physically displaced, a Resettlement Action Plan will be prepared and implemented prior to project construction.

3.6.3 Economic Displacement and Livelihood Impacts

There are a number of farmers and potential small businesses that could be displaced by development of the project. For the areas where project related civil works will be undertaken in locations where economic displacement could result, a Livelihood Restoration Plan will be prepared and implemented prior to project construction.

3.6.4 Power Plant

Sites around WW-P1 were examined for suitability for expansion of the geothermal project and power plant siting. It is proposed that the new separation plant be located on the western end of the existing wellpad. The remaining space on the wellpad should be conserved for future production drilling. Three sites have been identified which are suitable for the development, with relatively modest slope and located in close proximity to existing wellpad.

1) Option 1 immediately North of WW-P1 is large enough to accommodate a condensing plant, with provision to include the Option 1A site for ancillary requirements such as offices and maintenance facilities. Much of this site is in the ownership of the government as a 3.8 acre parcel of land was acquired for WW-P1.
2) Option 2 is to the east of WW-P1 and on approximately the same elevation. Ready access could be formed from WW-P1. The site would be suitable for a condensing plant, but also has a potential use as an extended wellpad for future drilling programs (i.e. export plant). A local preference was expressed by the Community Liaison Officer that this area be used for future drilling.

3) Option 3 is a larger site suitable for a binary plant. It is located some 100m north-east of WW-P1 and has a 12° slope to the north which could be readily levelled to form a platform. It is currently used for small scale agriculture.

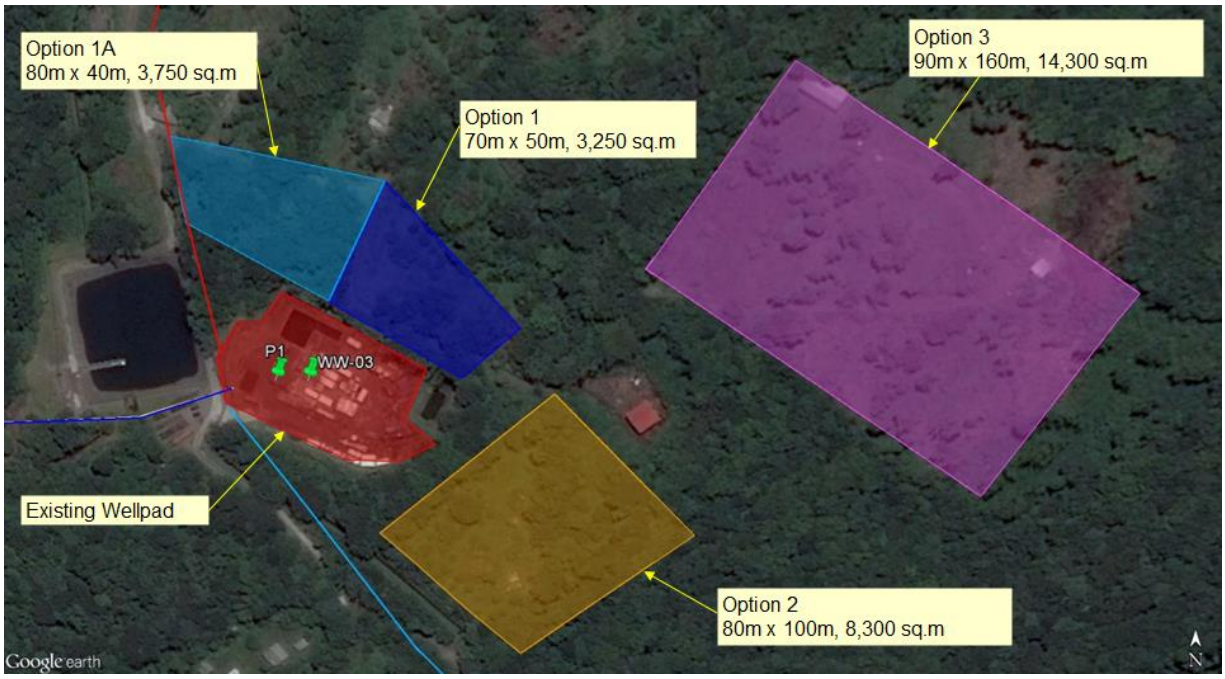


Figure 3-3: Power plant site options

Option 1 and 1A are the preferred sites as they are largely in the ownership of the Government. They are best suited to a steam Rankine condensing plant. If a binary plant is selected Option 3 is the preferred site, although it may be possible to place a binary plant with wet cooling onto Option 1 and 1A. Option 2 should be retained for future drilling and production expansion.

3.6.5 Steamfield

Options for steam/brine separation, steam pressure control, steam scrubbing, and start-up, normal and emergency shutdown operations need to be considered and the land required to achieve these operations needs to be determined through a preliminary steamfield design exercise. These will be practically the same for all power plant technology options.

The land requirements for the steamfield piping system are dominated by the brine reinjection pipeline, which will run from WW-P1 to WW-01 and/or WW-R1. The diameter of the pipeline would be approximately DN 250 to 300 mm (10 to 12 inches).

Site visits by mechanical and geotechnical disciplines identified eight possible pipeline routes. The routes were evaluated on the basis of the constructability, topography, geohazard exposure (i.e. landslides, rock falls, etc), estimated capital costs, operational considerations and social and environmental constraints. The following route options are preferred and shown in Figure 3-4:

- Option A, D and F
- Option C, D and F
- Option H and F

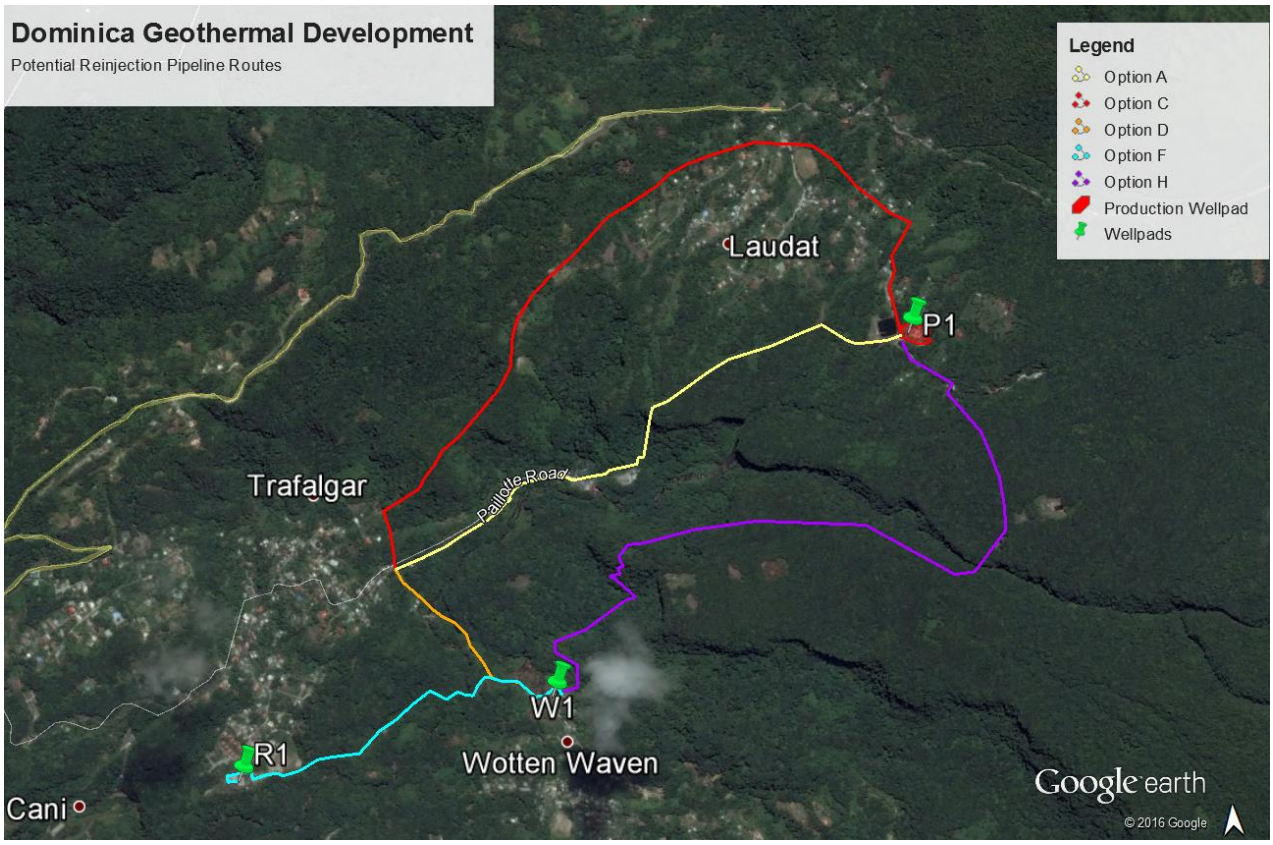


Figure 3-4: Proposed reinjection pipeline routes from WW-P1 to WW-R1 and WW-01

Final route selection will be carried out in close co-ordination between the process engineering, mechanical, geotechnical and civil engineering design disciplines, along with the Government, Land and Survey Division and environmental and social scientists.

Option A - Follows DOMLEC's hydropower pipelines across easily navigated topography and would need to utilise 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 (Figure 3-5). 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 WW-01 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 – 70m. The pipeline would then cross relatively flat terrain before descending down a short section of narrow pathway, which broadens and eventually comes out by WW-01.

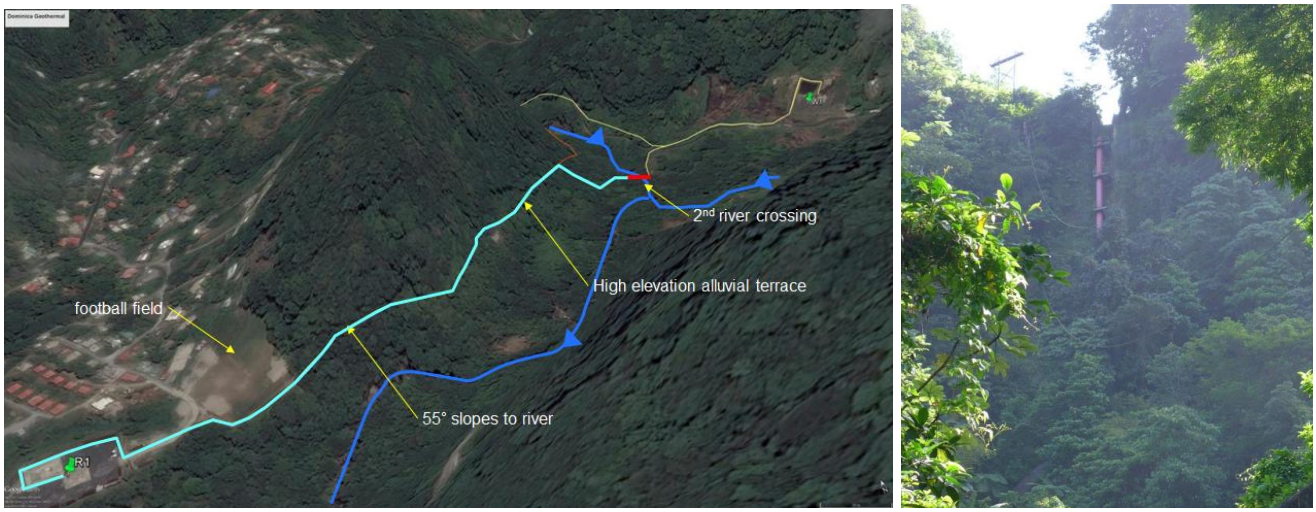


Figure 3-5: Recommended reinjection pipeline route from WW-01 to WW-R1

3.7 Electricity Transmission Infrastructure

There is still some discussion on the optimum transmission infrastructure, which is presently the subject of a power systems analysis. The geothermal plant will (likely) connect to the DOMLEC grid at the Laudat hydro power station and will require construction of a power line from WW-P1 to the Laudat power station, a distance of approximately 300m. An 11kV/33kV step-up transformer will (likely) be required to export power from the geothermal plant and it is likely that this would be located alongside the Laudat Power Station. The power line from Laudat to Fond Cole will need to be upgraded, but will follow the existing route. This will need to be considered as associated infrastructure related to the project. The details of this element of the project are still under discussion.

4. Scope of Work

4.1 Objective of the Study

The goal of the ESIA is to evaluate the temporary and permanent impacts of the construction, commissioning, operation and decommissioning of the power plant, steamfield and transmission infrastructure, on the natural and human environment. The study will make recommendations to mitigate or minimize the foreseeable negative impacts, which will be captured in the Environmental and Social Management Plan (ESMP). An Environmental and Social Management System (ESMS) will also need to be established to ensure implementation of relevant environmental and social controls.

The ESIA will build upon the existing safeguards work carried out for exploration and production drilling, baseline survey work carried out through the INTERREG IIIB Programme and recommendations provided in the 'Situational analysis for the preparation of the Wotten Waven-Trafalgar-Laudat field in the Roseau Valley'.

Any drilling of further wells at existing wellpads will be covered in the ESIA, but any future delineation wells for a new development (which maybe 10 years way or more) will not be included.

4.2 Baseline Environmental and Social Data

The Roseau Valley lies inland from the coast, bordering the capital city of Roseau. The valley is heavily wooded with rich vegetation and various communities exist in the area (Trafalgar, Laudat, Fond Cani and Wotten Waven). There also exist some very popular tourist attractions, such as the hot springs at Wotten Waven, Trafalgar Falls, the Boiling Lake, Titou Gorge, Valley of Desolation, and the Freshwater Lake.

Existing physical, biological and socio-economic conditions will be described in the ESIA to form the basis for an assessment of potential impacts from the construction and operation of the Project. This will include:

- Air quality, climate, meteorological and acoustic data
- Water quality and hydrology
- Land use, land cover and visual amenity
- Terrestrial and aquatic ecology, with an emphasis on rare, endangered and endemic species, critical habitats and ecosystems services
- Natural hazards, such as hurricanes, landslips and flooding
- Socioeconomic environment, including public health, settlements (demographic profile, gender profile and land ownership), social infrastructure, economic profile (i.e. level of employment) and economic activities
- Culture and heritage
- Transport infrastructure and traffic movements.

These will be established through the review of literature and findings of earlier studies and completion of supplementary baseline data collection activities to address any perceived gaps in information.

4.2.1 Studies Completed to Date

To date the following environmental and social studies have been completed:

- Caraibes Environment Development (2009) Regulatory Impact Assessment on the Initial Environment - Environmental Feasibility Study.
- Caraibes Environment Development (2011). Stage 1: Exploration Drilling Process – Environmental Impact Assessment.
- Caraibes Environment Development (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. These were summarised in the following reports (collectively referred to as the 'Baseline Study'):
  - Caraibes Environment Development (2015a). Initial environmental status of the Roseau Valley in Dominica, planned for development of geothermal electricity production. Final report, May 2015. Section 3 Biodiversity / Terrestrial Flora and Fauna.
  - Caraibes Environment Development (2015b). Initial environmental status of the Roseau Valley in Dominica, planned for development of geothermal electricity production. Final summary report.

4.2.2 Gap Analysis

A review of these studies has been carried out. The findings of this review are presented below along with any further baseline data collection proposed. In addition a review of the situational analysis prepared by the World Bank has been carried out, with relevant findings incorporated into the scope of work described below.

4.2.2.1 Air Quality

Caraibes Environment Development conducted baseline survey of air quality in 30 locations in 2014 (Caraibes Environment Development, 2015a/b). The survey monitored concentrations of sulphur dioxide (SO_2); hydrogen sulphide (H_2S); oxides of nitrogen (NOx) – nitrogen dioxide (NO_2); fine particulate (PM_{10}) and ultra-fine particulate ($PM_{2.5}$); and ozone (O_3) on two occasions, once during the dry season (23 April to 6 May 2014) and once in the wet season (20 November to 11 December 2014). The study also selected the location for the installation of a reference weather station, which enabled measurement of the principal weather features over the course of a year. This data will be used to establish the air quality baseline in the ESIA.

4.2.2.2 Noise

During baseline sampling, noise measurements were taken in the principal residential zones, the main tourist sites and valley hotels (Caraibes Environment Development, 2015a/b). Two noise measurement campaigns were carried out in the tourist high season (December 2013) and low season (April 2014). Five residential zones studied: Laudat, Fond Cani North / Fond Cani West & South, Trafalgar, Wotten Waven, Morne Prosper with 54 acoustic measurement points analysed over a 24 hour period. The results attributed ambient noise levels to local fauna, human activity, vegetation and running water (rivers and waterfalls, etc.). Ambient noise levels were generally higher at night and there were higher ambient noise levels closer to tourist sites and hotels. This data will be used to establish the baseline in the ESIA.

The data recorded as part of the baseline study has been deemed sufficient to use in the ESIA to satisfy the requirements of the local and international legislation and guidelines.

4.2.2.3 Hydrology and Hydrogeology

No information on hydrology (flows) or hydrogeology is presented in previous EIAs for drilling or the baseline report prepared by Caraibes Environment. However, gauging of surface water flows has been carried out at the following locations by DOWASCO:

Location	Coordinates	
River Claire	- N15d17'51.89"	W61d19'44.32"
River Douce	- N15d18'11.82"	W61d22'06.21"
Titou Gorge	- N15d19'44.66"	W61d19'30.11"
Trafalgar River	- N15d19'24.98"	W61d20'33.46"
River Blanc	- N15d18'41.39"	W61d19'29.96"
Tributary	- N15d18'37.83"	W61d19'21.78"

In addition, it is understood that DOMLEC carries out continuous monitoring of flows entering the hydroelectric power plant at Laudat. Therefore it is proposed to request information from DOMLEC regarding abstraction of water from Titou Gorge, which is the most likely source of water abstraction for development of the geothermal power plant, due to its proximity to the site. This will supplement the information already obtained by DOWASCO.

Detailed information on hydrogeology is not considered necessary for the ESIA as there is not proposed to be abstraction of groundwater for construction or operation of the project.

4.2.2.4 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.

There were three sampling trips undertaken to establish baseline conditions, and this information will be sufficient for preparation of the ESIA. However, it is recommended that further sampling be undertaken prior to construction of the project in order 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.

4.2.2.5 Landscape, Visual and Heritage

The baseline study for visual amenity captured the location of view points 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. The baseline data also included discussions with historians, botanists and residents from Laudat and documentary research. Landscape types were established, as well as key infrastructure and buildings in the locality. This data will be used to establish the baseline in the ESIA.

Further information may be collected on site visits by Jacobs and through ongoing consultation with the local communities, related to the temporary visual impact of vertical steam discharges.

4.2.2.6 Terrestrial Flora and Fauna

An initial baseline survey for flora and fauna and subsequent analysis was carried out in 2008 with the aim to provide an introduction to the biodiversity of the Roseau Valley, and also the legal context related to forest clearing and protected natural spaces. Three areas were initially selected in 2011 for detailed flora and fauna assessment and then a fourth added in 2015 (Caraibes Environment Development, 2015a/b). At each area the dominant habitat and flora and fauna species were described and matched to vegetation type descriptions. The general description of the biodiversity and flora and fauna in the Roseau Valley was informative and based on expert knowledge of the island biodiversity (using the International Union for Conservation of Nature (IUCN) Red Lists). There was also a high level classification of the sensitivity of the habitat carried out, which the geothermal resource areas into the following:

1) High sensitivity areas containing:
    - A high number of protected species inside (IUCN, French and Dominican legislation);
    - An area with very few anthropic influences;
    - A high number of endemic species (Dominican and Caribbean); or
    - The presence of species poorly represented elsewhere.
2) Medium sensitivity areas containing:
    - Lower number of protected species than high sensitivity areas;

- Higher level of anthropogenic disturbance than high sensitivity areas; and
- Less endemic species (Dominican and Caribbean)

3) Low sensitivity areas containing:
   - Higher level of anthropogenic disturbance than medium sensitivity areas; and
   - Fewer endemic and protected species than medium sensitivity areas.

The description of fauna species and habitats was based on opportunistic observations during the vegetation / flora survey and the methods and results of targeted surveys were not discussed. To address this limitation, the authors noted that up to 176 bird species were reported in the literature for the island, including three species of threatened status listed under the IUCN and two species protected in Dominica.

The bird species of the island of Dominica were listed and described in the baseline studies. However, these species were not identified in the reports or potential habitats mapped within the Project area. Similarly, it is not possible to determine from the reports whether threatened vertebrate species are present within the Project area. Therefore, further ground-based surveys will be required as part of the terrestrial ecological assessment in the footprint of the proposed power plant site and reinjection line route.

4.2.2.7 Natural Hazards (including Flood Risk)

Bibliographical data was collected in the Roseau Valley during baseline sampling activities (Caraibes Environment Development, 2015a/b). For flooding, the measurement and monitoring of water flow rates in the valley was recorded and for earthquakes and land movements, historical document describing previous seismic activities were assessed as well as analysis of precise geological maps of the valley. This desk-based survey was complemented by field data that allowed the determination of:

- The hydrological characteristics of the valley (water tables, flooding zones, population survey).
- Natural phenomenon index (lithology, slope, geomorphology).
- Correlation with hazards observed on neighbouring islands.

Analysis of this data allowed for flood modelling and hazard mapping for the valley, identifying areas along the potential reinjection routes which may be prone to landslips.

The data recorded as part of the baseline study has been deemed sufficient to use in the ESIA to satisfy the requirements of the local and international legislation and guidelines. This data will be used to establish the baseline in the ESIA.

4.2.2.8 Socio-economic

Current baseline information collected by Caraibes Environment Development in 2015 is based upon desktop study and data collection including 25-30 interviews conducted with local stakeholders. In addition, the report indicates that three public meetings were held on 11, 12 and 13 December 2013 in Laudat, Trafalgar and Wotten-Waven respectively. Additional meetings were also noted in November of 2013 and January of 2014 per memos from the Ministry of Public Works and Ports Geothermal Project Management Unit. Further details of the meetings completed to date will be provided to the extent feasible in the ESIA and Stakeholder Engagement Plan (SEP). The project socio-economic area of influence is not specifically defined but consultation is focused around the three communities of Laudat, Trafalgar and Wotten-Waven.

The baseline includes demographic information on the Roseau Valley from Dominica's Central Statistical Office supplemented by information from field surveys and the Caribbean Development Bank on quality of life, education, housing, infrastructure governance and the economy. There is very little information on community health and safety.

Further work is required in the following areas:

- Community engagement - Further engagement including focus groups will be carried out to broaden community understanding of the project and understand the communities concerns in greater detail. Details of the planned community engagement process during the ESIA preparation phase and during project implementation are outlined in the SEP being developed for the project.
- Community health - As part of the consultation conducted to date, health has been identified as a significant community concern. Therefore, it is important to establish baseline conditions for health in the Roseau Valley prior to construction of the project to understand any changes in local health following development of the project. Further data should include basic health statistics on disease, life expectancy, and illness.
- Livelihood –Socio-economic census data should be collected for the households and farmers that will be directly affected by the project to determine if a livelihood restoration process is required. Focus groups will also be conducted to better understand eco-tourism impacts and impacts on farmers.

There are no indigenous communities located in the immediate vicinity of the Project geothermal area, with the nearest community being an estimated 15 km north-east (the Carib Territory). Therefore, impacts upon indigenous communities are not considered relevant and have been screened out of the ESIA.

It is possible that the Project will provide community development opportunities through the provision of new jobs for local residents, indirect economic development impacts, collaboration and public involvement opportunities such as trips to other power facilities, and potential opportunities for education and industry diversification. As part of the Assessment, community development initiatives will be explored and considered. A community development program which sets out these initiatives may also be developed as appropriate.

4.2.3 Traffic

No baseline traffic data has been identified for the Roseau Valley. Although it is believed that traffic levels are not high, there is potential for existing road users to be affected by construction traffic. Therefore it is proposed to conduct traffic counts within the potentially affected communities of Laudat, Trafalgar and Wotten Waven to establish baseline conditions, and consider the influence of cruise ships. In addition, a site visit will be conducted to review the existing road infrastructure and take photographs to document its current condition.

4.3 Stakeholder Engagement

Building on stakeholder engagement that has already been completed, a process of identifying relevant stakeholders that may be directly or indirectly affected by the Project will be completed. A SEP is being prepared for the project which will guide engagement activities which are to be conducted in order to address the information gaps identified in Section 4.2.1.8. The objectives of this SEP are to:

- Identify the local legal framework of consultation activities and disclosure requirements, particularly in respect of those public consultation activities that are directly required under the local permitting process;
- Identify potential stakeholders in the area of influence, as well as relevant interested parties such as government agencies and other key stakeholders;
- Record all consultation activities, including those prior to the commencement of the environmental and social impact assessment (ESIA) process;
- Describe how concerns or grievances will be handled;
- Provide an action plan for further consultation during preparation, construction and operational phases of the Project, including details on appropriate formats for effective and culturally meaningful interaction with the community and relevant stakeholders; and
- Provide a disclosure plan, including the identification of any locations where relevant Project documentation will be available locally and elsewhere as well as languages to be used.

The Stakeholder Engagement Plan will be revised and updated periodically including upon completion of the ESIA to assist with ongoing engagement throughout the Geothermal Programme.

4.4 Impact Assessment

The assessment of all environmental and social impacts will encompass both potential impacts and uncertain risks. The level of investigation of potential impacts or particular risks will be proportionate to the severity of potential consequences and likelihood of such an event occurring.

To guide the ESIA and ensure sufficient focus on key issues/risks a preliminary risk assessment has been conducted by Jacobs. The key issues/risks identified through this process are highlighted in Table 4-1 below:

Table 4-1: Key Issues/Risks to be addressed in ESIA

Aspect	Potential Impact
Air Quality	• Emission of gases such as hydrogen sulphide (the primary indicator gas for odour) from the power plant during operation. • Generation of dust and combustion gas emission through earth moving and construction activities. • Odour from hydrogen sulphide emissions.
Greenhouse Gas	• Greenhouse gas emissions from construction machinery and the power plant during operation.
Natural Hazards	• Risks related from natural hazards, such as seismic activity, landslides, hurricanes, volcanic activity and flood inundation.
Geothermal Features	• Potential impact on surface geothermal features as a result of abstraction of steam and reinjection of brine/condensate
Community Health	• Potential impacts on community health, such as through emission of hydrogen sulphide and generation of dust, noise, subsidence and from major accident hazards if organic Rankine plant is installed. Fire risk is also a consideration in particular with binary plant. • During the commissioning stage of the Project, when various parts of the power plant are first started-up, discharges of non-condensable gases (NCGs) may occur outside of the normal disposal points.
Social (including land acquisition)	• Positive impacts upon the local community through the generation of employment opportunities. • Any physical displacement of members of the community as a result of land acquisition for the development of the power plant and steamfield. Physically displaced parties may require assistance with relocation. • Any economic displacement which may occur through construction of the geothermal power plant and steamfield inhibiting use of land acquired for the development. • There is also the potential for temporary effects upon communities and tourism if works (including construction traffic) inhibit access to schools, communities and tourist attractions. • Appropriate consideration will be given to livelihood restoration for any parties that are economically displaced by the Project. •
Working Conditions	• Consideration of the working conditions of employees/contractors engaged in construction and operation.
Noise	• Construction and operation of the power plant will generate noise (i.e. from steam discharges) which may impact upon the surrounding communities and wildlife.
Pest Species	• Importation of machinery/equipment for use in construction and operation can lead to introduction of pest species.
Soil and Groundwater	• Spillage of hazardous substances stored/used in construction and operation of the power plant. • Generation and disposal of construction and domestic waste. • Creation of solid wastes, sludge and slurries. • Contamination of shallow aquifers.
Terrestrial Flora and Fauna	• Removal of vegetation and earthworks to enable construction of the re-injection pipeline, which could result in impacts on biodiversity with particular reference to critical habitat for endangered species, associated with the nearby Morne Trois National Park World Heritage Site. Special

Aspect	Potential Impact
	reference will be made to any rare or threatened species as well as endemic species of both animals and plants. Impacts on the Outstanding Universal Value (OUV) of the Morne Trois National Park World Heritage Site in relation to biodiversity will be considered. • Noise and air quality impacts on the Morne Trois National Park World Heritage Site and the OUV of the site.
Visual Amenity	• Construction of new infrastructure will alter the visual landscape. • Vertical steam discharges could create temporary visual impacts. • Impacts on the OUV of the Morne Trois National Park World Heritage Site in relation to visual impacts.
Water Quality and Freshwater Ecology	• Reinjection of brine and condensate. • Sedimentation of water courses during construction as result of run-off from earthworks. • Spillage of hazardous substances used during construction and operation of the power plant. • Discharge of stormwater containing contaminants from the power plant to local water courses. .
Water Resources	• Abstraction of water for domestic purposes and fire suppression system within power plant.

An assessment of these issues/risks and all other potential environmental and social impacts of the proposed works described in Section 3 will be carried out, including any potential cumulative impacts. The ESIA will state the criteria adopted in assessing the proposed project and its impacts, such as compliance with relevant legislation, policies, standards, community acceptance and maximisation of environmental and social benefits and minimisation of risks.

To support the impact assessment, air dispersion modelling and acoustic modelling will be carried out to estimate potential impacts on the local population and wildlife.

4.4.1 Air Quality Modelling

For the air dispersion modelling assessment it is proposed to use the CALPUFF dispersion model to assess the effects of hydrogen sulphide releases from releases of geothermal fluids during the well testing and operational phases of the project. Meteorological data for the model will be developed using the diagnostic meteorological model WRF, and formatted for use with CALPUFF using the CALMET meteorological model. Locally collected meteorological data will be assessed to determine its quality, and if practicable will be integrated into the meteorological dataset for use with the dispersion model.

The modelling will be dependent upon assumptions made in regard to H_2S discharge rates and the nature of the discharges themselves. These will be informed by analysis of the geothermal fluid made previously, and by process descriptions which should provide details of the well locations, geothermal fluid discharge rates, and parameterisation of the discharges in terms of heights, velocities, and temperatures.

The resulting ground level concentrations of H_2S in the surrounding area will be compared to IFC Performance Standards 2012 and World Bank Environmental Health and Safety General Guidelines 2007 (listed above in Section 2) to assess the environmental impact and identify areas where potentially adverse health or nuisance effects may result. Locations of potentially sensitive receptors will also be identified using aerial imagery, and by information gathered during site visits.

ALOHA consequence modelling of major credible accident scenarios pertaining to use and storage of iso-pentane should the organic Rankine cycle plant option be selected to determine extent of an accident event such as vapour cloud release, vapour cloud explosion.

4.4.2 Acoustic Modelling

Monitored background noise levels will determine noise criteria in accordance with IFC Performance Standards 2012 and World Bank Environmental Health and Safety General Guidelines 2007 (refer to Section 2). Local guidelines will also be reviewed to determine if any are relevant to noise. Aerial imagery will be reviewed

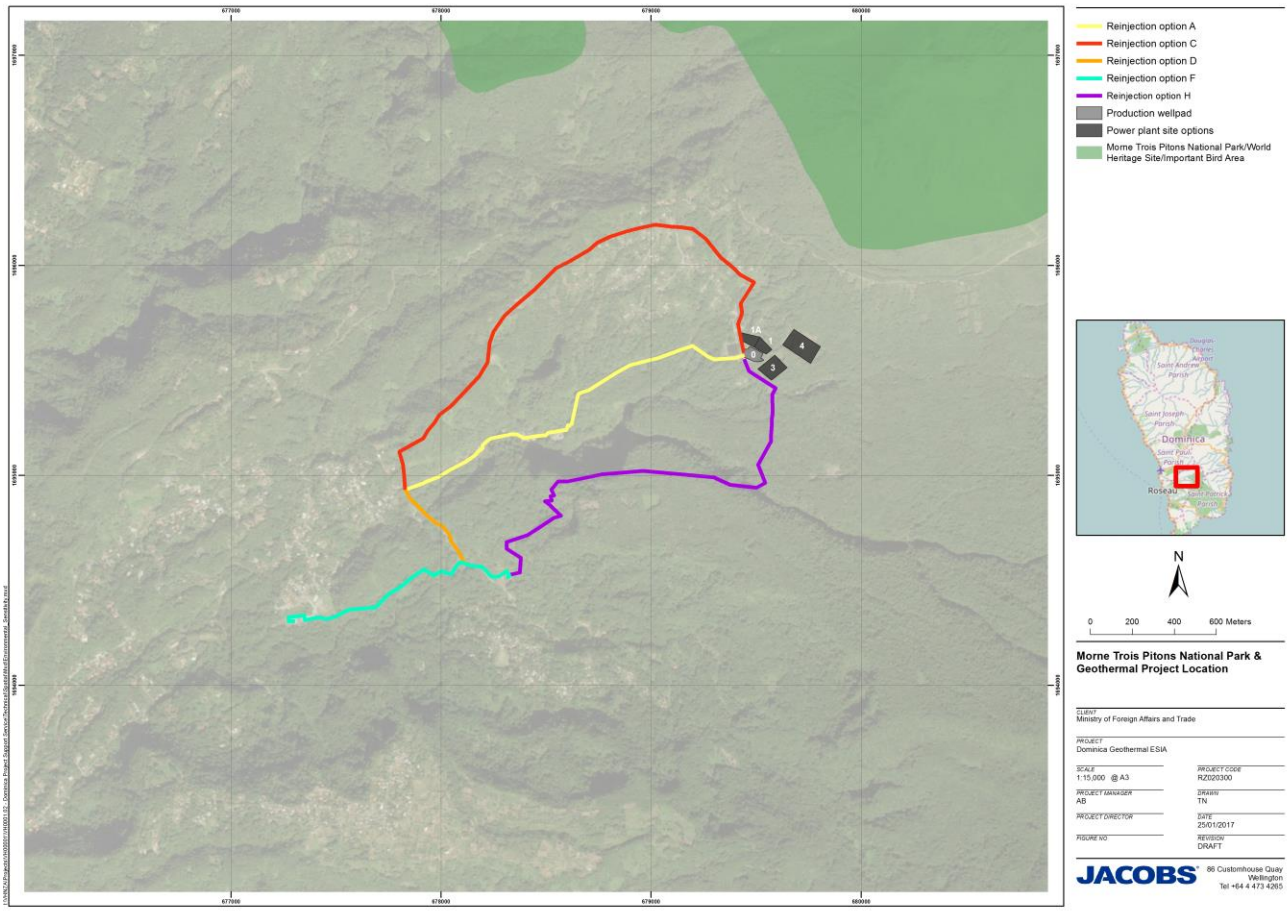
alongside the Caraibes Environment Development (2015a/b) baseline study report to determine nearby potentially affected receivers.

Based on the provided inputs and design, an equipment inventory will be prepared for the operational noise model. Noise levels will be modelled using the ISO9613-1 standard within SoundPlan 7.4 modelling software. Broad management measures for operational noise mitigation will be provided and re-modelled if required. Potential construction noise impacts will also be modelled using ISO9613. Basic construction noise management measures will be provided.

4.4.3 Morne Trois National Park World Heritage Site

The Project is estimated to fall around 400m from the boundary of the Morne Trois National Park World Heritage Site at its nearest point. Therefore, the ESIA will provide an assessment of potential impacts of the Project on the Outstanding Universal Value (OUV) of the Morne Trois National Park World Heritage Site, in line with IUCN's World Heritage Advice Note on Environmental Assessment. For reference, the location of the Project in relation to Morne Trois National Park World Heritage Site is shown on Figure 4.1 below.

Figure 4.1 : Location of the Morne Trois National Park World Heritage Site



4.5 Management and Monitoring

The ESIA will propose measures for the mitigation, avoidance and/or offsetting of potential adverse impacts to ensure adverse impacts are as low as reasonable possible. In addition it will include monitoring (including the performance measures that will be used) to be conducted to ensure control measures are effective and impacts are minimised.

4.6 Reporting

4.6.1 Environmental and Social Impact Assessment

The ESIA will provide stakeholders with sufficient information to understand the type and nature of the project, the potential environmental and social impacts, and the measures proposed to mitigate all adverse impacts. All phases of the project will be described including pre-construction, construction and operation. Direct, indirect and cumulative impacts will be identified and assessed with respect to environmental and social values and potential extent of impacts.

The ESIA report will include the following:

- A Non-Technical Summary of the potential environmental and social impacts of the project.
- A description of the project's objectives and rationale, as well as its relationships to strategic policies and plans.
- Description of the proposed construction works and operation of the power plant and steamfield.
- A description of feasible alternatives capable of substantially meeting the proposal's objectives.
- An outline of the relevant legislation and approvals required for the project to proceed.
- Descriptions of the existing environment, particularly where this is relevant to the assessment of impacts.
- An assessment of the risks of adverse and beneficial environmental and social impacts arising from the project.
- Measures for avoiding, minimising, managing and monitoring adverse impacts.
- A description of stakeholder consultation undertaken.
- Responses to issues raised during public and stakeholder consultation.

The ESIA will be supported by appendices containing relevant data, technical reports and any other sources of the ESIA analysis.

4.6.2 Environmental and Social Management Plan

An Environmental and Social Management Plan will be prepared, which identifies the potential environmental and social impacts, the proposed means of mitigation/avoidance and monitoring (including the performance measures that will be used) to be conducted to ensure control measures are effective and adverse impacts are minimised. The plans should also set out reporting requirements and corrective actions.

4.6.3 Environmental and Social Management System

An Environmental and Social Management System (ESMS) will be established to enable implementation of environmental and social controls for the project. The ESMS documentation will describe:

- **Policy** – overarching policy defining environmental and social objectives and principles guiding the project
- **Identification of risks and impacts** – Process for identifying environmental and social risks and impacts of the project
- **Management programs** – a suite of programs, including management plans and procedures that describe mitigation and performance improvement measures that address potential environmental and social risks and impacts associated with the project
- **Organisation capacity and competency** - identification of roles, responsibilities and authority for implementation of the ESMS
- **Emergency preparedness and response** – establish and maintain a system in collaboration with appropriate third parties to ensure preparedness for response to accidental and emergency situations associated with the project

- **Monitoring and review** – procedures for monitoring and measuring effectiveness of the management programmes, including compliance with legal/contractual and regulatory requirements
- **Stakeholder engagement** – process and mechanisms for ongoing engagement with stakeholders
- **External communications and grievance mechanisms** – procedures for addressing communications from external stakeholders, including recording receipt, screening of enquiries, evaluation of issues raised and response. Furthermore a grievance mechanism should be established to facilitate resolution of concerns raised by members of the effected communities
- **Ongoing reporting to affected communities** – periodic reporting i.e. of progress, to affected communities.

4.6.4 Stakeholder Engagement Plan

A comprehensive and inclusive program of consultation with stakeholders throughout the geothermal programme is required. To facilitate this, a Stakeholder Engagement Plan (SEP) will be prepared, which describes:

- The purpose, aims, objectives and protocols for community and stakeholder consultation.
- Issues or risks for community and stakeholder consultation (i.e. what will cause the consultation to succeed/ fail).
- Proposed consultation approach.
- Stakeholders to be consulted.
- Consultation activities to be undertaken for the ESIA.
- Undertaking stakeholder analysis and mapping, including identification of development stakeholders, residents of local communities, government agencies, etc.) and their likely areas of interest, assessment of potential stakeholder risks and establishment of a stakeholder register for the ESIA.
- Development of an implementation plan, including timeline/ key dates for key stakeholder consultation activities.
- Development of community and stakeholder consultation protocols, in consultation with the project team.
- Development of a grievance mechanism, which outlines a process for handling and responding to complaints and grievances raised by the community in respect of the proposed development.

In addition it is expected that a Livelihood Restoration Plan will be required addressing engagement with members of the community that will be economically displaced as a result of the project. At this time it is not expected there will be physical displacement and therefore a Relocation Action Plan will not be required. However, this will be confirmed through the land acquisition process.

4.7 Project Team

The team will comprise of personnel with expertise in the following fields:

- Project Management of ESIA to meet requirements of Equator Principle Financial Institutions
- Terrestrial Ecology
- Water quality and aquatic ecology
- Air quality and air dispersion modelling
- Acoustic modelling
- Stakeholder engagement and social impact assessment
- Economics
- Hydrology

- Hydrogeology
- Geographical Information Services
- Greenhouse Gas
- Visual impact
- Natural hazards (geology, geotechnical , geothermal features)
- Risk assessment of major credible accidents
- Waste, hazardous substances and occupational health and safety
- Management systems.

4.8 Schedule

The ESIA is proposed to be completed by June 2017.

5. References

Caraibes Environment Development (2009). Regulatory Impact Assessment on the Initial Environment - Environmental Feasibility Study.

Caraibes Environment Development (2011). Stage 1: Exploration Drilling Process – Environmental Impact Assessment.

Caraibes Environment Development (2013). Stage 2: Preliminary Environmental Impact Assessment of Geothermal Production and Re-Injection Drilling Wells in Dominica – Environmental Impact Assessment.

Caraibes Environment Development (2015a). Initial environmental status of the Roseau Valley in Dominica, planned for development of geothermal electricity production. Final report, May 2015. Section 3 Biodiversity / Terrestrial Flora and Fauna.

Caraibes Environment Development (2015b). Initial environmental status of the Roseau Valley in Dominica, planned for development of geothermal electricity production. Final summary report.

IUCN (2013). World Heritage Advice Note Environmental Assessment & World Heritage.

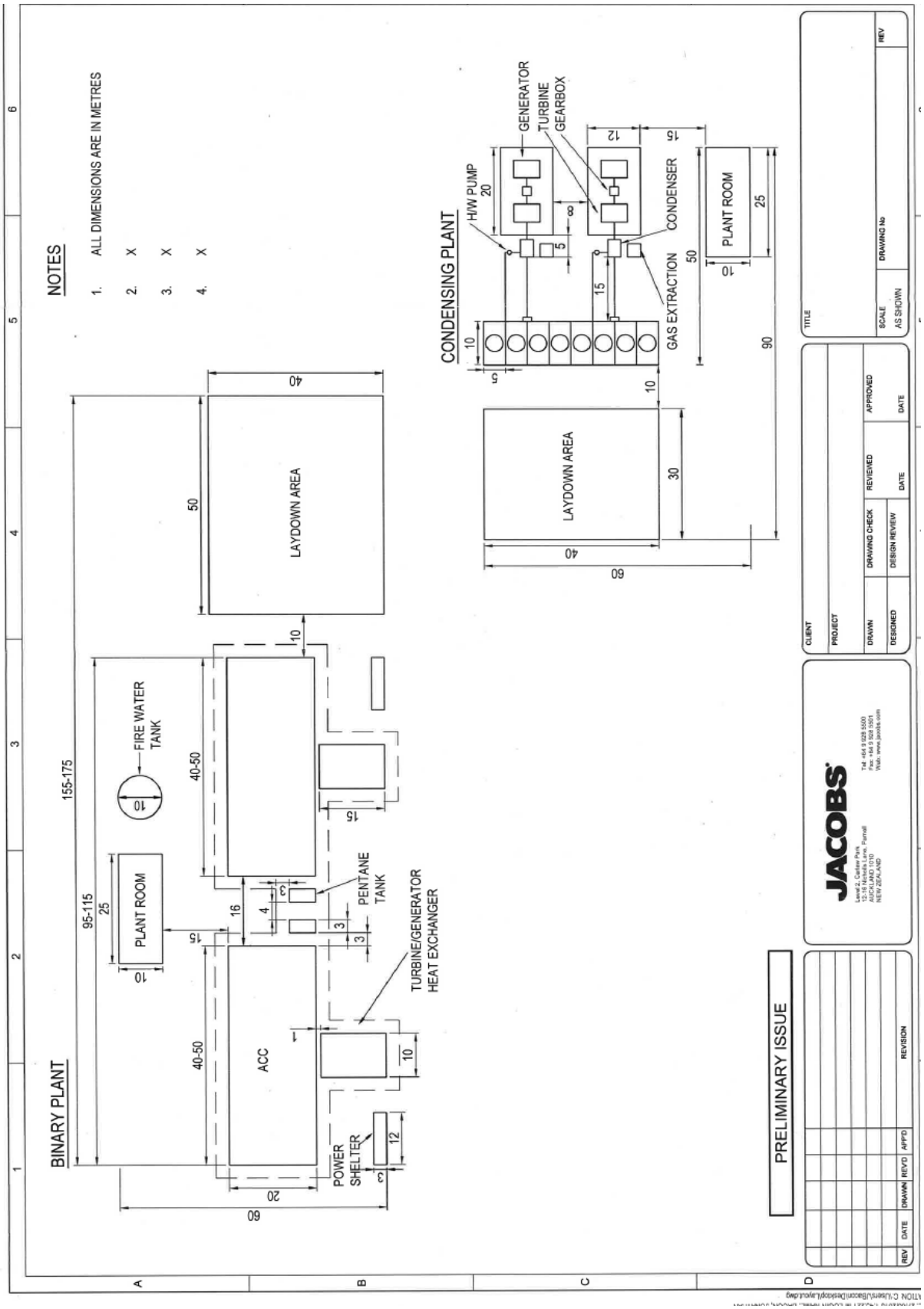
World Bank. Power Development in Dominica – A Situational Analysis for the Preparation of the Wotten Waven-Trafalgar-Laudat field in the Roseau Valley.

Appendix A. WBG IFC Performance Standards

Performance Standard	Objectives
Social and Environmental Assessment and Management Systems	• To identify and evaluate environmental and social risks and impacts of the project. • To adopt a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimize, and where residual impacts remain, compensate/ offset for risks and impacts to workers, Affected Communities, and the environment. • To promote improved environmental and social performance of clients through the effective use of management systems. • To ensure that grievances from Affected Communities and external communications from other stakeholders are responded to and managed appropriately. • To promote and provide means for adequate engagement with Affected Communities throughout the project cycle on issues that could potentially affect them and to ensure that relevant environmental and social information is disclosed and disseminated.
Labour and Working Conditions	• To promote the fair treatment, non-discrimination, and equal opportunity of workers. • To establish, maintain, and improve the worker-management relationship. • To promote compliance with national employment and labour laws. • To protect workers, including vulnerable categories of workers such as children, migrant workers, workers engaged by third parties, and workers in the client's supply chain. • To promote safe and healthy working conditions, and the health of workers. • To avoid the use of forced labour.
Pollution Prevention and Abatement	• To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities. • To promote more sustainable use of resources, including energy and water. • To reduce project-related GHG emissions.
Community Health, Safety and Security	• To anticipate and avoid adverse impacts on the health and safety of the Affected Community during the project life from both routine and non-routine circumstances. • To ensure that the safeguarding of personnel and property is carried out in accordance with relevant human rights principles and in a manner that avoids or minimizes risks to the Affected Communities.
Land Acquisition and Involuntary Resettlement	• To avoid, and when avoidance is not possible, minimize displacement by exploring alternative project designs. • To avoid forced eviction. • To anticipate and avoid, or where avoidance is not possible, minimize adverse social and economic impacts from land

Performance Standard	Objectives
	acquisition or restrictions on land use by (i) providing compensation for loss of assets at replacement cost and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected. • To improve, or restore, the livelihoods and standards of living of displaced persons. • To improve living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites.
Biological Conservation and Sustainable Natural Resource Management	• To protect and conserve biodiversity. • To maintain the benefits from ecosystem services. • To promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities.
Indigenous Peoples	• To ensure that the development process fosters full respect for the human rights, dignity, aspirations, culture, and natural resource-based livelihoods of Indigenous Peoples. • To anticipate and avoid adverse impacts of projects on communities of Indigenous Peoples, or when avoidance is not possible, to minimize and/or compensate for such impacts. • To promote sustainable development benefits and opportunities for Indigenous Peoples in a culturally appropriate manner. • To establish and maintain an ongoing relationship based on Informed Consultation and Participation (ICP) with the Indigenous Peoples affected by a project throughout the project's life-cycle. • To ensure the Free, Prior, and Informed Consent (FPIC) of the Affected Communities of Indigenous Peoples when the circumstances described in this Performance Standard are present • To respect and preserve the culture, knowledge, and practices of Indigenous Peoples.
Cultural Heritage	• To protect cultural heritage from the adverse impacts of project activities and support its preservation. • To promote the equitable sharing of benefits from the use of cultural heritage.

Appendix B. Nominal land area for 2 x 3.5MW binary and steam condensing technologies



Appendix C. Project Schedule

PROGRAMME

Reactive Monitoring Mission of the UNESCO World Heritage Centre (WHC) and the International Union for the Conservation of Nature (IUCN) to the Morne Trois Pitons National Park World Heritage Property

Commonwealth of Dominica

March 27-31, 2017

Meetings will be held at the Labour and Immigration Conference Room, Government Headquarters

Monday March 27, 2017

Arrival of representatives of WHC and IUCN

Chief of Latin America and the Caribbean Unit, World Heritage Centre

- Mr. Mauro Rosi

International Union for the Conservation of Nature (IUCN) representative

- Mr. Thiery Lefebvre

Tuesday March 28, 2017

9:00 am

Meeting with:

- Ms. Sonia Williams
- Ms. Jacqueline Andre
- Mr. Minchinton Burton
- Mr. Mauro Rosi
- Mr. Thiery Lefebvre

11:00 am

Meeting with PS/Ministry of:

- Trade, Energy and Environment-
- Agriculture and Fisheries
- Tourism & Urban and Renewal – Ms. Melvina Walsh Leslie
- Health and Environment
- Education & Human Resource Development
- Ms. Sonia Williams
- Ms. Jacqueline Andre
- Mr. Mauro Rosi
- Mr. Thiery Lefebvre

2:00 pm

Site visit to Emerald Pool

<u>Wednesday March 29, 2017</u>

10:00 am

Meeting with Ministers of:

- Agriculture and Fisheries
- Tourism and Urban Renewal
- Trade, Energy and Employment
- Health and Environment
- Ms. Sonia Williams
- Ms. Jacqueline Andre
- Mr. Mauro Rosi
- Mr. Thiery Lefebvre

11:00am

Meeting with people in charge of the Geothermal Project

- Ms. Sonia Williams
- Ms Jacqueline Andre
- Mr. Minchinton Burton

- Mr. Alexis George
- Mr. Michael Fadelle
- Mr. Edward Lambert
- Mr. Kelvin Rolle
- Mr. Marcus Lestrade
- Mrs. Lyn Fontelle
- Mr. Mauro Rosi
- Mr. Thiery Lefebvre

2:00pm

Field Trip to property to assess the state of Conservation of Morne Trois Pitons National Park.

<u>Thursday March 30, 2017</u>

9:00 am

Meeting with NGO and members of civil society

- Ms. Sonia Williams
- Ms. Jacqueline Andre
- Mr. Minchinton Burton
- Mr. Michael Fadelle
- Mr. Arlington James
- Mr. David Williams
- Mr. Adolphus Christian
- Mr. Gary Shillingford
- Mr. Albert Noel – Chairman (*Laudat Village Improvement Committee*)
- Ms. Marie Jose Edwards
- Mr. Mauro Rosi
- Mr. Thiery Lefebvre

11:00am

Discussions on findings

2:00 pm

Field Visit to Petit Savanne

<u>Friday March 31, 2017</u>

9:00am

Follow-up meeting and discussion on next steps

- Ms. Sonia Williams
- Ms.Jacqueline Andre
- Mr. Minchinton Burton
- Mr. Micheal Fadelle
- Mr. George Alexis
- Mr. Edward Lambert
- Ms Lyn Fontenelle
- Mr. Mauro Rosi
- Mr. Thiery Lefebvre