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Dominica Geothermal Development - Environmental Impact Assessment

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Non-Technical Summary

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 Project Manager: Alastair Brookes
 Author: Pete Gabriel (ESIA Project Manager)

Jacobs New Zealand Limited

Level 3, 86 Customhouse Quay,
 PO Box 10-283
 Wellington, New Zealand
 T +64 4 473 4265
 F +64 4 473 3369
 www.jacobs.com

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1. Introduction

1.1 Overview

This Non-Technical Summary (NTS) provides an overview, in plain language, of the main findings of the Environmental and Social Impact Assessment (ESIA) prepared for the construction and operation of the Dominica Geothermal Project (hereafter referred to as 'the Project'). The Project is the construction and operation of geothermal wells, reinjection systems and a geothermal power plant with a capacity of 7 Mega Watts (MW) and connection to the Dominica electrical grid and associated infrastructure. When complete, the Project will make an important contribution to the socio-economic development of the region and the Commonwealth of Dominica. It will provide a stable source of electricity for the island and reduce the overall reliance on diesel generation.

It is important to note that this NTS does not, and is not intended to, convey all of the information relating to the Project and its potential impacts on the physical and social environment. The text provided herein is a summary of the detailed assessments discussed in the ESIA. Therefore, for more detailed information pertaining to any part of this NTS, please refer to the ESIA and supporting specialist Technical Reports, which are available at the offices of the Dominica Geothermal Development Company Ltd (DGDC) (refer Section 4.6).

1.2 What is the Project?

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

- Geothermal Power Plant (nominally 7 MW);
- Production well (called WW-P1) which provides steam and brine to drive the power plant;
- Reinjection wells (called WW-R1 and WW-01) for the return of brine to the below ground geothermal reservoir;
- 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, water supply and wastewater treatment; and
- 11 kV underground interconnection to the DOMLEC electricity grid at the power plant site.

An overview of the Project and the location of its elements is provided below in Figure 1.1.

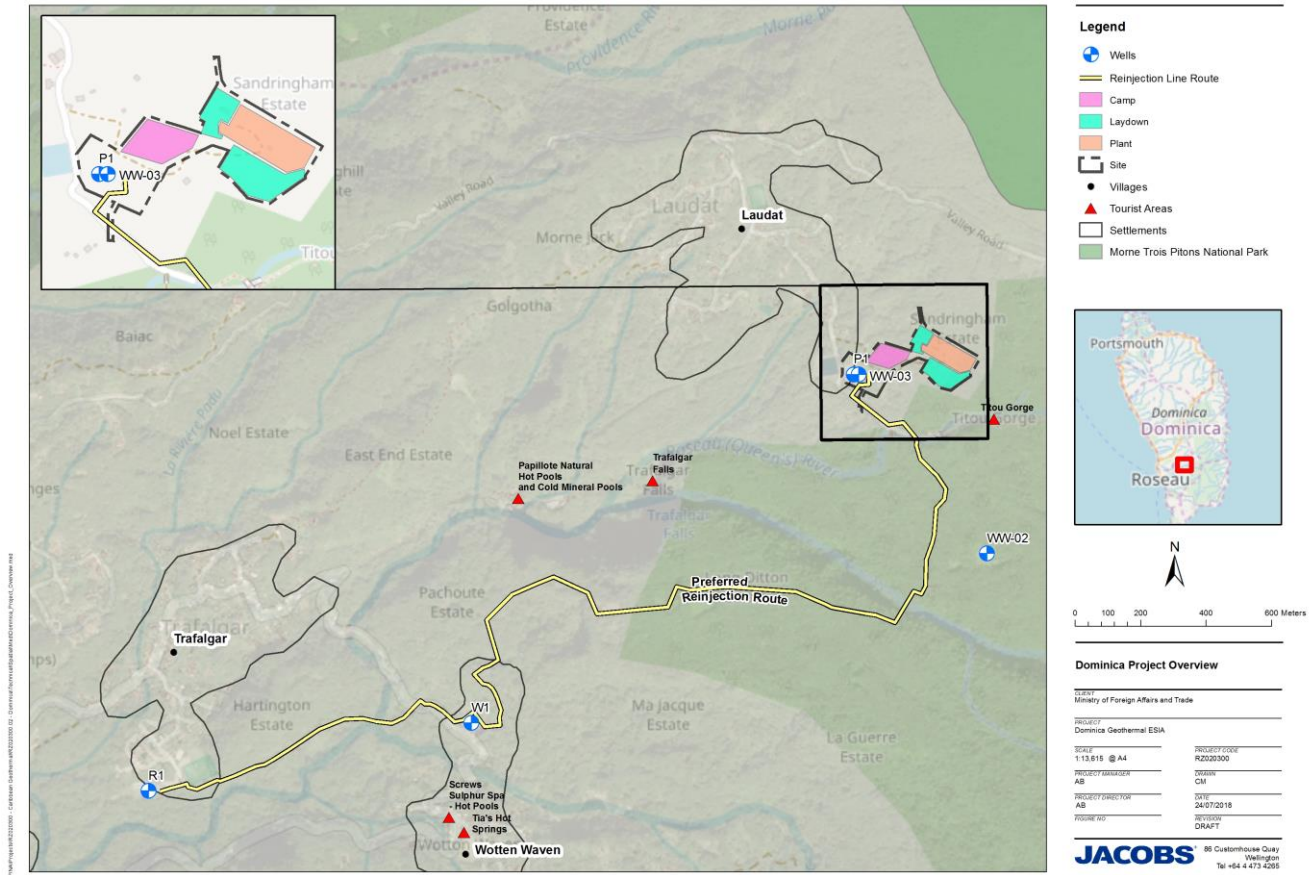


Figure 1.1 : Project Overview

1.3 Why is the Project Needed?

Dominica’s power system relies heavily on diesel fuel imports to generate electricity. As with many other island nations, Dominica’s primary source of electricity production is from diesel generation, which exposes the country’s economy to price uncertainty relating to the cost of diesel imports. The power system is operated by DOMLEC, a privately owned organisation that has the exclusive licence to transmit, distribute and supply electricity on the island, and a non-exclusive licence to generate electricity.

Changing the power generation mix and reducing the cost and volatility of electricity prices have become development priorities for Dominica. Being a relatively young volcanic island, Dominica has significant geothermal resource potential. Therefore, the Government of the Commonwealth of Dominica (GoCD) has pursued an exploration programme to evaluate the viability of geothermal resource in the Roseau Valley.

GoCD is actively moving towards a renewable sources of energy such as geothermal energy and away from a reliance on fossil fuel energy generation such as diesel and this change will assist in reduction in greenhouse gas emissions.

1.4 Where is the Project Located?

The Project is located in the Roseau Valley of Dominica, in close vicinity to a number of communities. The Power Plant is partially located within the settlement boundary of Laudat and the reinjection pipeline passes through the settlement areas of Wotten Waven and Trafalgar. The location of the power plant and reinjection line route within the Roseau Valley is shown in Figure 1.2 and Figure 1.3.

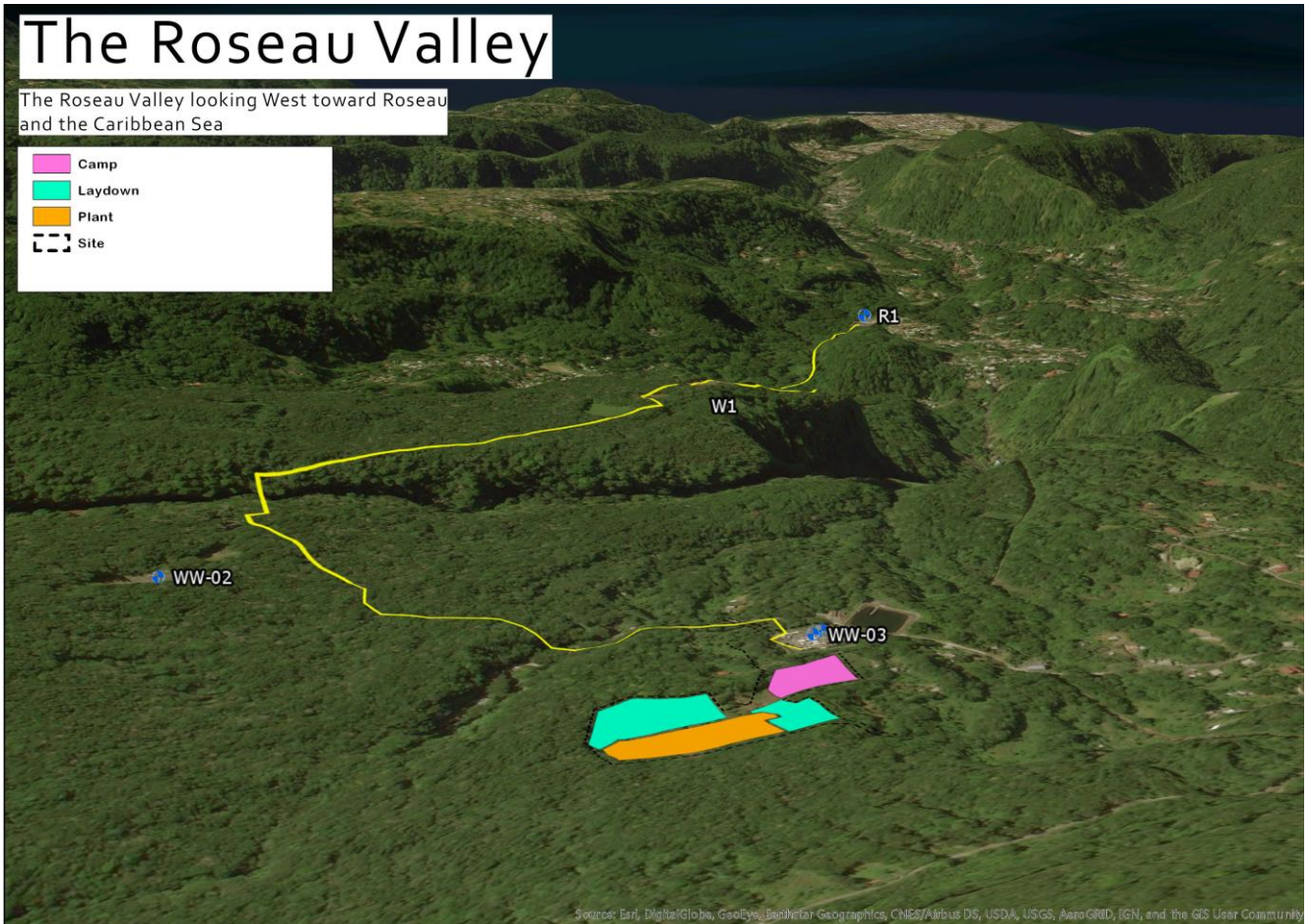


Figure 1.2 : The Roseau Valley looking west towards Roseau and the Caribbean Sea. The power plant and reinjection pipeline routes are also shown. Source: Google Earth, 2017

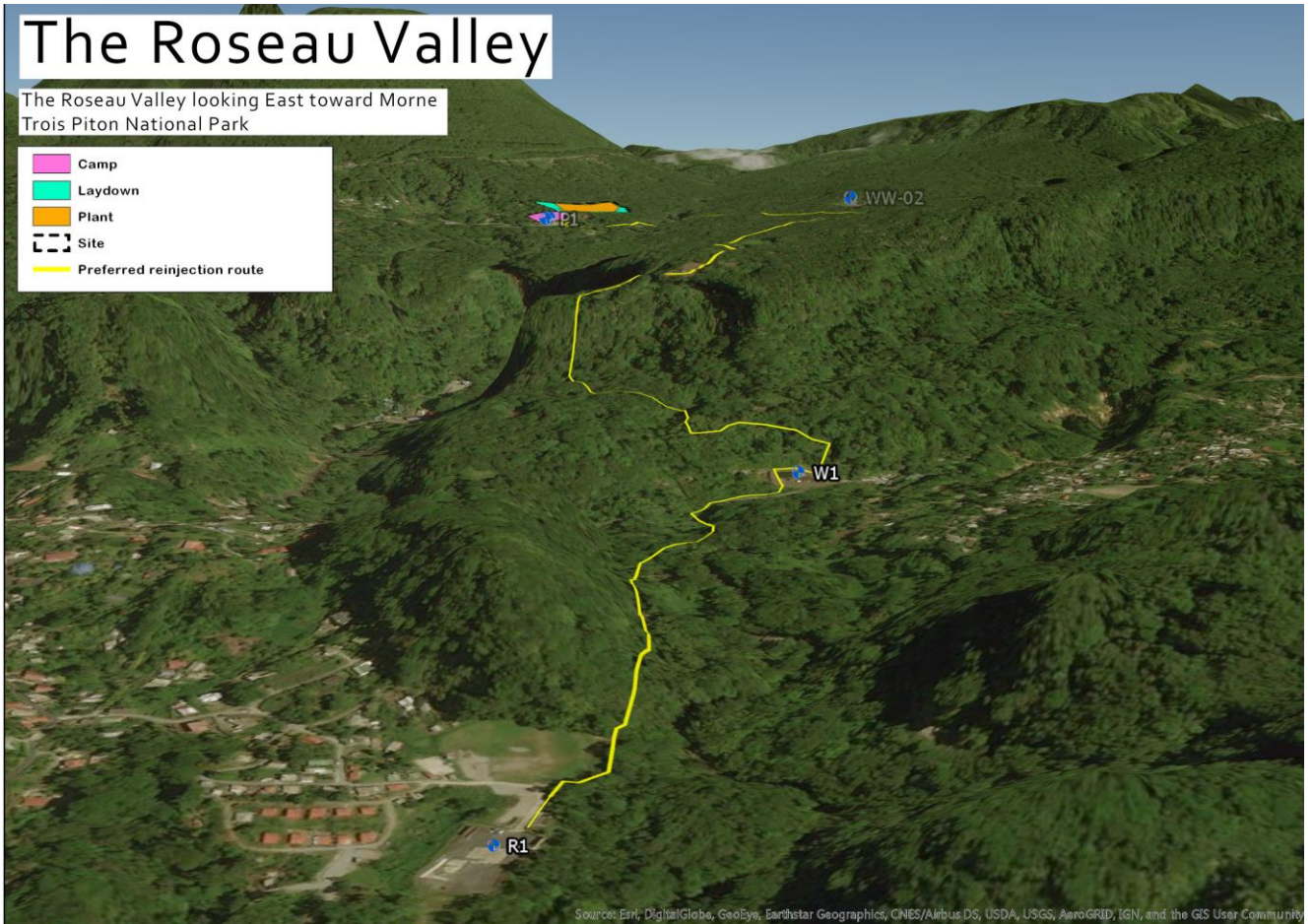


Figure 1.3 : The Roseau Valley looking west towards Morne Trois Piton National Park. The power plant and reinjection pipeline routes are also shown. Source: Google Earth, 2017

1.5 What will the Project look like?

Geothermal projects typically connect a production well 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 and trace gases including hydrogen sulphide). In this project, steam will be separated from the brine and used to drive a turbine. Used geothermal fluids produced by the geothermal projects (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.

An aerial image of how the power plant will look is shown below in Figure 1.4. Typical geothermal power plants wellpads, pumps and pipes are shown in Figure 1.5 - Figure 1.7.

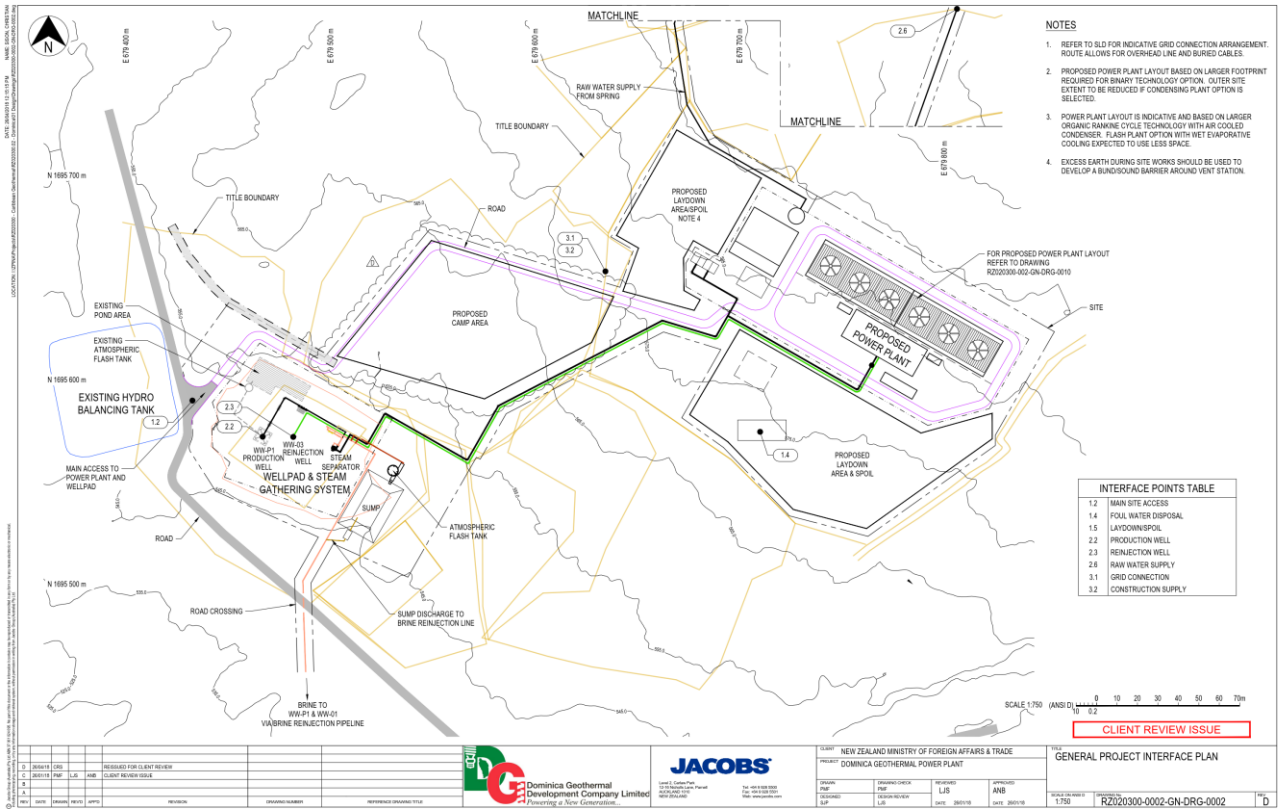


Figure 1.4 : General Power Plant and Steamfield Layout



Figure 1.5 : Typical Wellpads (left and right)



Figure 1.6 : Typical Production Well (left) and Reinjection Pipeline (right)



Figure 1.7 : Typical Bringe Pump (left) and Cooling Tower only 1-2 cells likely required for Dominica Project (right)

1.6 When will Construction start?

The construction of the project is anticipated to last 18 months to two years, following the indicative schedule below. Construction is anticipated to start in late 2018 or early 2019.

Table 1.1 : Indicative Construction Schedule

Phase	Year 1				Year 2			
Off-site preparatory work	■							
Site preparation		■	■					
Foundations for equipment and pipelines			■	■				
Powerhouse & permanent buildings				■	■			
Major equipment installation					■	■		
Interconnecting piping, wiring and instrumentation						■	■	
Switchyard and transmission line								■

The operational life of the geothermal development is anticipated to be 25 years.

1.7 What land requirements will there be?

The GoCD has ownership of the existing well pads, however, additional land will be required for the power plant site and for the reinjection pipeline. The land required for the power plant, and hence civil works required to prepare the site, will depend on the power plant technology selected. DGDC and the GoCD will be entering into a land acquisition process with the landowners whose land will be required for the power plant and reinjection pipeline.

The proposed plant layout as presented in Figure 1.4 has a land requirement estimate of 20,000 m² (2 hectares), for the larger binary plant option – including laydown / spoil areas. Approximately 10% of the power plant site will be concreted and the rest covered with gravel. The remaining areas of the site will be landscaped and replanted.

1.8 What will happen during the construction phase?

The majority of the construction activities will be concentrated on the main power plant, switchyard and separator station sites, but other work is required at the individual well-sites and in the piping corridors linking the wells to the power plant. The main activities during construction will include:

- Site preparation involving bulk earthworks, roading, and establishment of temporary construction facilities, security fencing, drainage controls and access control.
- Construction of foundations for major structures, equipment and pipelines.
- Construction of the powerhouse and permanent ancillary and amenity buildings.
- Erection of major and ancillary equipment such as steam-turbine generators, cooling towers, pumps.
- Interconnecting piping, electrical wiring and instrument installation.
- Switchyard and transmission line construction and connection to the grid.
- Construction of the reinjection pipeline, including the use of small drilling rigs for creating foundations, mobile cranes, trucks to transport materials and equipment, generators for pipe welding as well as excavators and trucks for foundation excavations. The felling of trees and other shrubs will be necessary in constructing a reinjection pipe corridor.
- Civil works at three existing well pads (including slope stabilisation, drainage works, fencing, security lighting etc.).

1.9 What will happen during the operation phase?

Prior to the plant being brought into operation a range of performance and reliability tests are undertaken. Having completed and passed performance and reliability tests the plant is handed over for commercial operation. This stage is known as 'commissioning' and will involve pre-operational testing of the steamfield, power plant and reinjection line.

The operation of the steamfield and power plant covers three phases:

- 1) **Start-up** - Involves the start-up of production wells and the introduction of steam into the piping systems. Process drain valves are generally left open to remove condensate from the pipes and vessels, draining to storage sumps. Brine from separator vessels and silencers are discharged to the storage sumps at the power plant and separator station locations. Steam is vented to atmosphere through the steam vent valves located at high point vents as well as at the rock mufflers located at the power plant.
- 2) **Operation** - during normal operation minimal steam venting occurs, the production steam is sent to the power plant and brine is sent to the power plant or directly to reinjection wells. When all power plant systems are in operation, the power plant generates electricity which is exported to the grid.

- 3) **Shut-down** - May be planned or due to unscheduled maintenance / outage or in some instances may involve a major transmission line outage. During shut-down the unit(s) stops generating electricity for export. The power plant vent valves will emit steam until the production wells are trimmed back to match the required remaining station demand. For a complete station shut-down the steamfield will likely be closed down and the steamfield piping systems will be drained to local storage sumps as well as to the separator stations' and power plant brine sumps. The production well will be either shut in or placed on bleed.

2. Description of the Environment

2.1 What are the general environmental conditions at the site?

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 km². The island is the largest and most northerly of the Windward Islands in the Lesser Antilles, lying between Guadeloupe and Martinique. An estimated 60% of the land is classified as the Morne Trois Piton National Park (MTPNP) World Heritage site by UNESCO, due to its rich biodiversity. The capital Roseau is located to the south-west of the island and has a population of around 15,000 people.

The climate of Dominica is tropical all year round, with high temperatures, high humidity and heavy rainfall. The magnitude of variation in ambient temperature is low, generally ranging from 26°C during the day in January to 32°C in June.

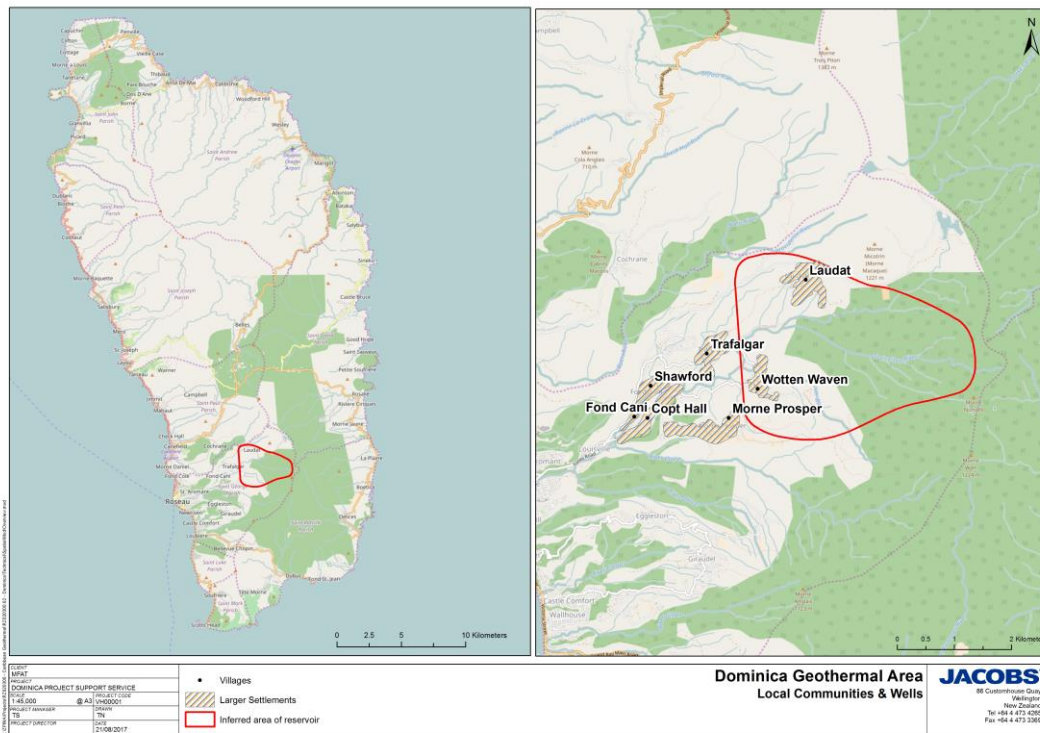


Figure 2.1 : Location of Roseau Valley (Site of proposed Geothermal Power Plant)

2.2 What is the condition of the physical environment at the site?

2.2.1 Air Quality

The existing air quality in the vicinity of the Project is expected to be generally good, given the relatively low population, absence of heavy industry, and the relatively small size of the island. Sources of air pollution are primarily limited to diesel-fired power generators, traffic, and solid fuel combustion for cooking, etc. As Dominica is a volcanic island there are natural sources of emissions, including steam, carbon dioxide, and hydrogen sulphide, via natural geothermal features such as vents and fumaroles. In some areas the smell of hydrogen sulphide is noticeable.

2.2.2 Water

Site investigations and observations of the stream channels indicate that the tropical environment and steep gradients leads to promotion of high velocity flood events with significant erosive force that may put infrastructure at risk during large events. Titou Gorge, the Roseau River and the Blanc River are all watercourses that may be potentially affected by the Project.

2.2.3 Geology and Soils

Dominica is a summit of a submerged mountain chain at the eastern edge of the Caribbean Tectonic Plate and consists of almost entirely of volcanic rocks. Soils found are consistent with those found in wet climates and receive a large volume of rain.

2.2.4 Natural Hazards

Hurricanes

Dominica is located in the hurricane belt and since 1979, tropical systems of note (storms and hurricanes) which have impacted Dominica include David (1979), Gert (1981), Gilbert (1988), Hugo (1989), Iris (1995), Marilyn (1995), Hortense (1996), Lenny (1999), Dean (2007) and Maria (2017).

Landslides

Landslides are a potential hazard throughout Dominica and especially in the high rainfall steeper areas. West and South of Morne Micotrin are within the high landslide risk including the entire village of Laudat.

Volcanic Eruptions

Dominica is characterised by the presence of volcanoes and historical eruptions and there are nine active volcanoes within Dominica. Frequent volcanic earthquakes and geothermal activity indicate that the island is still underlain by an active magma reservoir system and that future eruptions are highly likely, possibly within the next 100 years. There are a number of volcanic hazards within or adjacent to the Project area including Titou Gorge, the Boiling Lake and the Valley of Desolation.

Induced Seismicity and Subsidence

The proposed power plant site is located partially within 'moderate' and 'very low' earthquake risk areas. The majority of the reinjection pipeline is located within a very low risk area with only the lower section within a moderate risk area. The nearest area classified as having a high risk of earthquakes is located to the south west, 1.5 km from the end of the reinjection pipeline.

2.2.5 Geothermal Features

The Roseau Valley contains several geothermal features that are popular tourist attractions. These are listed below:

- Papillote Natural Hot Pools and Cold Mineral Pools (Trafalgar Falls);
- Screws Sulphur Spa Hot Pool (Wotten Waven);
- Tia's Hot Springs (Wotten Waven);
- Ti Kwen Glo Cho Hot Springs (Wotten Waven);
- Boiling Lake; and
- Valley of Desolation.

2.2.6 Landscape and Visual

Dominica is a volcanic island 46 km in length with a central mountain ridge running from Cape Melville in the north to the cliffs in the south. Morne Diablotin, the highest mountain on the island, rises to 1,447 m. There are numerous mountain streams and rivers, with waterfalls and luxuriantly wooded mountains, which has resulted in Dominica gaining the nickname the 'Nature Isle'.

The Roseau Valley is heavily vegetated with various scattered villages present as you travel up the valley from Roseau (Trafalgar, Laudat, Fond Cani and Wotten Waven). The Roseau Valley is characterised by key landscape types such as tropical rainforest, mountain forest, abandoned agricultural land urban villages and connecting roads.

The power plant is situated on disused agricultural land adjacent to patchy secondary growth rainforest. The reinjection line is located in areas of secondary growth rainforest and small-scale agricultural land.



Figure 2.2 : Typical Landscape types of the Roseau Valley. Left: Dense tropical rainforest, Right: Disused agricultural land with montane rainforest in the background (taken at the proposed power plant site). Source: Jacobs, December 2016



Figure 2.3 : Photographs from the Power Plant Site (left and right)



Figure 2.4 : Photographs from the Reinjection Line Site (left and right)

2.2.7 Noise

The nearest and most representative affected properties in the surrounding villages are potential receptors for noise generated by the Project: Laudat, Trafalgar, Copt Hall, Shawford, Fond Cani, Morne Prosper and Wotten Waven. Additionally, the following natural locations have been considered as potentially being affected by levels of noise: Boiling Lake, Valley of Desolation and Freshwater Lake (2.5 km north-east of Laudat).

2.3 What is the condition of the biological environmental at the site?

2.3.1 Freshwater Environment

Overall the water quality appears to be good across sampled rivers (Blanc River and Roseau River) both upstream and downstream of the proposed power plant operations. Ecological state varies and this appears to be especially linked to the flow and season, with poorer ecological conditions observed in the wetter season. However, in drier weather at both Roseau River sites and the Blanc Upstream site the ecology appears to be in a generally good state.

2.3.2 Land Animals, Birds and Bats

97% of Dominica's 205 resident and visiting bird species are categorised as Least Concern by IUCN, whilst 2% are Near Threatened, and 3% (equating to 6 species) are Globally Threatened, which comprises the categories: Vulnerable (3); Endangered (2); and Critically Endangered (1). None of these species were recorded during field surveys. Along the Trafalgar transect, 325 individual birds of 26 species were identified during the survey, all of Least Concern.

The same five species endemic to the Lesser Antilles, five are endemic to the Caribbean, and two native to a small number of Lesser Antillean islands were present at all three survey locations. These Dominican endemics/near endemics are the blue-headed hummingbird (*Cyanophaia bicolor*) and plumbeous warbler (*Dendroica plumbea*).

At all locations, field signs of agouti (*Dasyprocta antillensis*) were noted, and common opossum (*Didelphys marsupialis*) and rats (*Rattus rattus*) are reported. Along the Trafalgar transect and at the Wooten Waven and Laudat infrastructure locations, one amphibian was recorded, the Near Threatened tink frog *Eleutherodactylus martinicensis*.

No species which are Threatened or Rare have been recorded in the study area. One such species which is verifiably understood to be present, is the Red-necked parrot, which is determined to be Vulnerable. Habitat supporting this species is considered very important. The species occurs primarily in rainforest canopies, but is known to visit coastal areas to search for food. It is increasingly observed on agricultural land, feeding on citrus, passion fruit and mango plantations.

2.3.3 Plants and Habitat

The major vegetation type in all areas surveyed is secondary rain forest at varying stages of succession. Some agricultural habitats were also present, both those currently under cultivation and those apparently abandoned. No rare or threatened plant species were identified in any of the transects or plot-based surveys.

2.3.4 Morne Trois Pitons National Park

The Morne Trois Pitons National Park (MTNP) is a site of global importance and one of the world's Key Biodiversity Areas. The MTPNP covers nearly 7,000 ha area of the volcanic island, comprising rugged mountain landscape and deep canyons. It supports at least five species considered Threatened by IUCN: two amphibians, two parrots and one passerine bird. There are five live volcanic centres within the park, the highest of which reaches 1342m. The landscape is scenically striking and features natural hot springs, bubbling mud ponds, lakes and magnificent waterfalls. Within the park are the sources of the southern part of the island's major watercourses.

2.4 What is the condition of the economy and communities at the site?

2.4.1 The Roseau Valley

The Roseau Valley mainly consists of secondary forest and plantation. The eastern part of the valley tends to be agricultural land (including Wotten Waven and Laudat). The urban areas in the Roseau Valley are particularly concentrated at the entrance to the valley and in the eastern part of the valley.

Eight urban communities exist in the Roseau Valley, organised into independent urban areas: Laudat, Morne Prosper (at the Southern boundary of the study area), Wotten Waven, Trafalgar-Shawford, Fond Canie, Copt hall, Louisville and Silver Lake. Each urban area is organised around a main road with houses distributed along the streets directly leading off.

Tourist accommodation is scattered throughout the valley, notably in Wotten Waven. The urban areas are not scattered sporadically throughout the Roseau Valley and the houses are not aligned but rather distributed between forests, river and roads with varying orientations. There are local shops at crossroads and some informal dwellings (sheet metal and wooden cabins) that may not be properly permitted are regularly observed.

There are 88 total buildings within the 200 m buffer of the plant and reinjection line route (Figure 2.5 and Figure 2.6). It should be noted that these buildings were identified from aerial imagery and therefore may not all be occupied.



Figure 2.5 : Buildings within 200 m of the power plant and reinjection pipeline (northern end)



Figure 2.6 : Buildings within 200 m of reinjection pipeline (southern end)

Within the Roseau Valley, three main communities were considered relevant for this study because they were in closest proximity to the proposed Project footprint and represent the main communities that would be likely to be impacted by any employment, resettlement, community health and safety issues. The communities of Trafalgar, Wotten Waven and Laudat have been identified as the primary area of influence for the social impact assessment. All of these fall within the Roseau Valley and data from the Roseau Valley itself is utilised where appropriate and when more detailed data for each community is not available. Figure 2.7 shows the location of Trafalgar, Wotten Waven and Laudat.

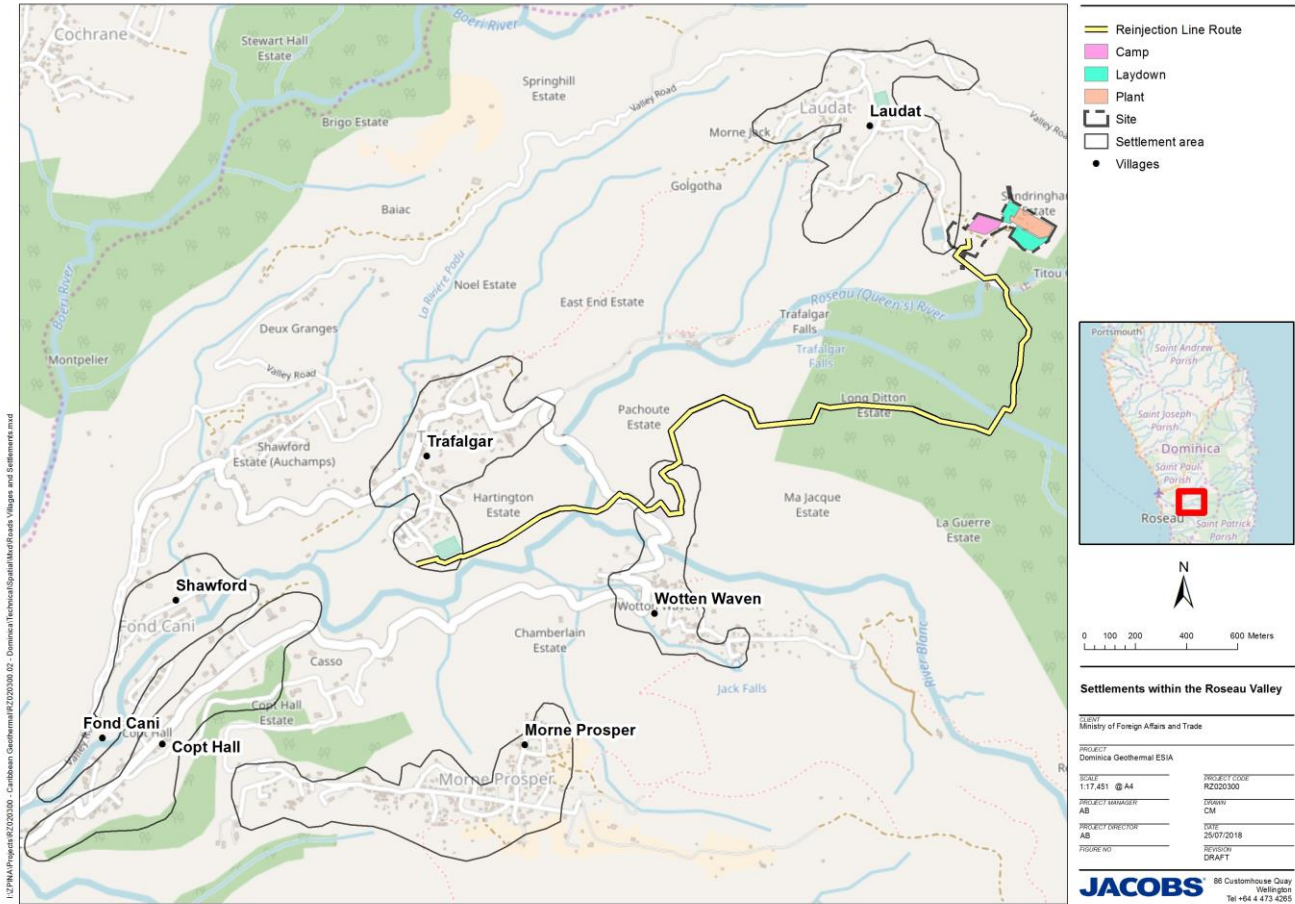


Figure 2.7 : Settlements within the Roseau Valley

2.4.2 Population

According to the Population and Housing Census of 2011, Dominica’s population was 71,293. Between 1991 and 2001, the population of the main townships of Dominica declined, including within the capital Roseau. The population of Dominica shows little increase in general, due to the exodus of people to other countries such as the more prosperous West Indies islands, the United States, the United Kingdom and Canada.

Approximately 1,800 people live in the Roseau Valley, of which nearly 1000 live in Trafalgar and Shawford, and the remaining in the hamlets of Wotten Waven/Casseau, Copthall, and Laudat. According to the 2011 census, the Roseau Valley gained 500 inhabitants between 2001 and 2011, i.e. a substantial increase of 32%. According to the Central Statistical Office, average household size in the Roseau Valley is 2.7

2.4.3 People of the Roseau Valley

Language

The great majority of the population is of African descent. English is the official language and is understood by everyone, but due to historical French influence, a French-based Creole language is widely spoken. The island is also the home of the last remaining indigenous population of the West Indies – the Caribs – who number 3,000, however they do not reside in the Project area.

Religion

Religion is an important aspect of life for many Dominicans. The majority consider themselves as Catholic (61.4 %), 7-8 % of the population practice other types of Christianity, 7% are not religious; 6% of the population are 7th day Adventists, 5% Pentecostal, 4% Baptist, 3% Methodist, and approximately 1-3% identify as Rastafarian, Church of God, or other religions. There are several churches in the Roseau Valley representing various religions. They are well-attended and play an important role in the island's social life.

Gender

The breakdown of the population by gender in the Roseau Valley is similar to national averages (48% of females and 52% of males, compared to 49% and 51% respectively for Dominica as a whole). There are, nevertheless, a few differences in certain communities such as a slightly higher proportion of females in Copthall (52%) and fewer at Wotten Waven (44%).

Education

National school enrolment rates are quite high in Dominica at 97.5% for 5-9 year olds and 98.3% for 10-14 year olds (The Caribbean Development Bank, 2010). According to the Ministry of Education, in 2014, 75 pupils from the Roseau Valley were attending primary school. Approximately 224 students from the Roseau Valley were in Secondary School in 2014. Every village in the Roseau Valley has its own primary school, but pupils must travel to Roseau once they reach secondary school age. This can represent a significant cost for parents, especially for transport.

Health

According to 2017 data from the Ministry of Health, 5.5-6% of births in the country were born to residents of the Roseau Valley in 2015-2016. In 2016, 162 people were seen at the Roseau Valley health clinic for issues ranging from hypertension, diabetes, asthma and colds to heart disease and anaemia. Approximately 75% of these patients were women. The death rate in Dominica is relatively low, 8.1-9.5 per 1000 live births between 2010 to 2015. Life expectancy is 77 years (81 for women and 74 for men). The infant mortality rate was 20.8 per 1000 live births in 2015. There were relatively few deaths in the Roseau Valley in 2015, 19 in total. Chronic illnesses recorded in the valley in 2015 included cancer, pneumonia, pregnancy related illness, hypertension, heart disease, motor neuron disease, birth defect, and diseases of the urinary system. Incidences of each were between 1-2 people. At least 30 cases of Zika virus were confirmed in Dominica in 2016. According to the CIA Factbook, in 2014 5.5% of GDP was spent on health.

There are three health centres in the valley one in each of the potentially affected communities (Trafalgar, Wotten Waven and Laudat). The Roseau Valley is also close to the capital of Roseau and its health facilities including the Princess Margaret Hospital, which is the country's top health care establishment. The hospital has 224 beds (including 56 in a psychiatric unit) and was recently expanded.

2.4.4 Cultural Heritage

The complex and ancient history of human occupation of the island has led to numerous influences on current and past architecture in the Roseau Valley. One example from Wotten Waven includes a water mill dating from the 18th century. However, it is generally considered that the Roseau Valley has few examples of extant historical heritage. Despite the rich and complex history of the island, with its multitude of anthropogenic influences long before the arrival of Europeans in the 15th century, few physical traces are still present. To date, there are no significant archaeological sites in the Roseau Valley.

2.4.5 Economy and Tourism

Gross Domestic Product (GDP) estimated in 2016 was 812 million dollars according to the CIA World Factbook. The economy in Dominica used to be primarily driven by agriculture, but has recently shifted towards tourism as

the Government increasingly promotes Dominica as a tourist destination. The income of the residents of Trafalgar, Wotten Waven and Laudat is primarily derived from agriculture, which is comprised of family-based farming for both local consumption and commercial purposes, and tourism. Most of the Roseau Valley residents have several jobs, including employment in the town of Roseau.

The Roseau Valley also includes the Boiling Lake, Waitukubuli National Trail, Middleham Falls, Freshwater Lake and Boeri Lake, the “Dragon’s Mouth” (an accessible cave with hot water) and Twin Falls and Middleham Falls in Trafalgar, Titou Gorge, the freshwater lakes, and the various hot springs in Wotten Waven and Papillote, the tropical gardens in the rainforest, and outdoor adventure activities among other attractions.

The villagers are trying to develop regional tourism involving exploration of the wildlife and geothermal resources. Several guest houses and self-catering holiday homes have opened in recent years. Tourist attractions are small in size and employ only a small number of persons. The average unemployment rate in Dominica is about 23%.

The Roseau Valley is a popular tourism site due to its proximity to the Morne Trois Pitons National Park. According to the Ministry of Tourism, tourism is now the main source of income for around 60% of the population according to local elected officials. In addition, many cruise ships that stop for the day in the Port of Roseau allow visitors to visit the Aerial Tram in the Roseau Valley. According to the Tourism Board, in 2008 approximately 590,000 people visited Dominica and the Roseau Valley on one-day organised tours.

2.4.6 Transportation

The area observed is characterised by a variety of terrain types ranging from flat areas to steep and mountainous areas with rock formations of which the topography makes driving conditions dangerous. The main road in the Roseau Valley area is Valley Road, which provides a link for traffic between Roseau City and Roseau Valley.

Cruise Ships

Cruise ships are a regular occurrence in Roseau during the cruise seasons (November to March) and occasionally there can be as much as two or three in the port in a single day. They can range in size from a small ship carrying 100-200 passengers to a ‘Royal’ class cruise ship holding over 4,000 passengers. The passengers from the cruise ships add to the road network as they tend to travel by either buses or private taxis.

Public Transport Network

While no reliable information has been found regarding the public transport network in Roseau, it was found in the traffic surveys that there is a relatively high volume of buses on the network. While not all of these buses are likely to be public – some are most likely from the cruise ship passengers being shuttled to tourist sites. Anecdotally, the public transport services in Roseau runs regularly and are popular with the locals.

The Waitukubuli National Trail

The Waitukubuli National Trail is the only large scale marked trail in the East Caribbean and is an important attraction for Dominica’s image as the ‘Nature Isle’. The Waitukubuli National Trail was officially declared as an eco-tourism site on May 10, 2013, in accordance with the Commonwealth of Dominica Statutory Rules and Orders No. 7 of 2013 National Parks and Protected Areas Regulations. Many tourists visit Dominica to experience a rugged and untouched side of the Caribbean the trail provides a relatively accessible marked route through the entire length of the island.

3. Consultation

3.1 What consultation has occurred?

During the current Project development phase, a town hall meeting was held in Trafalgar in December 2016 with approximately 40 in attendance to discuss the current project and ESIA. Another town hall meeting was held in Laudat in July 2017 with 43 in attendance. A third town hall meeting was held in Wotten Waven in August 2017. A final townhall meeting will be held to present the findings of the ESIA in June or July 2018.

In order to facilitate further understanding of community needs and conditions, focus group meetings were held in 2016, 2017 and 2018 in Wotten Waven, Trafalgar and Laudat, described in further detail below. Because the total population of the Project AOI is relatively small (approximately 1,600), and given that the general public and many of the focus groups and landowners that would be affected by the Project are the same parties, the four formal public meetings and 15 informal forums held on the Project were considered representative of the community.

A total of 15 focus group meetings were held as part of the ESIA baseline data collection. A meeting with six representative community leaders from all of the potentially affected communities was held in Trafalgar in November 2016 to discuss the Project and the most effective means of stakeholder engagement. Focus groups meetings were also held in June, July and August of 2017 including meetings with representatives of local hotels and resorts, handicraft vendors, hot springs businesses, and unemployed parties in the area. Groups consisted of 5-15 people and targeted questions were asked and recorded.

Five focus group meetings were held in the communities in March 2018 following Hurricane Maria. These included meetings with the community women in Laudat, Wotton Waven and Trafalgar, and vendor meetings in Wotton Waven and Trafalgar, to identify the impacts on the community of Hurricane Maria which hit Dominica in September 2017 and to understand how conditions in the Project area have changed since the ESIA baseline data was collected pre-Hurricane Maria.



Figure 3.1: Community Meeting in Wotten Waven (December 2016)

3.2 What has the feedback of consultation been so far?

Public perceptions of the Project were varied throughout the stakeholder engagement process. Everyone that was spoken to was familiar with the Project and many had been involved in Project related meetings for many years. The 2015 data showed the community had a number of concerns about the Project, but in 2017 most community members expressed support for the Project (approximately 80%). Concerns expressed in 2017 included:

- Health concerns about the steam and air quality emissions associated with the plant;
- Concerns about odours and impacts on the economy from the Project, particularly the tourism industry;
- Noise concerns; and
- Concerns about proper compensation for land to be acquired.

Post-Hurricane Maria, concerns now include:

- Natural disasters;
- Improvement of infrastructure;
- Livelihood and tourism impacts;
- Emergency response planning; and
- Cultural impacts from influx of workers during construction.

At public meetings, many questions also arose about public shares in the Project Company (DGDC) and the likelihood of adverse effects on the geothermal resource impacting on tourist businesses. Local residents also expressed concerns about plant emergencies and interface with storms and natural disasters. The ESIA process was explained and the methodology to be undertaken for analysis of relevant topics and plans and expectations for the company were also addressed. A Project Grievance Mechanism has been prepared, implemented, and disclosed to the local communities and several complaints have been recorded and addressed to date.

3.3 What commitments will DGDC make to address concerns?

Building on stakeholder engagement that has already been completed during the drilling phase, a process of identifying relevant stakeholders that may be directly or indirectly affected by the project was completed. A Stakeholder Engagement Plan (SEP) was prepared for the Project to guide engagement activities for the Project. 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. Vulnerable groups (elderly, disabled, unemployed) will be also identified as stakeholders
- Record all consultation activities, including those prior to the commencement of the ESIA process;
- Describe how concerns or grievances will be handled via a Grievance Mechanism;
- Provide an action plan for further consultation including at least two meetings bi-annually in each affected community 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 SEP will be revised and updated periodically including upon completion of the ESIA to assist with ongoing engagement throughout the Project.

3.4 ESIA Non-Technical Summary Disclosure

The ESIA Non-Technical Summary was disclosed to the communities of the Roseau Valley via three public meetings: one in Laudat, one in Trafalgar, and one in Wotten Waven in the first week of July. Meetings were attended by Jacobs, DGDC, and approximately 20 members of each community. The community had another opportunity to express concerns and ask questions about the Project and ESIA findings. Concerns generally included community health and safety issues, natural hazards, employment and construction impacts. A summary of the issues raised by each community is provided below.

3.4.1 Laudat

In Laudat, a community meeting was held on Tuesday 4th July 2018. Concerns expressed by the community included technical questions about the pipeline and public health considerations associated with operations of the plant. Community members also voiced concerns about the risks associated with volcanic activity near the project, equipment failure, and other natural disasters. Community members also expressed the desire to see policy changes associated with the Project and the need for some community benefit projects that would be realised in the community. They also asked about land acquisition and noted that Laudat has been the location for several other projects where few benefits were realised in the local community. The DGDC Team explained the costs and the benefits of the project and the ESIA findings in terms of H2S. DGDC also explained the technology being utilised in the plant and the low risks associated with this type of equipment. The DGDC Team further explained the risks and the planning and design measures that were selected for this project given the topography, risk of landslides and recent flooding from Hurricane Maria and the EPC Contractor requirements that will be put in place to reduce nuisance and community health and safety impacts such as the emergency response and other planning procedures. The current status of land acquisition was also explained and the need to complete compensation before construction can begin, as per OP 4.12. Ongoing monitoring and preventative measures such as the traffic management plan and erosion control measures were also explained. Comments on policy and community benefits were noted, but it was explained that this is ultimately under the control of government and policymakers, rather than the project.

3.4.2 Trafalgar

In Trafalgar, a community meeting was held on Wednesday 5th July 2018. Fewer comments were made at this meeting than in Laudat or Wotten Waven, likely because the community is further from the power plant site. The community asked a few technical questions about the distance of the pipeline and natural hazards that could affect the project. They also asked about the proximity to the nearby communities from the power plant and emergency response. The DGDC Team explained the risks and the planning and design measures that were selected given the topography, risk of landslides and recent flooding from Hurricane Maria. DGDC also explained the emergency response and planning procedures that will be put in place for the Project. Examples of other projects where a geothermal plant was located in close proximity to the community were given.

3.4.3 Wotten Waven

In Wotten Waven, a community meeting was held on Thursday 6th July 2018. A lot of concern was expressed at the meeting particularly about public health issues, employment, and direct benefits to the community. Specifically, people asked about job requirements, accidents at the plant and/or the pipeline, detrimental effects on thermal spas, the expected lifespan of a well, consumer benefits on electricity bills, health impacts of construction and noise, and property acquisition. A community member also suggested the need for a weekly briefing in the community during the construction phase. The DGDC Team explained the design of the plant and reinjection route given the topography, risk of landslides and recent flooding from Hurricane Maria and to reduce noise and visual affects at properties near the power plant. DGDC also explained the technology being utilised in the plant and the low risks associated with this type of equipment. The lack of changes anticipated for the

thermal surface features were also explained given the depth of the wells and associated activity and the plan to conduct ongoing monitoring of these features was also shared. The DGDC Team further explained in detail the noise associated with the steam blowing phase and the limited timeframe for this testing. The current status of land acquisition was also explained and the need to complete compensation before construction as per OP 4.12.

Following the disclosure of the NTS, the full ESIA will be made available to the community in August 2018 via the internet, a hard copy will be available at DGDC’s offices, and additional public meetings will be held and publicised by DGDC.

3.5 Is there an opportunity to comment on the Project?

Yes, the following member of the DGDC can be contacted below:

Name	Allan Toussaint
Address	DGDC P.O. Box 1454, 18 Kennedy Avenue Roseau Commonwealth of Dominica
Email	allan.toussaint@geodominica.com
Telephone Number	767-448-6178/275-7392

4. Managing Environmental and Social Impacts

4.1 How will the environment be affected during construction?

4.1.1 Power Plant

The following impacts have been identified during the construction of the power plant:

- Compaction of the site and exposed topsoil due to deforestation and land clearing/levelling during construction could increase runoff and sediment load, thus requiring some form of treatment or retention of water prior to discharge. However, following the implementation of mitigation measures designed to reduce the impacts of runoff and sediment load (i.e. interceptor ditches/sumps/silt fences etc.), this impact will reduce in significance to acceptable levels.
- When vegetation is cleared for the power plant the site soils will be highly susceptible to erosion. The resulting sediment runoff could impact upon the Roseau River water quality through increasing turbidity, reducing clarity and causing deposition of fine sediments. Indirect impacts could also affect the ecology of the river by a range of processes including directly smothering species, changes in habitat and direct impacts of sediment upon fish species. Without erosion or sediment controls in place then there is a potential for potential impacts downstream of the proposed works, through detectable changes to water quality and ecological health. With a well-developed Erosion and Sediment Control Procedure in place (incorporating elements such as staging, clean water diversions, sediment retention etc.), as well as other proposed mitigation measures, it is considered that the impacts resulting from erosion of soils would be reduced in significance to acceptable levels.
- There is potential for hazardous substances or waste to be accidentally discharged to the environment if inappropriately collected and stored on site. However, following the development of mitigation such as the Hazardous Substances and Waste Management Plan, this impact will be reduced to acceptable levels.
- There will be minor temporary impacts for local residents in relation to noise and dust during construction of the power plant, however, it is anticipated that with appropriate mitigation and monitoring by the Construction Contractor, this will be reduced to acceptable levels.

4.1.2 ReInjection Pipeline

The following impacts have been identified during the construction of the reinjection line:

- The earthworks and stream crossings phases of the pipeline construction are considered to be the higher risk activities to the existing water quality and ecology. The stream crossings will involve the placing of pipe bridges above the watercourses. Uncontrolled eroded soil material will cause direct and indirect sediment impacts, as discussed for the power plant location. Direct physical disturbance and additional sediment generation would also occur at stream crossing points. Unmitigated, this is considered to give rise to a potentially significant impacts. With a well-developed Erosion and Sediment Control Plan in place (incorporating elements such as staging, clean water diversions, sediment retention etc.), as well as other proposed mitigation measures, it is considered that the impacts resulting from erosion of soils would be reduced to acceptable levels.
- Temporary removal of terrestrial habitats to accommodate the construction corridor for the reinjection line. During construction, the corridor will be 10 m wide (of which 3-4 m will be permanent loss with an associated loss of 1.4 ha Modified Habitat and 1.7 ha Natural Habitat). Parts of the habitats to be lost could support threatened species but are not considered to be core habitat. The extent of the habitat loss is relatively small, and the vegetation along the reinjection line is expected to regenerate rapidly.
- The Waitukubuli National Trail will be intersected by the proposed reinjection line route adjacent to WW-01. During construction, there will be temporary potential impacts on pedestrians wishing to utilise the trail, leading to potential impacts. Following the implementation of mitigation (such as the development of a

Traffic Management Plan), impacts on non-motorised users of the Waitukubuli National Trail will reduce to acceptable levels.

- During construction, pedestrians and cyclists will be disadvantaged by the general increased level of traffic along the roads being used. This may lead to temporary diversions and minor delays, resulting to potential impacts. Following the implementation of mitigation (such as the development of a Traffic Management Plan), impacts on non-motorised users of the road network will reduce to acceptable levels.

4.2 How will the environment be affected during operation?

4.2.1 Power Plant

The following impacts have been identified during the operation of the power plant:

- There is potential that the Project may increase subsidence in the Project area as a result geothermal fluid extraction and therefore, prior to mitigation there may be potential. Overall, natural hazards including volcanic activity, landslides and hurricanes present potential impacts to the Project. However, following the application of mitigation incorporated through steamfield design and additional mitigation applied during construction and operation (i.e. Subsidence Management Procedure), the impacts are expected to be reduced to acceptable levels.
- Once the power plant is operational, ~2 ha will have a permanent change from soil with forest/scrub cover to a mixture of concrete and gravel pads. The power plants site is anticipated to be 10% concrete and 90% gravel. This will permanently increase localised runoff results in potential impacts, given this will lead to a permanent change in runoff characteristics. However, with additional design mitigation in place, such as stormwater management and drainage, the impact will reduce to acceptable levels.

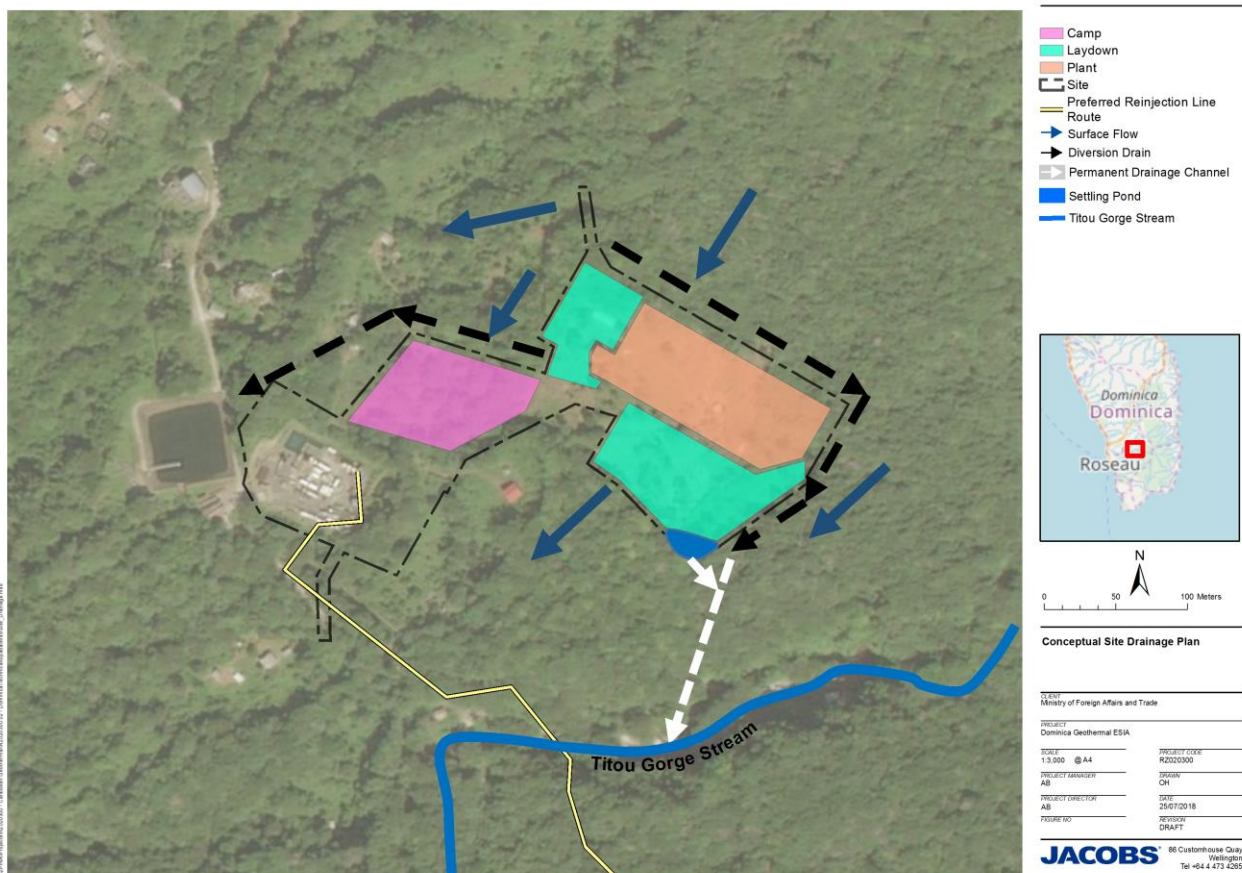


Figure 4.1 : Conceptual diversion drain and stormwater capture pond

- During operation there may be a number of properties surrounding the power plant that experience adverse views of the power plant from their properties or when accessing their properties using the existing access road. There are high adverse impacts expected. However, it is anticipated that these adverse views will reduce over time through vegetation growing up around the perimeter of the power plant. Following mitigation measures such as planting regimes and site fencing, the impacts for both the power plant are expected to be reduced to acceptable levels.
- Plant operations are likely to comply with the noise criteria at all surrounding receivers (Figure 4.2). During commissioning works there will be noise impacts at Laudat (south), Trafalgar (east), Trafalgar (south) and Wotten Waven. However, it is understood that commissioning testing will only occur for a relatively short period and following the application of the mitigation measures (operations conducted during daytime periods only; temporary localised screening be installed during steam gathering system operation and commissioning testing), impacts from commissioning activities impacts are considered to reduce to acceptable levels.

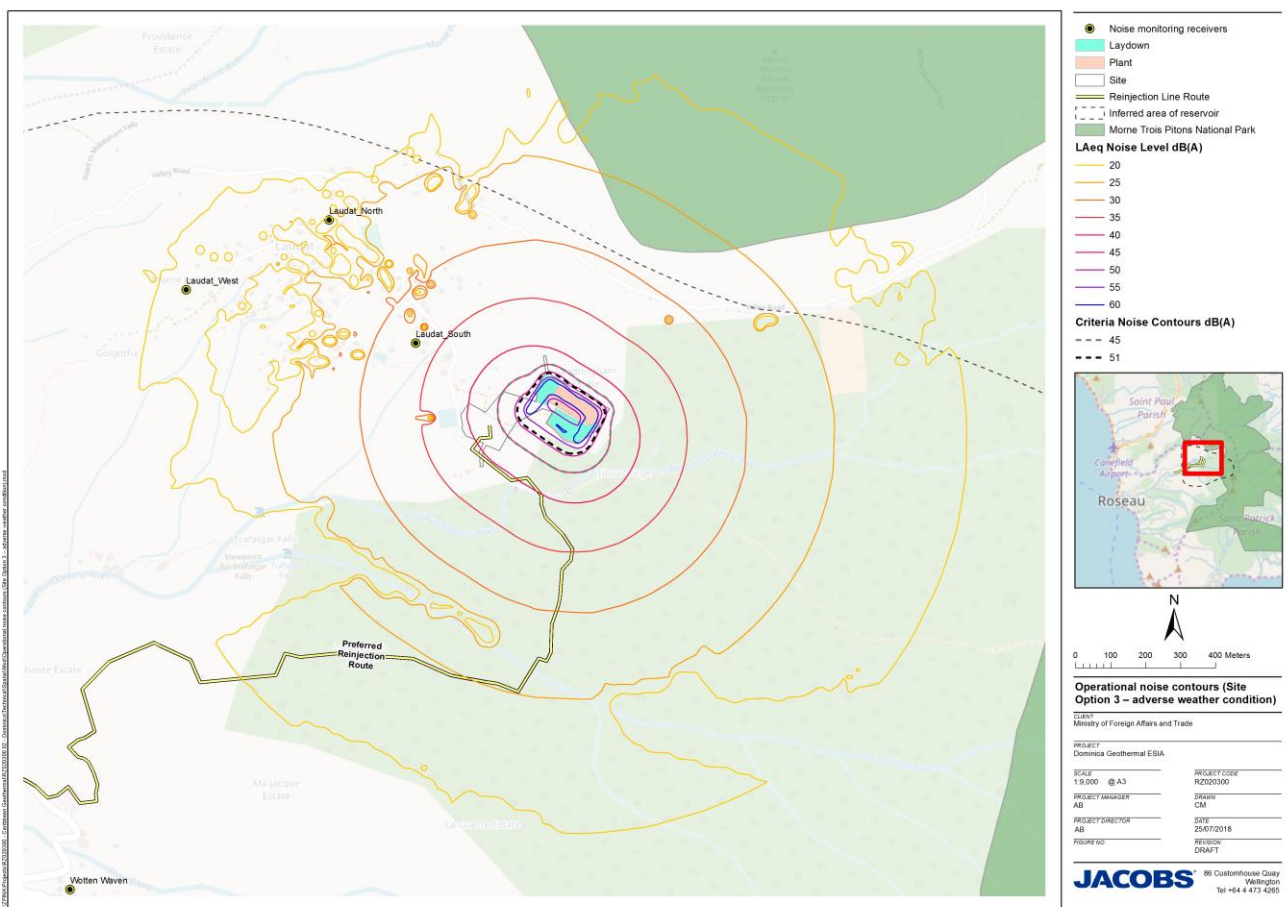


Figure 4.2 : Predicted noise contours (Adverse weather condition)

- There is anticipated to be an increase release in H₂S (producing a ‘rotten egg smell’) as a result of the Project’s activities. It is possible that the operation of the power plant could result in a discernible increase in odour from H₂S discharges at residences nearest to the Project area. However, given the active geothermal nature of the area and the existing baseline levels of H₂S in this area, it is unlikely that these would reach nuisance levels. Despite this, ambient monitoring has been recommended to monitor for H₂S during operations, at sensitive locations (e.g. nearby residential areas), using low-level ambient H₂S monitors such as Odalog, which can be deployed at multiple locations for up to two months at a time.

4.2.2 Reinjection Pipeline

The following impacts have been identified during the operation of the reinjection pipeline:

- The reinjection pipeline will be at some risk from flooding. The torrential downpours, annual rainfall >8,000 mm/year (in the upper mountains) and steep nature of the catchments result in a flashy system with high peak flows and velocities. Subsequently, any pipe crossings (pipe bridges) over waterways will be at risk from potential flood impacts in terms of high water levels and debris carried with these flows (modelling in the ESIA showed this - Figure 4.3). This could cause significant damage or loss of certain areas of the pipeline and is a critical component to the ongoing success of the power plant and energy supply in Dominica. This is a potential impact to the Project’s operability and is considered significant, given this would critically affect infrastructure and lead to plant shut downs. With recommended detailed design mitigation measures in place to reduce the risk of flooding and debris strike, impacts for the reinjection pipeline are to reduce to acceptable levels.

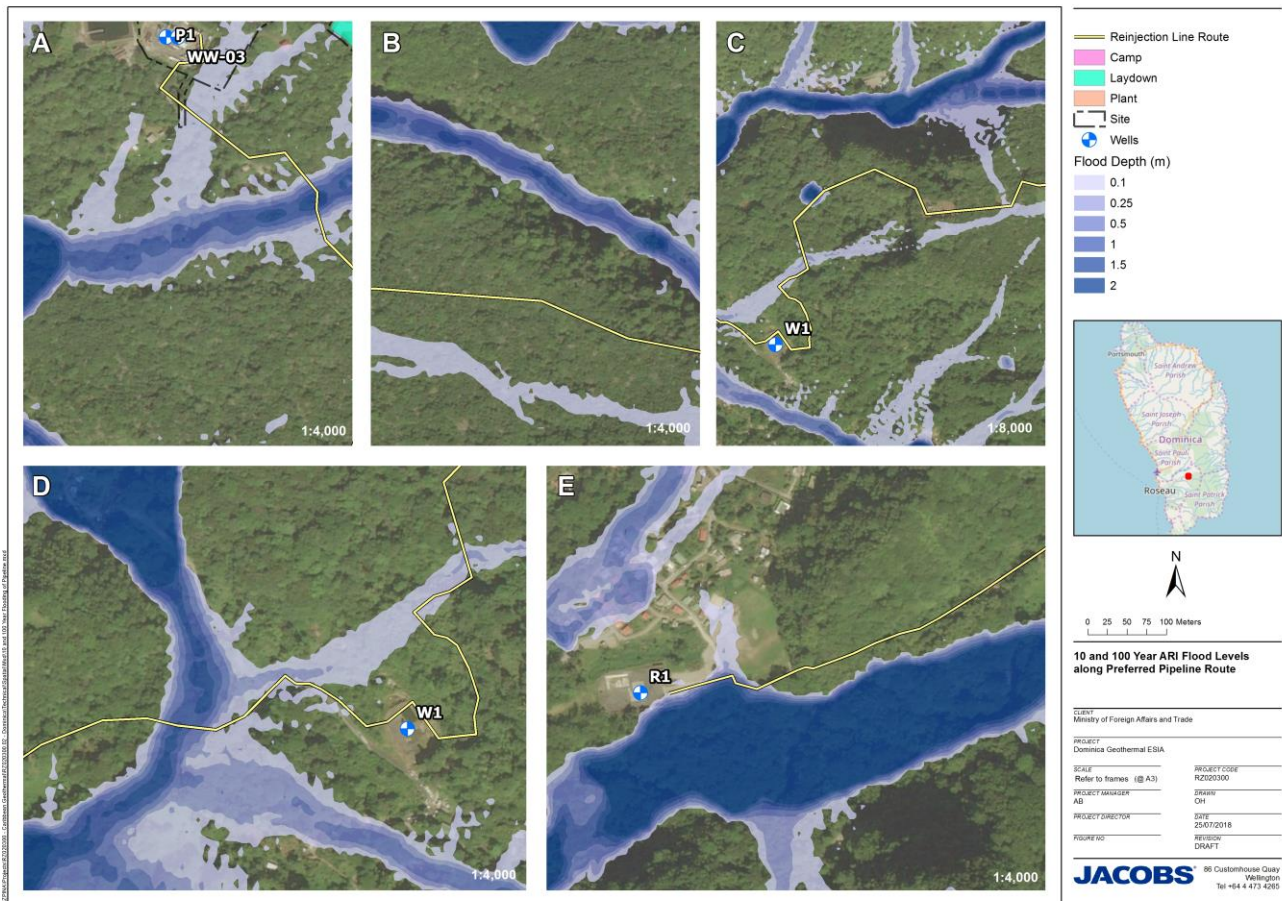


Figure 4.3 : 100 yr ARI 12 hour flood water levels and the at risk areas of preferred pipeline route.

4.3 What about the potential for natural hazards?

Of particular note when considering natural hazards is the devastating effects that Hurricane Maria brought to Dominica and the increased likelihood of landslides following the event. Based on the location and nature of the proposed Project and natural hazards identified within the vicinity of the Project area, overall potential impacts are considered to be significant. The impacts from natural hazards as result of the proposed Project following the application of mitigation incorporated through steamfield design and additional mitigation applied during construction and operation (i.e. an ESCP including a Landslide Management Procedure), the impacts are expected to be reduced and are therefore not significant.

4.4 How will the people be affected?

4.4.1 Construction

The social impacts associated with the Project during construction are summarised as:

Employment

It is likely that 30 to 40 workers will be the power plant site at the peak of construction and a team of 10 to 15 working on the pipeline. These workers are likely to be sourced from outside of Dominica. The majority of employment during construction is likely to be short-term and significant employment opportunities for local communities would be limited. The unskilled and semi-skilled workforce is anticipated to generally come from the local area, but accommodation in the form of a worker's camp will be developed on the site to house mainly expat and out of town workers for the duration of construction to minimise traffic trips to the site from Roseau. There is the potential for women to be disproportionately affected as many of the construction jobs will be geared towards men. The Project will have a beneficial impact on employment during construction in the Roseau Valley. Additional jobs created indirectly (through retail, hospitality, transportations etc.) would also bring minor beneficial impacts for employment in the local area. Furthermore, the GoCD has committed to funding some community development initiatives along with development of the power plant, which will provide further benefits to the community.

Land Acquisition

For construction of the power plant and re-injection route pipeline, approximately 13 properties would need to be acquired including some structures, in consisting of 2-3 residences. Some farming is presently occurring on at least three of the proposed sites.

Of the potential 13 properties to be acquired, physical displacement of structures in approximately three affected properties are predicted to occur as a result of the Project, which will be permanent. Impacts of this nature can result in poverty and / or dislocation of communities and the severance of extended support networks. Post-Hurricane Maria, impacts to any vulnerable parties may be even more severe. If not mitigated appropriately and early, resettlement impacts can cause great controversy and result in significant public objections, time delays and considerable cost overruns for the Project.

For proposed land acquisitions and resettlement associated with the Project, an Abbreviated Resettlement Action Plan (ARAP) has been developed in consultation with affected parties. The ARAP will provide resettlement sites where appropriate and / or cash compensation and livelihood restoration measures including consideration of those considered to be severely affected and or vulnerable.

In the long-term, impacts are expected to decrease further as affected people realise some of the benefits of compensation and livelihood restoration initiatives, and as the other mitigation and monitoring measures are implemented along with community development initiatives.

4.4.2 Economic Displacement and Livelihood Impacts

Along with experiencing physical displacement, some of the parties affected by resettlement for the proposed power plant site and the reinjection pipeline route will experience economic displacement effects as many of the affected properties include agricultural crops, livestock, and trees.

Ecotourism resources could also be affected including thermal spas, medicinal plants, handicrafts, and water related resources. The Project could potentially have a negative impact on water resources in the area, which would in turn affect ecosystem services. Post-Hurricane Maria, impacts to any vulnerable parties may be even more severe.

The additional livelihood impacts that could result from impacts to agriculture and livestock as well as ecosystem services would be considered minor prior to mitigation.

4.4.3 Impacts to Tourism

Project impacts to tourism could result from roadway access restrictions during construction restricting access for visitors in the Valley; potentially adverse effects to the World Heritage site or geothermal features in the Roseau Valley; and potentially beneficial impacts to local tourism businesses due to increased activity during construction and operations.

Women, in particular, tend to work as vendors in the tourism industry and may be disproportionately impacted by any effects on the tourist industry that would result from the Project. As such, it will be particularly important that any proposed mitigation measures specifically consider additional opportunities for women.

As a result of all of the above both adverse and beneficial impacts to tourism combined, a minor impact on tourism businesses in the community would still be anticipated.

4.4.4 Community Health, Safety and Security Impacts

Dust and noise related nuisance impacts from construction are anticipated to be short-term. H₂S concentrations during operations are predicted to be well below World Health Organisation (WHO) thresholds of observed adverse effect levels. Overall health impacts of the Project are therefore considered to be negligible and the life expectancy of 77 years in Dominica is not anticipated to change as a result of the proposed Project.

Community safety impacts from increased roads and traffic and associated safety risks would be considered to have a potential impact of moderate. However, impacts would likely be short-term and localised and risks would be highest during the peak construction period. Children and other vulnerable people and livestock may be more susceptible to traffic risks as elderly, children, and those with existing health problems would likely be most susceptible to the community health risks. With the mitigation measures the impacts are expected to be reduced to an acceptable level.

4.5 What will the key mitigation and monitoring for the project to protect the people and the environment of the Roseau Valley?

The Construction Contractor and DGDC will ensure that mitigation and monitoring practices are undertaken during construction and operation of the Project. This will help reduce any adverse impacts on the environment or the communities of the Roseau Valley. Various plans and procedures will be developed for mitigation and monitoring practices. These will include those related to the following topics:

- Pest and weed management;
- Biodiversity restoration;
- Waste management;
- Hazardous substance management;
- Soil and erosion management;
- Air quality/dust management;
- Environmental and social monitoring;
- Stakeholder engagement;
- Grievance mechanism (community and workers);
- Emergency preparedness and response;
- Noise and vibration management;

- Recycling plan;
- Landscape management;
- Subsidence risk management;
- Landslide stabilisation risk management;
- Occupational safety and health management; and
- Traffic management.

4.6 Conclusion

This ESIA summarises a large amount of technical work undertaken to assess the impacts of the proposed Project. The ESMP sets out mitigation and monitoring actions that address the key environmental and social impacts identified in the analysis. Control measures will be implemented through a Project Environmental and Social Management System to ensure that the environmental and social impacts of the Project are acceptable and in compliance with the Dominican legislation and international guidelines.