

CONNECT ST HELENA LTD

# DEEP AQUIFER EXPLORATION DRILLING FEASIBILITY STUDY ST HELENA ISLAND





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CONNECT ST HELENA LTD

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# 1 INTRODUCTION

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## 1.1 PROJECT BACKGROUND

WSP was appointed by Connect Saint Helena Limited to carry out a feasibility study on deep aquifer exploration drilling on Saint Helena Island. The feasibility study covers the entire Island of St Helena, to identify the most suitable areas for deep aquifer exploration drilling, but considers the location of existing bulk water infrastructure on the island and in particular the four water treatment works (WTW) which currently serve the island. Drilling targets are thus assessed in terms of their proximity to these treatment works.

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## 1.2 AIMS

The primary aims of the feasibility study are to:

- Determine if potential deep aquifer drilling targets can be used to supplement the surface water sources available on the island, and are available within a reasonable distance of the existing water treatment and distribution system;
  - Formulate a detailed deep aquifer exploration-drilling regime to be used to direct drilling by an external drilling contractor;
  - Supervise the drilling and completion of the boreholes;
  - Comment on the feasibility of establishing deep aquifer groundwater wells that can be used to supplement surface water sources; and
  - Make recommendations for future groundwater borehole developments based on the findings of the study.
- 

## 1.3 SCOPE OF WORK

The scope of works was divided into the following 3 stages:

- 1 Desktop study of all available data;
  - 2 Technical assessment of data to formulate a drilling plan; and
  - 3 Execution of deep aquifer exploration drilling programme
- 

### 1.3.1 DESKTOP STUDY

The first stage was a desktop study during which the following scope applied:

- Consultation and liaison with all key stakeholders to be associated with the project;
  - Assessment of all information, data and reports on the project component (include all legislative and development control regulations, as well as forward planning measures employed to regulate physical development on the island);
  - Preparation of detailed georeferenced datasets and GIS maps;
  - Identification of outstanding and / or further data to be obtained by means of further research and on-site surveys; and
  - Prepare an inception report that highlights aspects impacting on further stages of the project.
- 

### 1.3.2 TECHNICAL ASSESSMENT OF DATA

The second stage allowed for the technical assessment of the information collated in the first stage and for the formulation of suitable interventions to allow the third stage to be completed. The second stage therefore included:

- Facilitation of supplementary technical surveys and assessments required;
- Formulation of criteria and parameters used to underpin and direct the exploration drilling programme;
- The preparation of conceptual deep aquifer exploration drilling proposals; and
- A final inception report to be used to direct the execution of the third stage.

The inception report generated at the end of stage 2 of the programme summarised all hydrogeological data relevant to the current programme. The report formed the basis for the third stage of the works, and proposed the conceptual model on which the borehole site selection and drilling programme were based. The inception report can be viewed in **Appendix A**.

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### **1.3.3 EXECUTION OF DEEP AQUIFER DRILLING PROGRAMME**

The third and final stage of the feasibility study yielded a detailed deep aquifer exploration-drilling regime to adequately direct on-site drilling work. This included:

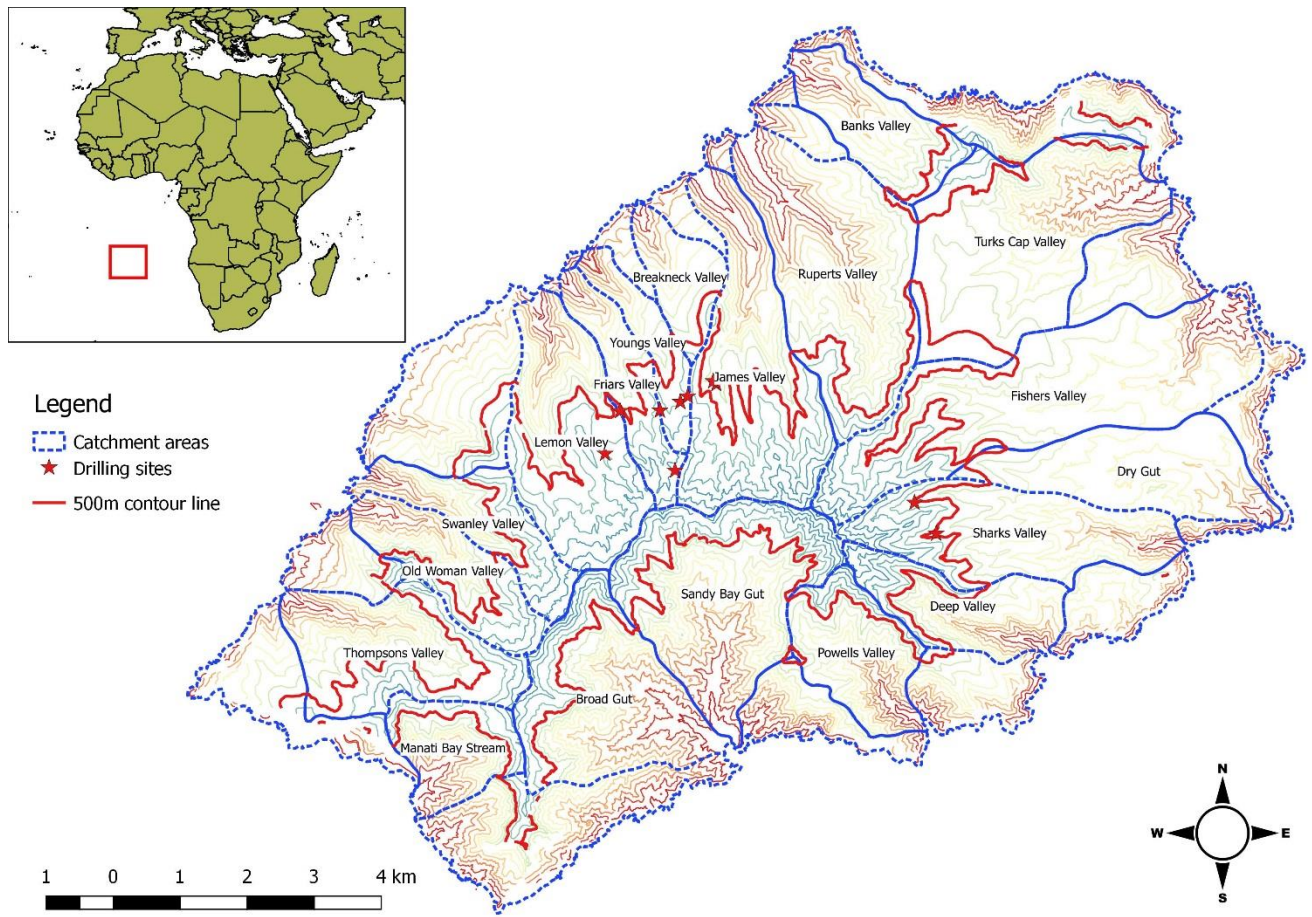
- Agreed criteria and parameters to be used in determining final exploration sites;
  - Preparation of a Hydrogeological Database to be used during the drilling programme and that allows for future monitoring data to be captured;
  - The implementation and execution of the Deep Aquifer Drilling programme, whereby 10 boreholes were drilled, targeting deep aquifers on the island; and
  - Reporting on completed feasibility study.
- 

## **1.4 SITE SETTING**

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### **1.4.1 LOCATION**

St Helena is a volcanic island in the South Atlantic Ocean. It is located approximately 1900 km from the African coastline and 3200 km from the South American Coastline (Figure 1).



**Figure 1: St Helena regional setting**

## 1.4.2 GEOLOGY

The geology of the island is dominated by rocks that originated from two volcanic centres, these are referred to as the North Eastern (NEVC) and South Western Volcanic Centres (SEVC). A younger less prominent centre is also known to have formed in the east and many dykes, related to various stages of the island evolution, are present.

The NEVC is older and consists of subaerial lavas and submarine breccia. Dykes within the NEVC are reported to be north-south trending features with lesser amounts of east-west trending dykes. These dykes are typically thin (1.2m). The dykes were feeders to the younger SWVC and are noted to be more resistant to erosion than the country rock. They therefore create a distinct relief where they outcrop.

The SWVC is more complex and consists of three shields. The “Lower Shield” is known to also have dykes that cause prominent relief. The last of the shields, the “Upper Shield” only occurs in the north-eastern parts of the SWVC and fills erosional features that had developed in the intermediate age “Main Shield”. The lava flows and pyroclastics dip radially from the Sandy Bay area at low angles.

Late stage features include pipe intrusions and dykes. The late stage dykes have a general North East – South West strike and are up to 20m thick. The basaltic lava was subjected to periods of erosion between lava flows, which resulted in the formation of channels that were filled with sediments before later flows covered them.

### 1.4.3 HYDROGEOLOGY

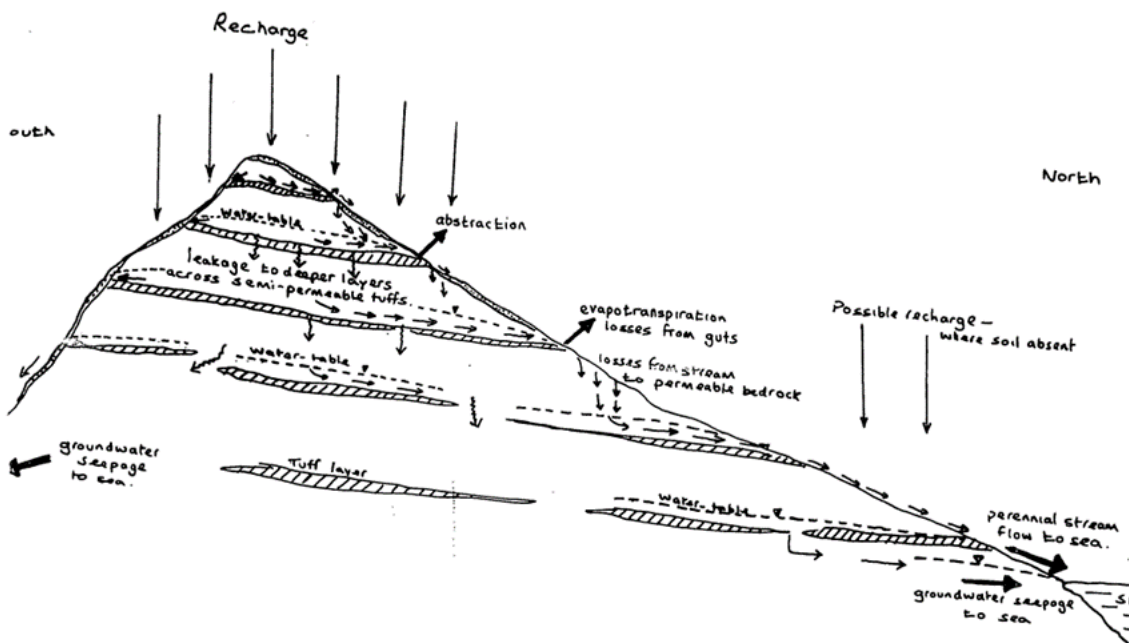
#### GENERAL HYDROGEOLOGY

Due to the basaltic nature of the lavas on the island, the majority of the soils contain a clay component. The soils therefore have an intermediate to poor permeability. In the valleys, soils are more gravelly and relatively thick accumulations of unconsolidated gravels occur. These gravels can hold large amount of groundwater and therefore create, with the upper layer of fractured bedrock, a superficial perched aquifer of limited storage capacity, which is easily recharged by surface runoff and rainwater. These superficial aquifers are typically responsible for feeding the many springs around the island. The limited storage of these aquifers makes them susceptible to periods of drought or low rainfall when favourable recharge conditions may not occur.

An aquifer type of even less storage capacity is the primary aquifer consisting of vesicular and brecciated lava that forms along the contact between two lava flows. These are very localized features and are unlikely to store significant volumes of groundwater. They may however be significant zones of transmissivity.

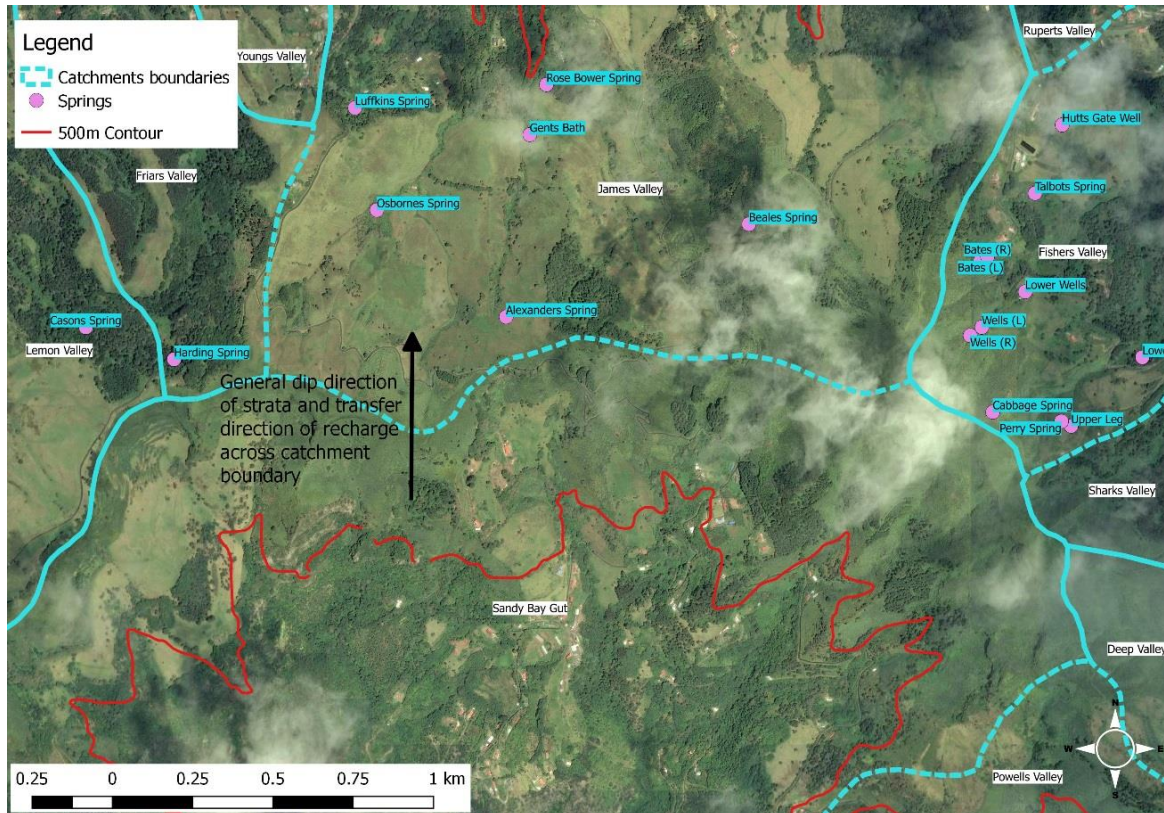
Secondary, fractured, basalt aquifers of low porosity but high permeability exist in areas of faults, dykes and fissures. The deeper aquifers are generally unexploited except for a few boreholes that have been developed in the Frenches Gut, Iron Pot and Spring Gut (including a horizontal borehole) Water Distribution Systems on the western side of the island. Some of these boreholes are reported to be artesian and most borehole water is used untreated. The boreholes are however relatively shallow (<22m deep). The existing boreholes are therefore most likely intercepting partly confined shallow fractures and are not accessing the deeper secondary aquifers. It appears that the reason for deep wells not being attempted previously is the limited availability of suitable drilling rigs.

Within the lava flows are layers of impermeable tuff. Many of the springs on the island are attributed to the daylighting groundwater flowing along the contacts of such aquitards. These springs drain perched water tables located on top of the aquitard layers. The perched aquifers holds water in the lava contact zones and fractured secondary aquifers (as described above). The above-described hydrogeological conceptual hydro-geological model was presented by Lawrence (1983) (reproduced in Figure 2). The tuff layers are, despite being described as laterally persistent over hundreds or even thousands of metres, likely to leak to lower layers. The lower layers therefore do store and transmit groundwater recharge originating from the entire overlying surface area and not only from the limited area where that layer daylight. These lower layers are laterally more extensive and therefore will store a greater volume of water than the higher layers.



**Figure 2: Conceptual hydro-geological section of a typical landform on St Helena Island (as presented by Lawrence, 1983)**

The conceptual model presented in Figure 2 also explains why many springs are located on one side of a water divide but not on the opposite side. All groundwater flows in the direction the strata dips, therefore recharge on areas where the strata dips into the slope will be transferred to the adjacent catchment where the strata dips out of the slope (for example, recharge on the left of the divide in Figure 2 flows to the right of the divide along the dipping strata). On the island, this is best illustrated at the divide between the Sandy Bay Catchment and the James Valley Catchment (Figure 3). Here many springs occur on the northern side of the divide while springs are essentially absent on the southern side. The northward dipping strata in the area conducts groundwater that infiltrates on the southern side of the divide to the northern side where it daylights as springs.



**Figure 3: An example of the distribution of springs relative to the catchment boundaries due to hydrogeological conditions, the example being at the southern end of the James Valley catchment, where it meets the Sandy Bay Gut Catchment**

The exploitation of deeper layers below those that produce high altitude springs will therefore allow access to water that currently does not contribute to the high altitude spring flow and is ultimately lost as baseflow to surface streams or the ocean at low altitude. The recharge is also likely to originate from adjacent catchments due to the dip of the strata.

These boreholes were located in the drainage channel and most likely intercepted both the superficial alluvial aquifer and a deeper fractured aquifer. The boreholes were however cased and sealed and as such, the high water level was attributed to the hydrostatic head present in the lower aquifer layers. The surface geology at these borehole locations is part of the Upper Shield. It may be that the deep water strikes at depth are associated with the Upper Shield contact zone with the Main Shield. This can however not be verified with the available information and it may therefore be that the water bearing layers are associated with fractures or horizontal aquitard layers similar to those illustrated in Figure 2.

## GROUNDWATER RECHARGE

Surface runoff on the island is minimal and most stream flow is obtained from interflow and springs. Groundwater recharge occurs primarily in the high lying areas, i.e. > 500 meters above mean seal level (mamsl), where the majority of precipitation falls. Lower areas have low rainfall and high evaporation rates. Aquifers situated in the areas below an elevation of 500m are therefore not directly recharged from rainfall. Total recharge figures calculated by previous

studies range from 1.5 to 3.6 x 10<sup>6</sup> m<sup>3</sup> per annum. The mean annual precipitation on St Helena Island is in the order of 47.0 x 10<sup>6</sup> m<sup>3</sup>.

When only recharge occurring above 500 mamsl is considered the catchment areas with the largest volume of recharge are the James Valley (259 753 m<sup>3</sup>) and Lemon Valley (208 094 m<sup>3</sup>) with all other catchments receiving significantly less recharge per annum.

The annual volume of groundwater recharge to the James, Young’s, Friars, Lemon, Swanley, Old Woman’s, Fishers, Sharks, Deep and Sandy Bay Valley catchments (the catchments that account for most of the area above 500 mamsl is estimated at 1.00 - 1.55 x 10<sup>6</sup> m<sup>3</sup>. It is also estimated that 1.0x10<sup>6</sup> m<sup>3</sup> of the recharge is discharged into the ocean by the streams from these catchments as baseflow (Lawrence, 1983).

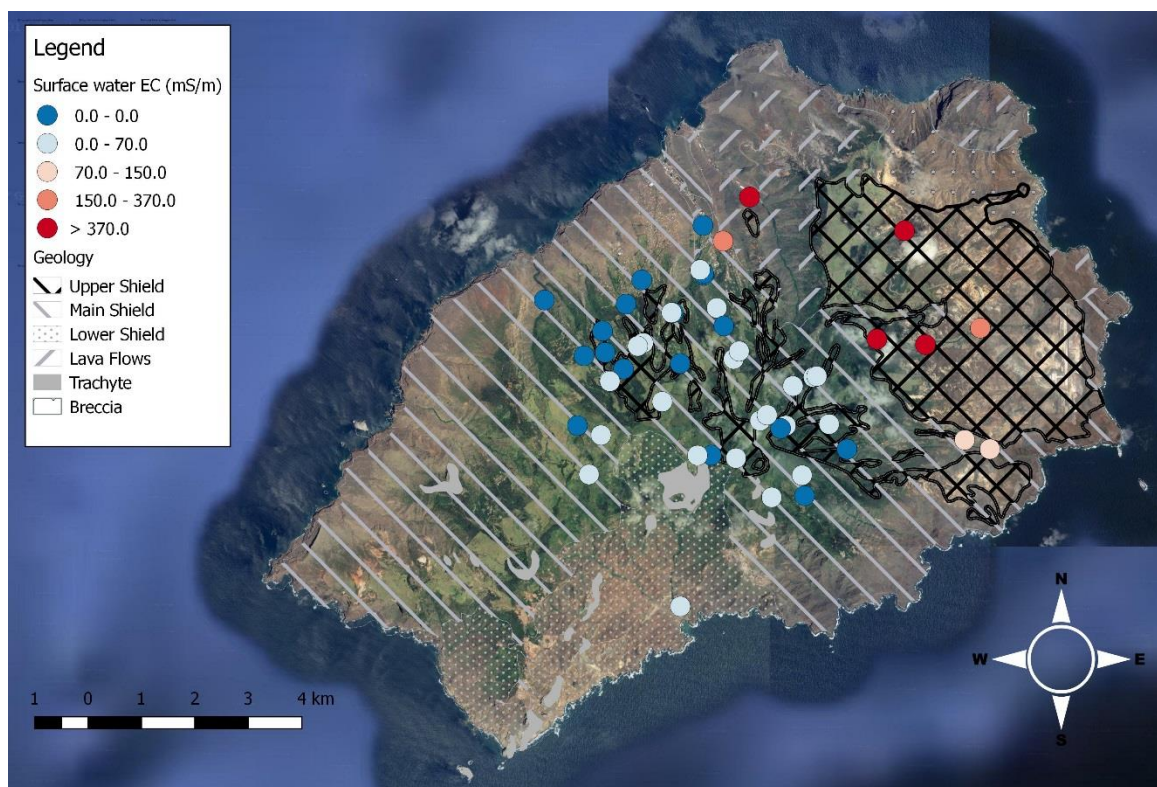
Based on these recharge estimates from previous studies and the fact hydrogeological model presented above the majority of water that may be harvested is likely to be found in the catchments listed above.

## WATER QUALITY

Rainfall salinity data indicates that higher salinities along the south eastern side of the island. A similar trend is observed when surface water electric conductivity (EC) is considered with values generally low (<70mS/m) in areas above 500 mamsl or in areas in close proximity to the central region above that altitude (Figure 4). Higher EC surface waters are all located at lower altitudes but also seem to be associated with younger geological units. These observations are however based on the limited data and no data was obtained for surface waters in the south western and far western parts of the island.

Spring water EC values also seem to be low in the high altitude areas and when located close to the central high areas. EC data was found for only one spring located far from this central area and the water from that spring had an elevated, but not extreme, EC value.

Two deep boreholes wells, located in the Upper Shield layers in the eastern part of the island where surface water EC values are high (>300 mS/m), have EC values of zero and ≈100 mS/m. It is not clear if the waters in these wells are located in the Upper Shield layer, in a deeper geological unit or on the contact between the Upper and Main Shield layers. The difference in EC values does point toward the possibility of suitable drinking water being present in deeper aquifers irrespective of the surface water quality. The low-lying areas should therefore not automatically be disqualified from water exploration activities.



**Figure 4: Surface water EC values**

# 2 METHODOLOGY

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## 2.1 INTRODUCTION

Following the completion of the first two stages of the study remotely, a WSP hydrogeologist was on site on St Helena Island (from the 12<sup>th</sup> of March to the 28<sup>th</sup> of April 2017) to implement and execute the deep aquifer exploration drilling programme. During that time, the drilling study activities proposed in the inception report were adjusted according to consultation and liaison with all key stakeholders on the island and the conditions encountered at each site. The following three sections discuss the process followed:

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## 2.2 BOREHOLE SITE SELECTION

Borehole locations were selected based on criteria determined during the desktop study phase of the programme. These criteria included the following:

- The geological model;
  - Topographical and elevation constraints;
  - Avoidance of potentially environmentally sensitive areas; and
  - Proximity to existing infrastructure.
- 

### 2.2.1 GEOLOGICAL MODEL

It was determined that the most likely means of successfully intercepting sustainable borehole yields in deeper aquifers was to target contact zones between different lithological units at depth. It was estimated that the contact zone between the Upper Shield and the Main Shield would potentially act as a preferential pathway for groundwater flow, and that boreholes drilled into this contact zone may provide a sustainable source of deep groundwater.

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### 2.2.2 TOPOGRAPHICAL AND ELEVATION CONSTRAINTS

The topographical nature of the island, with narrow, steep sided valleys dominating a large portion of the terrain, limited viability of selecting drill sites in many areas. Steep sided slopes prevented access to certain areas and would require large amounts of earth moving in order to prepare a stable drill platform.

Because the majority of groundwater recharge occurs above the 500 meter elevation mark and springs and streams below 500 meters often tend to have a higher salinity, all areas below 500 meters elevation were discarded from the target areas.

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### 2.2.3 POTENTIALLY ENVIRONMENTALLY SENSITIVE AREAS

The environmentally sensitive nature of the island was acknowledged and understood, and as a result, the potential impact on the natural environment during drilling was strongly considered. Borehole target areas were selected in areas that had already been impacted through human activity, such as agricultural areas, roads and forestry zones. Any areas flagged as being potentially environmentally sensitive were first discussed and subsequently approved by the Environmental and Natural Resources Department (ENRD) in order to ensure no adverse environmental impacts were caused.

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### 2.2.4 PROXIMITY TO EXISTING INFRASTRUCTURE

The large majority of water users are located in the areas where current distributions systems are present and the predicted future demand are also concentrated in these areas. Furthermore, the feasibility of establishing wells in areas where additional costs of establishing new infrastructure and pumping water, either over great distances or up

significant gradients, was considered to be very unlikely. As a result, drill sites were restricted to a reasonable (approximately 1 km) radius of existing infrastructure within the high demand areas, and preferably up-gradient of such infrastructure.

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## 2.3 DRILLING

Drilling was carried out using conventional down the hole hammer (DTH) air percussion methods in areas where the upper geological zones were relatively stable during drilling, and odex drilling methods where any significant instability was encountered. Boreholes were drilled at 203 mm diameter through the weathered zone until hard rock was reached. Thereafter the remainder of the hole was drilled at 165 mm. 177 mm solid steel casing was installed to the contact with hard rock. In cases where significant water inflow was encountered within the upper weathered zone, the solid steel casing was perforated using an in situ perforation tool in order to allow water inflow into the borehole. Boreholes were drilled to an average depth of 100 meters. Upon completion of each borehole, the hole was flushed using compressed air in order to remove excess silt from the borehole.

Hydrogeological information, such as depth of water strikes, depth of weathering and geological material drilled were collected and logged by the on site hydrogeologist in order to produce vertical hydrogeological logs for each borehole.

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## 2.4 YIELD ESTIMATES & WATER QUALITY ANALYSIS

During the flushing process, an estimate of the yield of the borehole was determined. This was done by directing all of the displaced water into a single discharge point, such as a PVC pipe, and measuring the flow rate using a bucket and a stopwatch, allowing a yield in volume (litres) per unit time (seconds) to be calculated. This allows an estimate of the yield of the borehole, known as a blow yield, to be determined. It should be noted that this is not a final sustainable yield for the borehole, but rather an indication as to whether the borehole will be able to yield significant volumes of water, and to be used to guide sustainable yield testing at a later stage if needed.

Once flushing was completed, a water sample was collected and analysed in-field using a portable hand held YSI multiparameter probe. The following parameters were recorded:

- Temperature °C
- pH pH units
- Electrical conductivity (EC)  $\mu\text{S}/\text{cm}$
- Salinity ppt
- Total dissolved solids (TDS) mg/l
- Dissolved oxygen (DO) mg/l
- Oxidation and reduction potential (ORP) mV

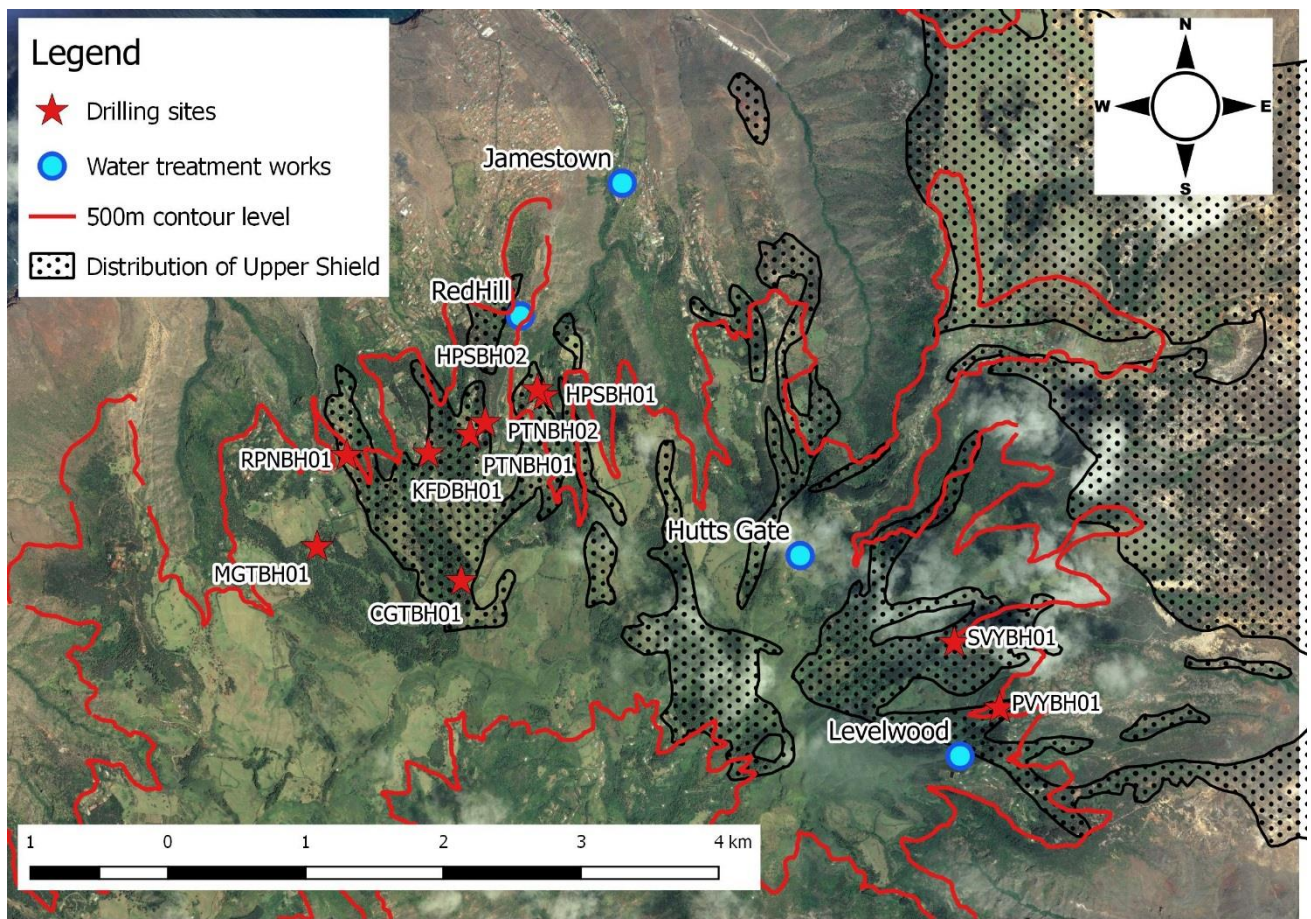
# 3 RESULTS

## 3.1 CURRENT DRILLING PROGRAMME

### 3.1.1 DRILLING RESULTS

Following the methodology laid out in Section 2, borehole locations were selected in areas where mapped Upper Shield geology was expected to be found above elevations of 500 meters, while being in relatively close proximity to existing water infrastructure. In total, 10 boreholes were drilled in the following 8 areas (Figure 5):

– Harper’s	2 borehole	HPSBH01; HPSBH02
– Shark’s Valley	1 borehole	SVYBH01
– Pleasant Valley	1 borehole	PVTBH01
– Molly’s Gut	1 borehole	MGTBH01
– Rosemary Plain	1 borehole	RPNBH01
– Kunji Field	1 borehole	KFDBH01
– Plantation	2 boreholes	PTNBH01; PTNBH02
– Cason’s Gate	1 borehole	CGTBH01



**Figure 5: Locations of completed boreholes**

In total, 8 of the 10 completed boreholes were successful in that they intercepted deep water strikes of potentially sustainable yields. Blow yields between 0.3 l/s (Rosemary Plain) and 4.3 l/s (Shark's Valley) were recorded. Depth of weathering was recorded at between 12 meters and 36 meters. The main water strikes in the successful boreholes were generally encountered between depths of 26 meters (Pleasant Valley) and 85 meters (Harper's). Geological material encountered directly prior to intercepting the main water strikes generally showed considerable weathering, indicating that these water strikes were most likely associated with the Upper Shield/Main Shield contact, thus validating the proposed conceptual model of groundwater flow along the contact between these two zones.

Of the 10 boreholes drilled, 8 intercepted the contact zone between the Upper Shield and the Main Shield lithologies. HPSBH01 and MGTBH01 did not intercept this contact zone, the former due to wet ground creating access issues, which resulted in the borehole being drilled slightly away from the preferred target area, and the latter due to Connect St Helena requesting that the borehole be drilled in close proximity to an existing water supply well located outside the target zone. According to the available geological maps, in both these borehole positions, the Upper Shield is not present and the Main Shield is the surface lithology.

Of the 8 boreholes which did intercept the target contact zone, 6 intercepted a main water strike on the contact zone between the Upper and Main Shield. PTNBH01 and PTNBH02, both in the plantation area, intercepted the contact zone, but did not encounter any water strikes. It is not clear why the contact was dry in these locations. It may be that, due the position on the side of the valley (Young's Valley) most water in the contact zone is located along the main valley drainage line to the west of these holes (assuming the valleys filled by the Upper Shield units had a similar shape to the current valleys). Borehole KFDBH01, located on the other side of the valley, did however have water in the contact zone and therefore the above explanation is not sufficient. Unfortunately, the lack of borehole cores limits the possibility of further interpretation as why these contacts were dry. An alternative explanation may be that the weathered contact is not of sufficient transmissivity.

**Table 1: Comparison of geology vs water strike depth**

Borehole ID	Depth of main water strike (m)	Depth of weathering prior to main water strike (m)	Depth of suspected Upper Shield/Main Shield contact zone (m)	Water strike associated with Upper Shield/Main Shield contact (Y/N)
HPSBH01	N/A	N/A	Contact zone not intercepted	No
HPSBH02	85	80-85	85	Yes
SVYBH01	66	60-66	66	Yes
PVYBH01	26	14-26	26	Yes
MGTBH01	45	N/A	Contact zone not intercepted	No
RPNBH01	59	54-59	59	Yes
KFDBH01	64	60-64	64	Yes
PTNBH01	8	N/A	79-86	No
PTNBH02	N/A	39-45	45	N/A
CGTBH01	36	21-36	36	Yes

The differences in blow yields (Table 2) indicate that wells SVYBH01 and PVYBH01, both on the eastern side of the island, have significantly higher (>3 l/s) blow yields when compared to other water bearing wells (<1 l/s). The reason for this is also difficult to explain using the available information but it may be because the up-slope contact between the Upper Shield and the Main shield is located at a very high altitude in this area. The exposed contact area, where large amounts of recharge can occur, therefore receives higher rainfall than the exposed contact at the other well locations.

Completed boreholes had 177 mm steel casing installed in the weathered zone. Boreholes in high visibility and/or high traffic zones had the casing cut off below ground level with a man hole cover installed to facilitate access to the borehole when required. An example of a completed borehole can be seen in Figure 6. A summary of the details of the completed boreholes can be seen in Table 2, with the full borehole logs presented in **Appendix B**.



**Figure 6: Example of completed borehole with a manhole and cover (Rosemary Plain)**

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### **3.1.2 WATER QUALITY RESULTS**

Based on the conceptual model, it was expected that all water encountered have relatively low EC as a result of low salinity. The recorded EC values ranged from 261  $\mu\text{S}/\text{cm}$  at SVYBH01 (Shark's Valley) to 703  $\mu\text{S}/\text{cm}$  at HPSBH02 (Harper's). This represents water of relatively low salinity that has been recently recharged, and ties in with the assumptions of the conceptual model. The complete set of field parameters for each borehole can be seen in Table 3.

**Table 2: Drilling summary**

Borehole ID	Area	Coordinates (DDD° MM' SS.S")		Start date	End date	Drilled depth Meters	Casing		Water strikes* Depth (meters)	Blow yield L/s	Casing height magl	Static Water Level	
		Latitude (South)	Longitude (West)				Depth (meters)	Perforation (meters)				mbc	mbgl
HPSBH01	Harper's	15°57'13.23"	5°42'57.83"	2017/03/23	2017/03/24	100	0-18	N/A	29	-	0	Unable to measure due to low water volume	
HPSBH02	Harper's	15°57'11.78"	5°42'59.40"	2017/03/25	2017/03/27	100	0-12	N/A	8; 36; <b>85</b>	1.0	0.48	79.88	79.40
SVYBH01	Shark's Valley	15°58'12.74"	5°41'18.33"	2017/03/28	2017/03/29	100	0-12	N/A	11; <b>66</b> ; 78	4.3	0.28	67.29	67.01
PVYBH01	Pleasant Valley	15°58'28.31"	5°41'7.45"	2017/03/29	2017/03/30	100	0-30	24-30	<b>26</b> ; 77; 94	3.2	0.3	23.20	22.90
MGTBH01	Molly's Gut	15°57'48.16"	5°43'53.70"	2017/04/08	2017/04/09	74	0-24	N/A	30; <b>45</b>	0.4	0.3	Unable to measure due to suspected collapse	
RPNBH01	Rosemary Plain	15°57'26.71"	5°43'46.16"	2017/04/10	2017/04/11	102	30	N/A	45, <b>59</b>	0.3	0	86.10	86.10
KFDBH01	Kunji Field	15°57'26.44"	5°43'26.18"	2017/04/11	2017/04/12	102	36	N/A	33; 57; <b>64</b>	0.4	0	Unable to measure due to suspected collapse	
PTNBH01	Plantation	15°57'22.19"	5°43'15.91"	2017/04/13	2017/04/15	132	18	6-18	<b>8</b>	0.5	0	Unable to measure due to suspected collapse	
PTNBH02	Plantation	15°57'19.36"	5°43'12.22"	2017/04/16	2017/04/16	100	18	N/A	N/A	-	0	Unable to measure due to low water volume	
CGTBH01	Cason's Gate	15°57'56.63"	5°43'18.60"	2017/04/20	2017/04/20	69	30	N/A	<b>36</b>	Unable to measure	0	Unable to measure due to suspected collapse	

\*Main water strike depth in bold

mbgl: meters above ground level

mbc: meters below casing

mbgl: meters below ground level

**Table 3: Water quality field parameters**

Borehole ID	Water quality field parameters						
	Temperature °C	Dissolved oxygen mg/l	Electrical conductivity µS/cm	Total dissolved solids mg/l	pH pH units	Redox potential mV	Salinity ppt
HPSBH01	-	-	-	-	-	-	-
HPSBH02	21.0	6.90	703.0	455.00	7.66	233.30	0.34
SVYBH01	19.5	8.85	261.0	196.65	7.03	251.10	0.12
PVYBH01	19.6	8.61	531.4	345.15	7.26	124.30	0.26
MGTBH01	26.0	7.16	299.0	194.35	7.17	59.70	0.14
RPNBH01	26.3	6.73	652.0	422.50	7.63	167.60	0.31
KFDBH01	26.6	7.24	264.3	171.60	7.14	144.00	0.12
PTNBH01	24.0	7.60	373.2	242.45	6.54	96.61	0.18
PTNBH02	-	-	-	-	-	-	-
CGTBH01	-	-	-	-	-	-	-

Insufficient yield to allow field-testing

### 3.1.3 GIS DATABASE

To create a database from previous studies performed on St Helena Island 41 resources, as listed in Table 4, were studied. The resources have been supplied with this report in a digital format with the reference number in Table 4 included in the file name. Additional data obtained during the exploration drilling referred to in this report was also added to the database.

Data was extracted to create the main database, composed using Microsoft™ Access, that is comprised of six (6) data input tables briefly outlined as follows:

1. 'obs\_points': This sheet primarily contains physical information in relation to the specific observation or sampling point. Information contained therein includes hole depth, place, name, type of observation, drill date, geographic coordinates and various other information related specific to an observation point. This sheet was compiled using the available information and some gaps may be present where data was insufficient.
2. 'stratigraphy' : This sheet describes the simple drill depth intersections of the sub-surface lithologies. In addition, any comments from field notes are contained herein. Only information for the 2017 WSP drill campaign contained lithological descriptions and therefore only these observations have been included in this table.
3. 'w\_flow': data within this table relates to any flow measurements that may have been undertaken at an observation point. Most of the data relates to blow yield and pumping tests
4. 'w\_level': All data related to groundwater level measurements are contained in this table. Data inputs include casing height and elevation for each observation point.
5. 'w\_qual\_field': The following table includes data inputs related to field measured water quality parameters. The table makes allowance for variable parameters, units of measure, date of measurement, staff details, instrumentation used and actual parameter readings for each observation point.
6. 'w\_qual\_lab': This table includes all data inputs related to laboratory measured water quality parameters and is essentially similar in structure to the 'w\_qual\_field' table. The table additionally makes allowance for depth of sample, project information, analysis method and laboratory report information for each observation point.

Once all data had been refined, and consolidated into the Access Database the data tables were exported to .csv format where they were imported into a Midvatten database in QGIS. As only spatially referenced data can be imported into a Geographic Information System (GIS) not all table entries in Access Database appear in the QGIS database.

Midvatten is a freeware hydrogeological toolset plugin for QGIS licenced under the terms of the GNU GPL License V2. The plugin is used in conjunction with QGIS as a toolset for the editing and viewing of spatial hydrogeological observational data (drillings, water levels, seismic data etc.) The observational data imported is stored in a spatial-enabled SQLite database and allows for the spatial analysis of the data captured in the tables described above.

For a tutorial on how to use the Midvatten plugin please visit: <https://github.com/jkall/qgis-midvatten-plugin/wiki/Tutorial>.

**Table 4: Resources used to compile St Helena database.**

Resource number	File Name	Date	Summary of details / data type
1	BASIL READ SAL09318	Aug-2016	Laboratory Analysis Certificate
2	BASIL READ SAL09457	Sep-2016	Laboratory Analysis Certificate
3	Water Quality Monitoring Report - 2016 Aug & Sept	Sep-2016	Report using resource 1 and 2
4	BH testing results 13-08-12	Aug-2012	Borehole data from 2012
5	Borehole dip sheet + salinity 2nd June - 7th July	Jul-2013	Borehole dipping data & salinity readings

6	Borehole dip sheet + salinity 31st Mar - 5th May	May-2013	Borehole dipping data & salinity readings
7	Borehole Dip Sheet 29 July - 9th Sept 13	Sep-2013	Borehole dipping data & salinity readings
8	Borehole dip sheet July 2014	Jul-2014	Borehole dipping data & salinity readings
9	Copy of Borehole dip sheet	Nov-2014	Borehole dipping data over multiple dates
10	Salinity boreholes July 2014	Jul-2014	Salinity readings
11	Borehole dip sheet march	Mar-2013	Borehole dipping data & salinity readings
12	water salinity	Mar-2013	Salinity readings
13	Water Quality Database Borehole 5	Feb-2015	Multiple water quality readings
14	Record	Dec-2013	Multiple water level readings
15	Blackbridge V notch Dimensions	Aug-2013	Diagram of a well or hole
16	sws_k0580 osb 2 fg_140425094535_K0580	-	Multitple unusable Diver files
17	In10806 CL 004 Further Assessment of Groundwater Resources - June 2011 - DRAFT	Jun-2011	Installation details of 2 boreholes
18	St Helena Drilling July 2012	Jul-2012	Installation details of 5 boreholes
19	Proposed Drill Sites May 2007	May-2007	Info on proposed drilling sites
20	Iron Pot	May-2016	Water meter readings at 4 boreholes over 9 years
21	Sandy Bay Readings	Sep-2015	Water meter readings for multiple sites
22	Spring gut, mollys gut.... readings	Mar-2017	Water meter readings for multiple sites
23	Borehole dip sheet from till 4 Aug14	Oct-2014	Borehole dipping from 2014
24	borehole locations with yields	Oct-2014	Annotated aerial photo from Google Maps
25	summary of borehole results - co-ordinates + drill depths	Oct-2014	Summarised data of boreholes
26	Borehole details	Mar-2014	Activity status of boreholes
27	Notes, R Leyland	Mar-2017	Notes on 1983 and 1987 reports
28	WD_OS_83_12	Jun-2083	Groundwater Resources Report of St. Helena in 1983
29	WD_OS_87_13	Jul-2087	Groundwater Resources Report of St. Helena in 1987
30	Borehole Tests at Fishers Valley	Jun-2011	Blank template for pump tests
31	Boreholes – Sent	Mar-2017	Folder containing files already reviewed
32	Subadra Reports - Sent	Mar-2017	Folder containing files already reviewed
33	BH_testing_results_13-08-12	Dec-2016	Same as resource 4
34	Borehole depths vs drawdown	Dec-2016	Borehole depths and elevations

35	Drilling for water - progress	Aug-2012	Drilling progress spreadsheet
36	Toens Water Resources Report 2000	Dec-2000	Boreholes, spring, rainfall & streams data
37	water_dam_plan_14-08-12	Aug-2012	Drilling summary and dam capacities
38	waterplan_ver2	Aug-2012	Map showing data from resource 37
39	LDCP Adopted Revised Plan 2012-2022	Apr-2012	Policy document
40	original_86005-A1-GE-3000-Appendix_1-110615	Jun-2011	Figures of boreholes, springs & streams
41	original_86005-A1-GE-3000-Water_Resources_Plan_Final_Draft-110515	Jun-2011	Report compiling many data sources into one report

## 3.2 COMPARISON WITH BASIL READ DRILLING PROGRAMME

Basil Read previously carried out a similar water supply drilling programme in order to provide water for various aspects of the airport construction project. The main aim of the Basil Read project was to supply water for the construction phase of their programme, with proximity to the airport construction site the main priority. The following points can be made regarding this programme:

- The drilling programme was successful, with the majority of the boreholes producing useable yields;
- The boreholes were all drilled in areas of mapped Upper Shield geology, although no geological logs were recorded during the drilling process; and
- Many of the boreholes produced water with relatively high levels of salinity.

Given that fact that these boreholes were drilled in the Upper Shield areas, it is likely that the water strikes were intercepted at the contact zones between the Upper Shield and the Main Shield lithologies. However, due to the target area falling below the 500 meter elevation contour, the salinity levels are considerably higher than those recorded in the current drilling programme. This leads to confirm the assumptions regarding both yields and quality made in the conceptual model.

# 4 RECOMMENDATIONS AND WAY FORWARD

---

## 4.1 BOREHOLE COMPLETION

The borehole construction methodology described in Section 2.3 was agreed directly between Connect St Helena and 121 Drilling (the appointed drilling contractor). While the method of installing steel casing through the weathered zone and leaving the fresh rock section uncased is widely used and very often successful, WSP recommends that all production boreholes be completed with an inner PVC casing to the end of hole depth. The annulus between the borehole walls and the PVC casing should be filled with 2-5 mm gravel, in order to facilitate groundwater flow into the casing. This serves to protect the borehole from collapsing or silting up and to protect the longevity of the borehole. During the drilling programme, difficulty measuring static water levels in a number of boreholes after drilling was completed may indicate a need to install PVC casing as described. The boreholes in question are:

- MGTBH01;
- KFDBH01;
- PTNBH01; and
- CGTBH01.

Installing PVC casing in this manner can be achieved by making use of the drilling equipment currently on the island. The following simplified guide can be followed in order to install the casing:

- Using the drill rig owned by Connect St Helena, install the drill rods to the base of the borehole (or as near as can be reached);
  - Flush the borehole with compressed air until the water runs clear and the drill rods are able to reach the end of hole depth without obstruction;
  - Immediately after flushing, install PVC casing, ensuring that perforated casing is installed over the sections where water strikes were recorded; and
  - Install 2-5 mm gravel in the annulus between the borehole wall and the newly installed casing.
- 

## 4.2 MONITORING SCHEDULE

Monitoring of water levels in the boreholes should be carried out on a biannual basis, covering both wet season and dry season, in order to establish long term seasonal trends in water level data. Should the boreholes be intended to be commissioned for water supply, the monitoring should be increased to quarterly, and should include chemical and bacteriological analysis of water samples. It would be preferable to establish this quarterly monitoring at least one year prior to commissioning the boreholes. In all cases a specific sampling protocol would be required to ensure representative samples are obtained and that these are not contaminated during sampling.

---

## 4.3 SUSTAINABLE YIELD TESTING AND SUITABILITY FOR PRODUCTION WELLS

It is difficult to predict whether the boreholes that have been drilled will be suitable for production wells prior to carrying out a long-term sustainability test. This is generally achieved by conducting a constant discharge pumping test, whereby the aquifer characteristics, such as hydraulic conductivity and storativity, are determined through a series of long-term discharge and recovery tests and calculations. These values can then be used to estimate a long-term sustainable pumping rate for each borehole. It is recommended that a suitably qualified professional carry out these tests in order to obtain reliable results.

Based on previous experience, it is deemed unlikely that any boreholes with yields less than 0.5 l/s will deliver sustainable yields sufficient for the needs of the island, with boreholes that have yields of 1 l/s and above being the most preferable for upgrade to abstraction wells. With this in mind, Table 5 provides the boreholes WSP recommends for further testing (in decreasing order of blow yield values) if any boreholes are to be further developed into production.

**Table 5: Boreholes to be prioritised for development production wells**

<b>Borehole ID</b>	<b>Area</b>	<b>Blow yield (l/s)</b>
SVYBH01	Shark's Valley	4.3
PVYBH01	Pleasant Valley	3.2
HPSBH02	Harper's	1.0
PTNBH02	Plantation	0.5

It should also be noted that, although initial indications show that water qualities are good, this is based solely on a small number in-field parameters measured during drilling, and is thus only an indicative assessment. Furthermore, it is possible for water quality to change once pumping has begun. Therefore, it is recommended that the same in-field parameters be measured at regular intervals for the duration of the pump testing for sustainable yield tests, and that samples are collected and analysed for chemical and microbiological constituents at the end of each test.

# 5 CONCLUSIONS

The St Helena Deep Aquifer Exploration Drilling Feasibility Study was carried out between the 12<sup>th</sup> of March and the 28<sup>th</sup> of April 2017. The investigation was successfully carried out in accordance with the methodology identified during the preliminary stages of the study. The following conclusions can be drawn from the programme:

- 10 boreholes were drilled to an average depth of 100 meters. Borehole locations were selected to intersect the contact between the Upper Shield and Main Shield geological units at elevations above 500 meters, and were selected with ease of connecting to existing water distribution networks in mind;
- 8 of the 10 boreholes had successful yields, ranging between 0.3 l/s and 4.3 l/s. Main water strikes in all successful boreholes were encountered at depth, confirming the availability of deep groundwater sources. Groundwater flow in these instances appears to be associated with the contact zone between the Upper Shield and the Main Shield, which appears to act as a preferential flow path along which groundwater can be transmitted;
- Field measurements of water quality indicate that all boreholes have relatively low electrical conductivity values, ranging between 261  $\mu\text{S}/\text{cm}$  and 703  $\mu\text{S}/\text{cm}$ ; and
- Based on the information gathered, it can be concluded that deep aquifers are a potentially feasible source of potable groundwater, which can be used to supplement the island's water supply during times of water shortage or increased demand.

In light of these conclusions, the following recommendations are made:

- Any boreholes intended to be commissioned as production boreholes should have PVC casing and a gravel-pack installed in order to protect them against collapse and preserve them for long term use;
- Boreholes which show signs of collapse should be flushed out using compressed air and have PVC casing and gravel installed in order to prevent further collapse;
- Monitoring of water levels should be carried out on a biannual basis in order to establish seasonal trends. Should any boreholes be intended to be commissioned as supply boreholes, the monitoring should be increased to quarterly, and should include chemical and bacteriological analysis;
- Prior to commissioning a borehole, sustainable yield tests should be carried out in order to determine both the suitability as a production borehole and to determine sustainable long term pumping rates for the borehole; and
- Of the wells drilled during the exploration project, there are 3 wells with yields over 1 l/s (SVYBH01, PVYBH01 and HPSBH01) that are considered very suitable for further development and testing.

# APPENDIX

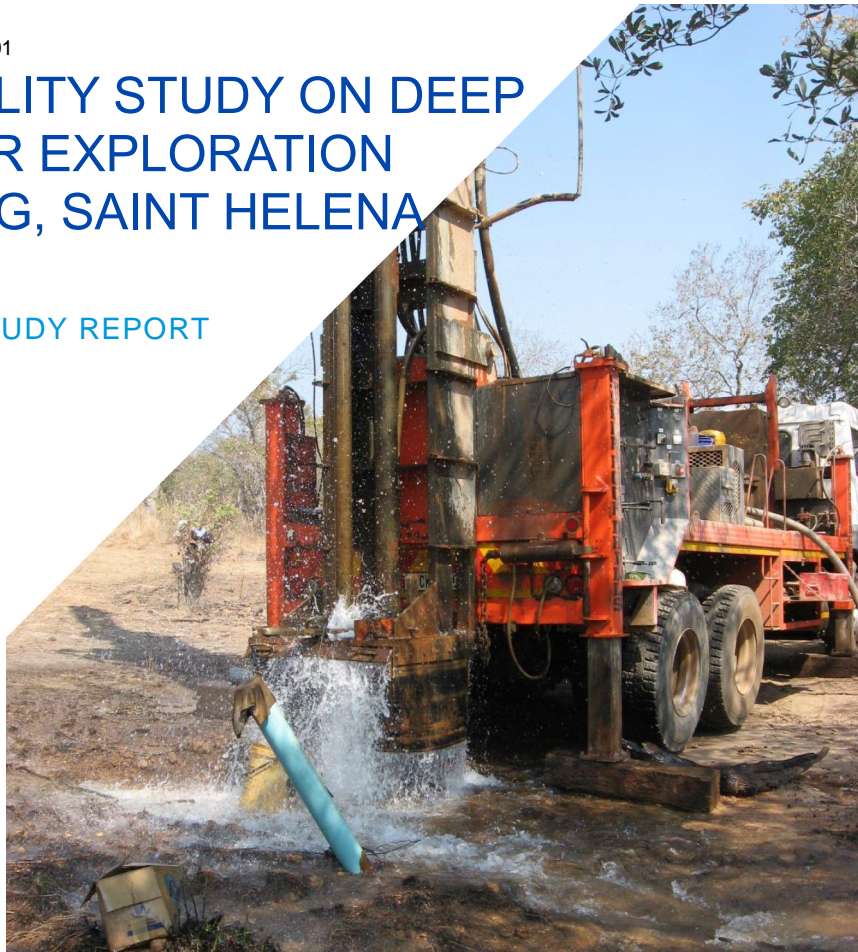
# A INCEPTION REPORT



REPORT N° 48429-01

# FEASIBILITY STUDY ON DEEP AQUIFER EXPLORATION DRILLING, SAINT HELENA ISLAND.

DESKTOP STUDY REPORT



MARCH 2017

# FEASIBILITY STUDY ON DEEP AQUIFER EXPLORATION DRILLING, SAINT HELENA ISLAND.

DRAFT REPORT

Connect Saint Helena



Project No: 48523  
Date: March 2017

—  
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# QUALITY MANAGEMENT

ISSUE/REVISION	FIRST ISSUE	REVISION 1	REVISION 2	REVISION 3
Remarks	Draft Report	2 <sup>nd</sup> Draft		
Date	February 2017	March 2017		
Prepared by	R Leyland	R Leyland		
Signature				
Checked by	J McStay	G Lottreux		
Signature				
Authorised by	J McStay	S Doel		
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# 1

## INTRODUCTION

### 1.1 PROJECT BACKGROUND

WSP Environmental (Pty) Ltd was appointed by Connect Saint Helena Limited to carry out a feasibility study on deep aquifer exploration drilling on Saint Helena Island. The feasibility study covers the entire Island of St Helena, to identify the most suitable areas for deep aquifer exploration drilling, but considers the fact that a limited number of water treatment works (wtw) currently serve the Island and that the proximity of these treatment works should be considered when identifying any potential drilling areas. Successfully established boreholes that are in close proximity to the established water treatment and distribution networks will allow the water to be utilized most economically.

### 1.2 AIMS

The primary aims of the feasibility study are to:

- Determine if potential deep aquifer drilling targets, that can be used to supplement the surface water sources available on the island, are available within a reasonable distance of the existing water treatment and distribution system.
- Formulate a detailed deep aquifer exploration-drilling regime to be used to direct drilling by an external drilling contractor.

### 1.3 SCOPE OF WORKS

The scope of works is divided into 3 stages. The first is a desktop study during which the following scope will apply:

- Consultation and liaison with all key stakeholders on Island to be associated with the project.
- Assessment of all information, data and reports on the project component (include all legislative and development control regulations, as well as forward planning measures employed to regulate physical development on the Island).
- Preparation of detailed georeferenced datasets and GIS maps.
- Identification of outstanding and / or further data to be obtained by means of further research and on-site surveys.
- Prepare an inception report that highlights aspects impacting on further stages of the project.

The second stage will allow for the technical assessment of the information collated in the first stage and for the formulation of suitable interventions to allow the third stage to be completed. The second stage will therefore include:

- Facilitation of supplementary technical surveys and assessments required
- Formulate criteria and parameters to be used to underpin and direct the exploration drilling programme

- The preparation of conceptual deep aquifer exploration drilling proposals
- A final Conceptual Exploration Drilling Report.

The third and final stage of the feasibility study will yield a detailed deep aquifer exploration-drilling regime to adequately direct on-site drilling work. This will include:

- Agreed criteria and parameters to be used in determining final exploration sites
- Preparation of a Geohydrological Database to be used during the drilling programme and that allows for future monitoring data to be captured
- The production of a detailed Deep Aquifer Exploration Drilling Pre-Feasibility Report

The project will then progress to the second phase that will consist of on-site technical coordination and assessments.

## 1.4

### LIMITATIONS

This report is the inception report and therefore the first deliverable of the first phase of the study. The data presented in this report was collected from pre-existing reports and publications. Minimal interpretation of the data has been performed on the data. The data has been used to identify where additional data will be required to inform the next second stage of the investigation. As such the way the data is presented and discussed is relevant to the feasible study and any comments are not intended for use in any other form of assessment.

# 2

## AVAILABLE DATA

The following data and documents were supplied by Connect St. Helena:

- 1: 10 000 Topographical maps in digital format, georeferenced.
- Geology, soils and vegetation maps of St Helena (shapefiles)
- Land Use data (shapefile)
- 10m and 50m interval contour lines (shapefiles)
- Land Parcel, reservoir, water treatment works and water distribution network location data (shapefiles)
- Shapefiles as follows:
  - boresite2007, no metadata
  - bore\_all\_shp, no metadata
  - boresite1984\_shp, no metadata
  - drilltarget1984\_shp, no metadata

- ec\_map\_shp, no metadata
- ec\_water\_shp no metadata
- catchment\_waterplan\_shp, no metadata
- halcrowmonpnt\_shp, no metadata
- sh\_map\_dd\_shp, no metadata
- sh\_smdef\_dd\_shp, no metadata
- spring\_topo\_shp, no metadata
- studyareas\_shp, no metadata
- tp\_sampling\_shp, no metadata
- Reports on:
  - An assessment of the Ground Water Resources of St Helena Island (Toens & Partners, 2000)
  - Land Development Control Plan (SHG, 2012)
  - Drilling Reports from Subadra:
    - Further Assessment of Groundwater resources in Fishers Valley, St Helena (Subadra, 2011)
    - Drilling Works on St Helena (Subadra, 2012)
  - Draft 20-year Water Resource Plan (Fairhurst, 2011)
  - Water quality report from St Helena Airport area (Basil Read, 2016)
  - The Groundwater Resources of St Helena (Lawrence, 1983)
  - A Review of the Groundwater Investigation Programme on St Helena (Lawrence & George, 1987)

# 3

## 3.1

# LITERATURE REVIEW

## GENERAL GEOLOGY

The geology of the island is dominated by rocks that originated from two volcanic centres. These are referred to as the North Eastern (NEVC) and South Western Volcanic Centres (SEVC). A younger less prominent centre is also known to have formed in the east and many dykes, related to various stages of the island evolution, are present.

The NEVC is older and consists of subaerial lavas and submarine breccia. Dykes within the NEVC are reported to be north-south trending features with lesser amounts of east-west trending dykes.

These dykes are typically thin (1.2m). The dykes were feeders to the younger SWVC and are noted to be more resistant to the country rock. They therefore create a distinct relief where they outcrop.

The SWVC is more complex and consists of three shields. The “Lower Shield” is known to also have dykes that cause prominent relief. The last of the shields, the “Upper Shield” only occurs in the north-eastern parts of the SWVC and fills erosional features that had developed in the intermediate age “Main Shield”. The lava flows and pyroclastics dip radially from the Sandy Bay area at low angles.

Late stage features include pipe intrusions and dykes. The late stage dykes have a general North East – South West strike and are up to 20m thick.

The basaltic lava was subjected to periods of erosion between lava flows, which resulted in the formation of channels that were filled with sediments before later flows covered them.

## 3.2 HYDROGEOLOGY

Due to the basaltic nature of the lavas on the island, the majority of the soils contain a clay component. The soils therefore have an intermediate to poor permeability. In the valleys, soils are more gravelly and relatively thick accumulations of unconsolidated gravels occur. These gravels can hold large amount of groundwater and therefore create, with the upper layer of fractured bedrock, a superficial aquifer of limited storage capacity, which is easily recharged by surface runoff and rainwater. The limited storage of these aquifers makes them susceptible to periods of drought or even low rainfall when favourable recharge conditions may not occur.

An aquifer type of even less storage capacity is the primary aquifer consisting of vesicular and brecciated lava that forms along the contact between two lava flows. These are very localized features and are unlikely to store significant volumes of groundwater. They may however be significant zones of transmissivity.

Secondary, fractured, basalt aquifers of low porosity but high permeability exist in areas of faults, dykes and fissures. The deeper aquifers are generally unexploited except for a few boreholes that have been developed in the Frenches Gut, Iron Pot and Spring Gut (including a horizontal borehole) Water Distribution Systems on the western side of the island. Some of these boreholes are reported to be artesian and most borehole water is used untreated. The boreholes are however relatively shallow (<22m deep). The existing boreholes are therefore most likely intercepting partly confined shallow fractures and not deeper secondary aquifers. It appears that the reason for deep wells not being attempted previously is the limited availability of suitable drilling rigs.

Within the lava flows are layers of impermeable tuff. Many of the springs on the island are attributed to the daylighting groundwater flowing along above the contacts of such aquitards. These springs drain perched water tables located on top of the aquitard layers. The perched aquifers holds water in the lava contact zones and fractured secondary aquifers (as described above). The above-described hydrogeological conceptual hydro-geological model was presented by Lawrence (1983) (reproduced in Figure 1). The tuff layers are, despite being described as laterally persistent over hundreds or even thousands of metres, likely to leak to lower layers. The lower layers therefore do store and transmit groundwater recharge originating from the entire overlying surface area and not only from limited area where that layer daylights. These lower layers are laterally more extensive and therefore will store a greater volume of water than the higher layers.

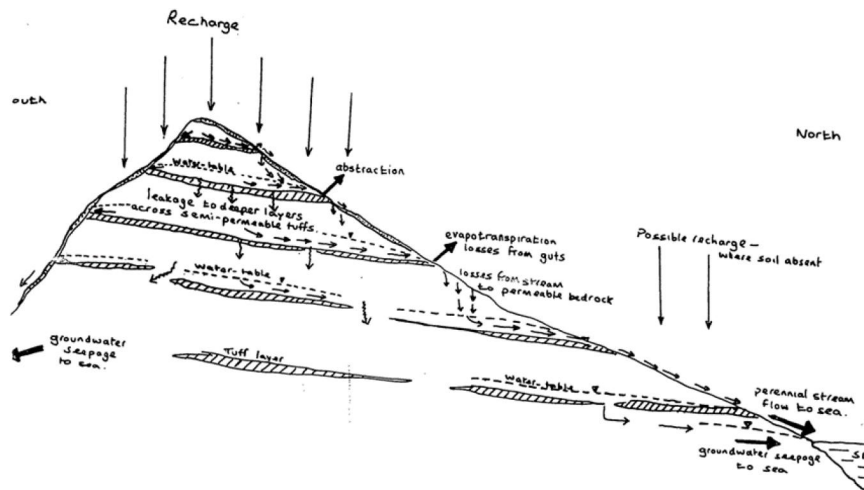
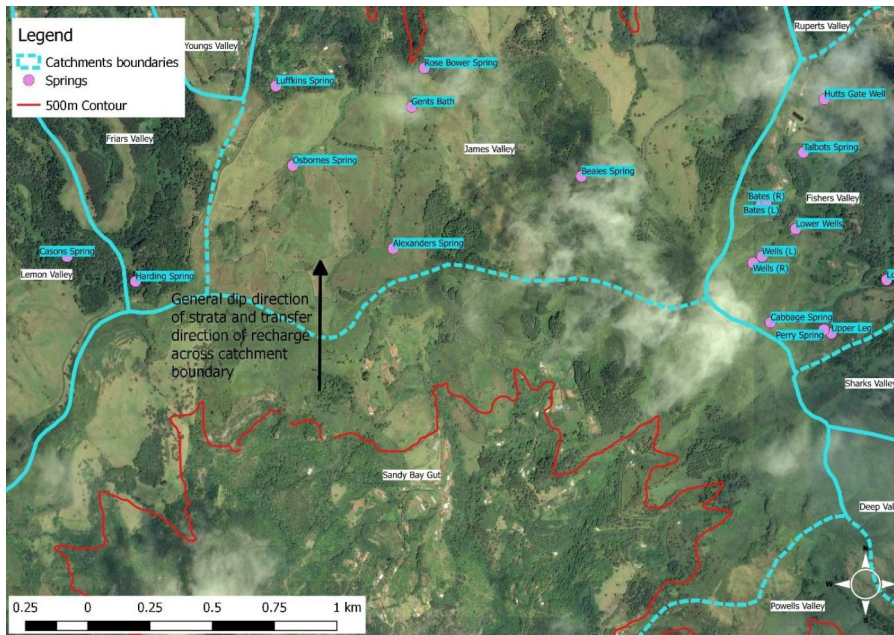


Figure 1. Conceptual hydro-geological section of a typical landform on St Helena Island (as presented by Lawrence, 1983).

The conceptual model presented in Figure 1 also explains why many springs are located on one side of a water divide but not on the opposite side. All groundwater flows in the direction the strata dips, therefore recharge on areas where the strata dips into the slope will be transferred to the adjacent catchment where the strata dips out of the slope (for example, recharge on the left of the divide in Figure 1 flows to the right of the divide along the dipping strata). On the island, this is best illustrated at the divide between the Sandy Bay Catchment and the James Valley Catchment (Figure 2). Here many springs occur on the northern side of the divide while springs are essentially absent on the southern side. The northward dipping strata in the area conducts groundwater that infiltrates on the southern side of the divide to the northern side where it daylights as springs.



**Figure 2.** An example of the distribution of springs relative to the catchment boundaries due to hydrogeological conditions, the example being at the southern end of the James Valley catchment, where it meets the Sandy Bay Gut Catchment.

The exploitation of deeper layers below those that produce high altitude springs will therefore allow access to water that currently does not contribute to the high altitude spring flow and is ultimately lost as baseflow to surface streams or the ocean at low altitude. The recharge is also likely to originate from adjacent catchments due to the dip of the strata.

Wells intercepting such deeper aquifer layers are likely to be artesian or close to artesian. In previous drilling reports it was reported that boreholes drilled, as part of the St Helena Airport development, in Fishers Valley, down to depths of 58-61m intercepted weak water strikes at shallow depths and stronger flow at depths of >40m. The rest levels in at least one of the holes was 1.2m below ground level despite the low-level water strikes.

These boreholes were located in the drainage channel and most likely intercepted both the superficial alluvial aquifer and a deeper fractured aquifers. The boreholes were however cased and sealed and as such the high water level was attributed to the hydrostatic head present in the lower aquifer layers. The surface geology at these borehole locations is part of the Upper Shield. It may be that the deep water strikes at depth are associated with the Upper Shield contact zone with the Main Shield. This can however not be verified with the available information and it may therefore be that the water bearing layers are associated with fractures or horizontal aquitard layers similar to those illustrated in Figure 1.

### 3.3

## SILLS AND DYKES

A report by Daly (1927) was the only literature found that contains significant notes on the presence of intrusive features on St Helena. In his report, the only sill like feature discussed is a layer of up to 12m thickness cutting across basaltic flows. The location of the sill is not disclosed. Dykes are

more common but, as would be expected, the number of the dykes is noted to decrease with elevation. The recognition of dykes during field investigations is described as being difficult due to the similarity of the intrusive material to the lava flows (both basaltic) and due to the steep terrain and a mantle of transported soils that cover the majority of the area. The dykes are also commonly thin (cm to dm width) and have therefore not affected the landscape formation. This is in contrast to previously discussed notes which described the dykes as causing obvious relief changes. Daly does however note that larger dykes do have a topographical effect. Most of the dykes form a NE-SW striking swarm that project above the surface. Pipe like rock outcrops such as Castel Rock and Lot's Wife are local enlargements of such dykes.

### 3.4 EXISTING WATER INFRASTRUCTURE

As described in the Toens & Partners report there are 15 water distribution systems on St Helena and these typically are not located in any one-catchment system. Three of these systems, Hutts Gate, Red Hill and Jamestown, supply approximately 81% of the inhabitants of the island with water. As seen in Figure 3 the water treatment works on the Island are all located in the central areas of the island.

The three main systems collect water from a combination of open-ended pipes and springs and store the water in tanks, reservoirs or small dams before treatment and distribution. The Hutts Gate system also receives some water from two boreholes in the so-called "Willowbank Well field". Other smaller systems are present, in the western parts of the island.

### 3.5 GROUNDWATER RECHARGE

Surface runoff on the island is minimal and most stream flow is obtained from interflow and springs. Groundwater recharge occurs primarily in the high lying areas, i.e. > 500 mamsl, where the majority of precipitation falls. Lower areas have low rainfall and high evaporation rates. Aquifers situated in the areas below an elevation of 500m are therefore not directly recharged from rainfall. Total recharge figures calculated by previous studies range from 1.5 to 3.6 x 10<sup>6</sup> m<sup>3</sup> per annum. The mean annual precipitation on St Helena Island is in the order of 47.0 x 10<sup>6</sup> m<sup>3</sup>.

When only recharge occurring above 500masl is considered the catchment areas with the largest volume of recharge are the James Valley (259 753 m<sup>3</sup>) and Lemon Valley (208 094 m<sup>3</sup>) with all other catchments receiving significantly less recharge per annum.

The annual volume of groundwater recharge to the James, Young's, Friars, Lemon, Swanley, Old Womans, Fishers, Sharks, Deep and Sandy Bay Valley catchments (the catchments that account for most of the area above 500masl is estimated at 1.00 - 1.55 x 10<sup>6</sup> m<sup>3</sup>. It is also estimated that 1.0x10<sup>6</sup> m<sup>3</sup> of the recharge is discharged into the ocean by the streams from these catchments as baseflow (Lawrence, 1983).

Based on these recharge estimates from previous studies and the fact hydrogeological model presented above the majority of water that may be harvested is likely to be found in the catchments listed above.

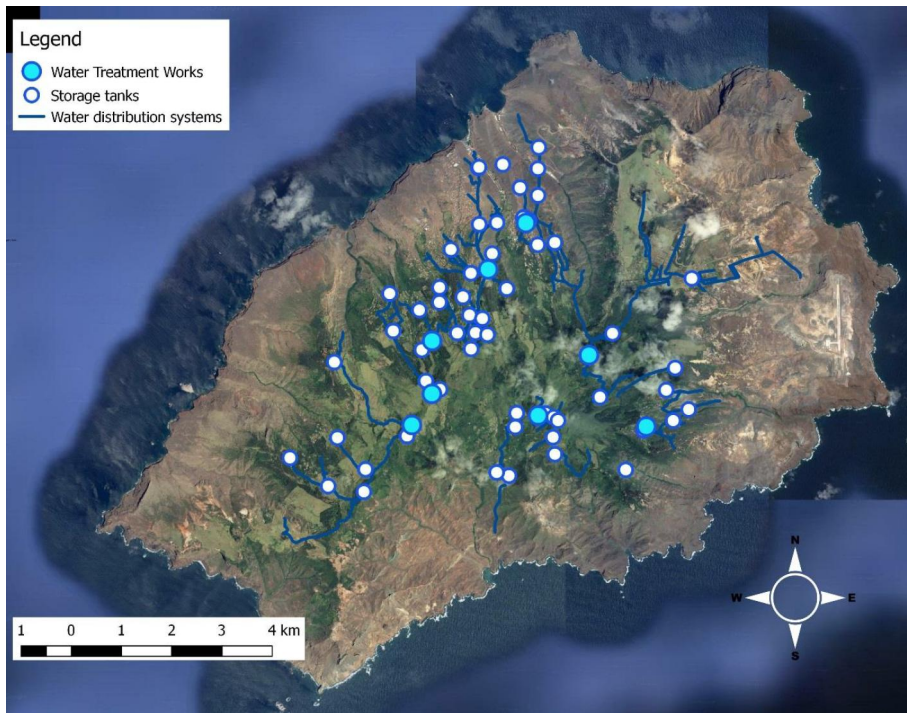


Figure 3. Distribution of water supply infrastructure for which the location has been captured.

### 3.6

#### WATER QUALITY

Rainfall salinity data indicates that higher salinities along the southeastern side of the island. A similar trend is observed when surface water electric conductivity (EC) is considered with values generally low (<70mS/m) in areas above 500mamsl or in areas in close proximity to the central region above that altitude (Figure 4). Higher EC surface waters are all located at lower altitudes but also seem to be associated with younger geological units. These observations are however based on the limited data and no data was obtained for surface waters in the southwestern and far western parts of the island.

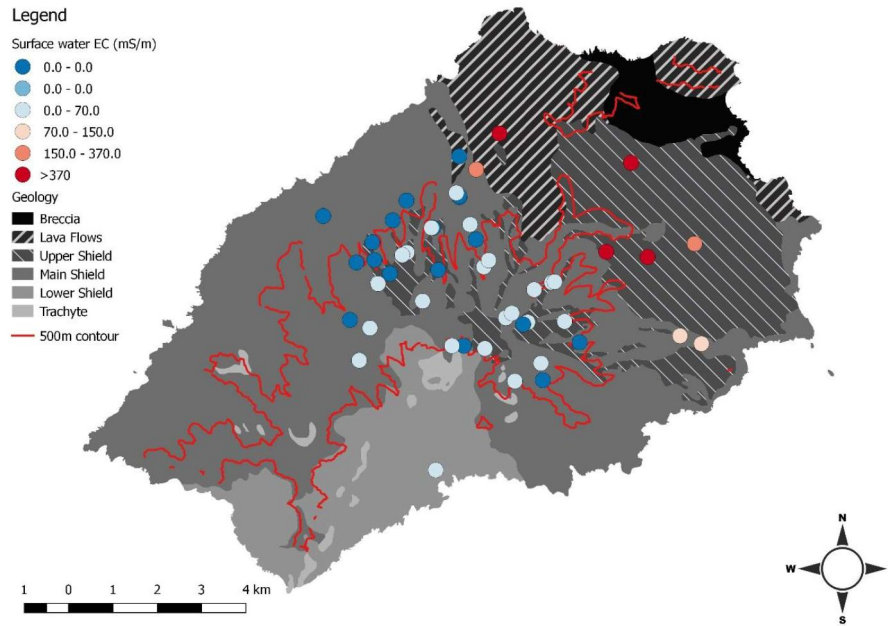


Figure 4. Surface water EC values.

Spring water EC values also seem to be low in the high altitude areas and when located close to the central high areas. EC data was found for only one spring located far from this central area and the water from that spring had an elevated, but not extreme, EC value.

Two deep boreholes wells, located in the Upper Shield layers in the eastern part of the Island where surface water EC values are high (>300 mS/m), have EC values of zero and  $\approx 100$  mS/m. It is not clear if the waters in these wells are located in the Upper Shield layer, in a deeper geological unit or on the contact between the Upper and Main Shield layers. The difference in EC values does point toward the possibility of suitable drinking water being present in deeper aquifers irrespective of the surface water quality. The low lying areas should therefore not automatically be disqualified from water exploration activities.

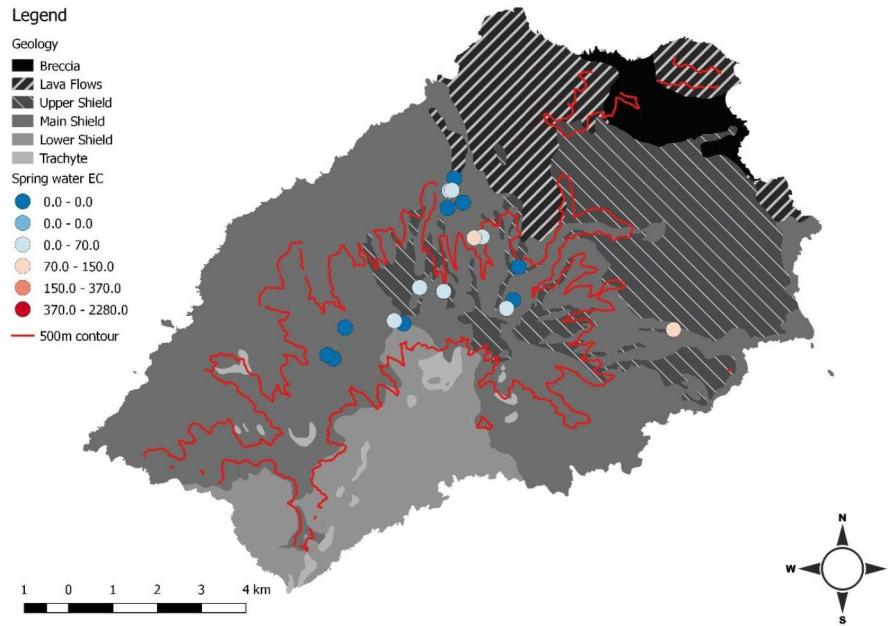


Figure 5. Spring water EC values.

## 4

### DISCUSSION ON PROPOSED TARGET AREAS

As the large majority of water users are located in the areas where current distributions systems are present and the predicted future demand being concentrated in these areas it follows that initial water supply boreholes should be established in these areas. If successfully established the boreholes can feed water directly into the existing distribution systems. Knowledge gained from boreholes being established in this area can then be used to establish sustainable boreholes in other parts of the island.

Unfortunately, the dykes which may act as subsurface barriers causing the accumulation of groundwater are mostly located in younger geological units that are located at great depths in the areas of recharge and where the majority of the water infrastructure is located. There may however be localized dykes in the main shield that have not been mapped. Surface expressions of these will have to be located during field mapping. If located, an assessment of the potential for a water borehole to be drilled on the one side of the dyke will be made. In the interim, however it should be assumed that dykes will not play a major role in the water exploration process.

Of the three main aquifer types on the Island, it is not proposed that the shallow alluvial aquifers in valleys be further developed. These are prone to flow changes and droughts and also easily disturbed by the development of aquifer catchment structures. Exploration should therefore focus on the deeper fractured aquifers and the contact zone aquifers that will act as high transmissivity zones between fractures. It is also proposed that deep wells be utilized to exploit the deeper layers that transmit water from more than one catchment area and from which water is currently lost through surface runoff at low altitudes. These aquifers are less prone to drought periods.

Based on the above interpretations it is proposed that target positions be identified within 1km of the existing water treatment plants or collection points. Initially a simple 1km buffer zone has been utilized to evaluate such areas but due to the steep terrain the area of consideration may be extended further uphill, where additional distance is not problematic due to gravity feed, and shortened in the downhill direction or to the top of hills. Once field mapping around target locations is performed the secondary targets may also be adjusted accordingly.

As seen in Figure 6 the geology within the 1km buffer zone of the major water Treatment Works (WTW) (in the higher density population areas) is dominated by the Main and Upper Shield of the SWVC. The elongated nature of the Upper Shield areas is due to these being located in erosional features formed in the Main Shield. The contacts between these two Shield units and the base of the Upper Shield are potential water bearing areas. Minor late stage lavas are present in the northern parts of the buffer zone and in the southern parts of the buffer, Lower Shield units are present.

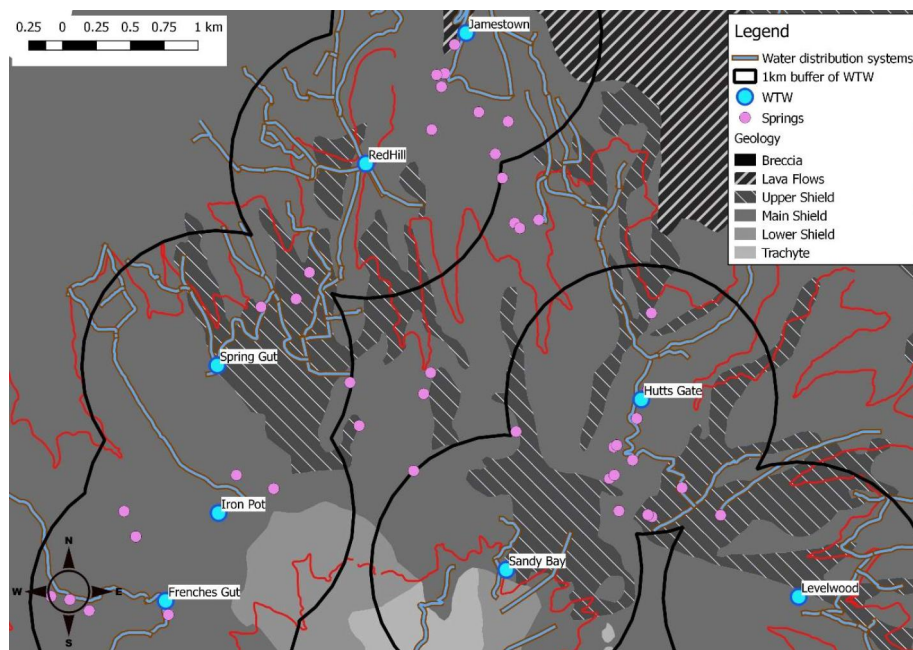


Figure 6. Regional geology map in area within 1km of the major water treatment works.

The geology map created by Daly (1927) (Figure 7) does not indicate the position of any dykes in the buffer area of interest except for 2 dykes in the far southern area close to Sheep Knoll. The only different feature indicated on this map is the presence of some parasitic cone pyroclastics in the area. These are however likely to be superficial features and not of any significance.

The vegetation cover in the area of interest varies significantly and includes areas of pastures, woodland, scrub and even barren areas in low-lying areas. Some developed areas exist, especially in the northern areas close to Jamestown. These areas are however not true urban areas and could still be suitable for the development of groundwater boreholes.

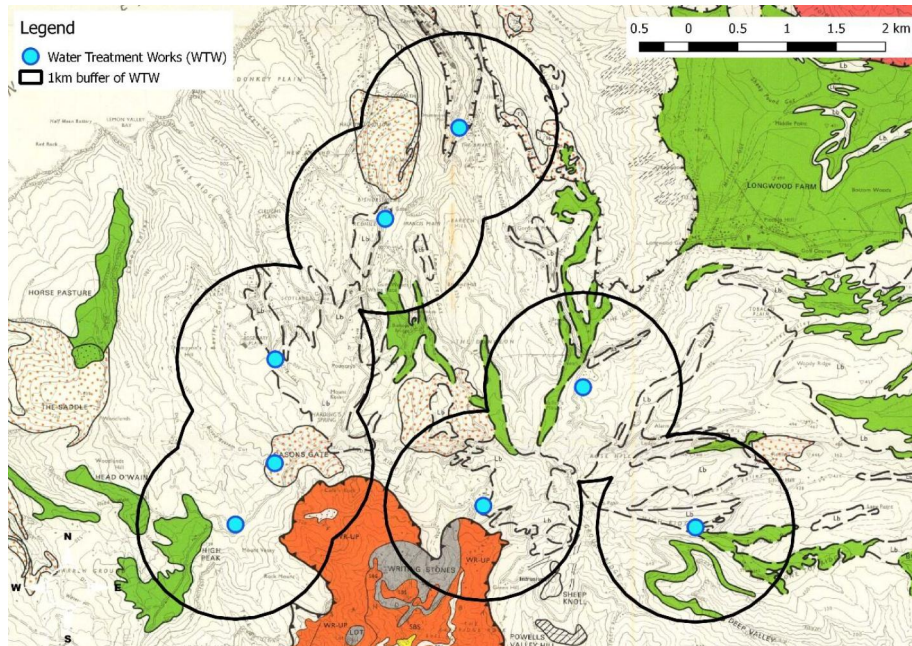


Figure 7. Daly (1927) geology map for the areas within 1km of WTW.

An area that meets the other exploration criteria, namely a lower elevation where a well can be established that will exploit deeper aquifer layers, is that area between the Red Hill and Jamestown water treatment works. In this area, it is very likely that deeper aquifers would be intercepted by a deep borehole. This area is however characterised by steep slopes and limited accessibility. It is therefore not ideal for exploration drilling or the establishment of production boreholes.

The valley to the southeast of Red Hill Water Treatment Works is a more feasible location that also meets the current exploration criteria. The stratigraphy in this valley dips approximately north and as seen in Figure 8 the area is characterised by numerous contacts between the Upper Shield and Main Shield Units. The area has well developed water distribution infrastructure associated with the surface reservoirs (Harpers and Scotts Mill Reservoirs) and is readily accessible by for drilling. The initial deep drilling should be performed in this area. The feasibility of the exploration target zones (i.e. deeper layers and the potentially water transmitting contact between the Upper Shield and Main Shield units).

Depending on the success of the drilling in this area, further target locations will be decided. These will also be informed by field mapping observations made by a hydro-geologist present on the Island during the exploration activities. Similar conditions are found in the Sharks Valley Catchment close to the Levelwood Works and Friars Valley within 1km of the Spring Gut Works.

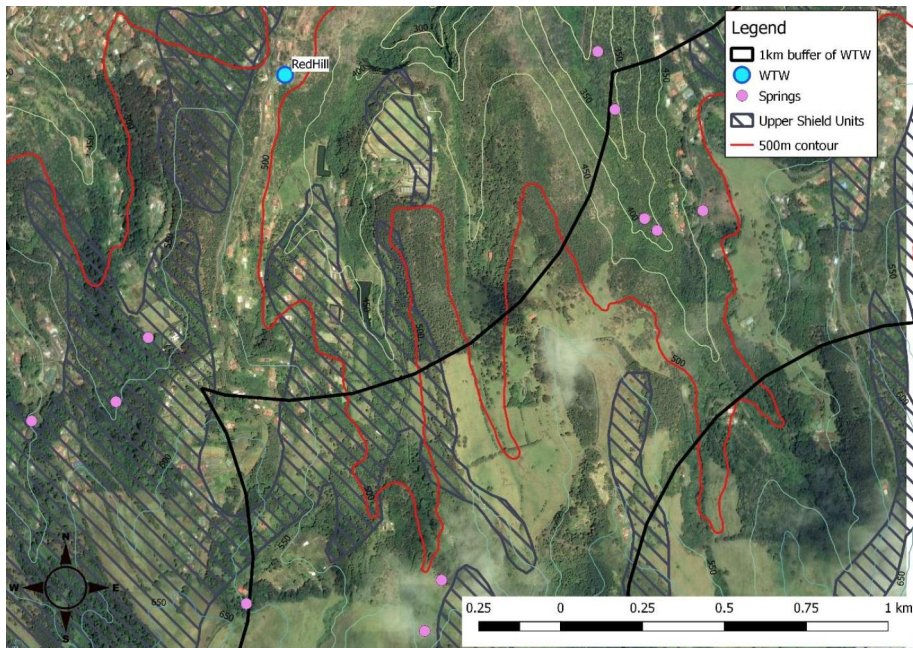


Figure 8. Proposed first exploration area southeast of Redhill WTW.

## 5

### PROPOSED METHODOLOGY

As the existing geological information is not sufficient to identify structural features within the area of interest it is proposed that the next phase of the groundwater borehole development should be conducted with field mapping of potential drilling areas followed directly by drilling of potential targets. Once mobilized to the island our hydrogeologist will visit the areas identified and determine if any features related to structural breaks in the geology or dykes are present and if these are likely to affect the feasibility of water borehole establishment. While drilling at the first target is initiated, further areas will be mapped and further targets identified.

The first area to be targeted by mapping is the area upstream of Heart Shape Waterfall in the Francis Plain Gut Valley and in the areas surrounding the Harpers Reservoirs. This valley is situated southeast of the Redhill WTW and contains many of the surface water storage reservoirs of the Redhill system. Upper Shield units (Figure 8) and the contact between these units and the underlying Main Shield will be the primary targets. During drilling detailed logging of arising will be performed to determine the layers being penetrated.

# 6

## CONCLUSIONS

The available information indicates that the majority of the rainfall falls at high altitude areas and therefore where most groundwater recharge occurs. The majority of springs do not seem to be barrier springs where large deep aquifers decant due to a barrier in the geological profile but rather shallow aquifer springs caused by the intersection of perched water tables (on thin aquicludes of tuff) with the natural slope. The water in these springs is therefore relatively young and the aquifers that feed them are superficial resources that fluctuate depending on the annual recharge received.

Previous drilling close to the St Helena Airport has proven that deep wells in the Upper Shield and Main Shield Layers can produce sustainable large quantities of good quality water. The location of such units in a valley close to the Redhill WTW and the excellent accessibility of the area makes these an ideal first target for the exploration of deep, water boreholes. Once this area has been mapped, drilling of potential targets can commence. If successful, the methodology can be applied again in areas close to the Spring Gut, Sandy Bay, Levelwood and Hutts Gate Water systems where similar geological conditions have been mapped.

# APPENDIX

## **B** BOREHOLE LOGS





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 Fax: + 27 11 361 1381

# ROTARY DRILLHOLE LOG

Hole No.  
**CGTBH01**

Project  
**Saint Helena Island Deep Aquifer Feasibility Study**

Sheet  
**1 of 1**

Job No  
**48325**

Client  
**Connect Saint Helena Ltd**

Date  
**20-04-17  
 20-04-17**

Contractor / Driller

Method/Plant Used

Logged By

G. Lottreaux

Co-Ordinates (NGR)

E -15.966  
 N -5.722

Ground Level (m AOD)

RUN DETAILS				STRATA								Install / Backfill
Depth	Total CR	Solid CR	RQD	(SPT 'N') Fracture Spacing (mm)	Rock Test Result (MPa) Water Depth	Elev. (mAOD)	Depth (Thickness)	Main Description	Discontinuities	Legend	Geology	Dia. mm
							2.00	Reddish/brown SOIL.			NODATA	
							19.00	Reddish/brown CLAY.			NODATA	
							21.00					
							15.00	Blue/brown, highly weathered BASALT.			NODATA	
							36.00					
							12.00	Blue/grey, fresh, moderately weathered BASALT.			NODATA	
							48.00					
							21.00	Blue/grey, fresh BASALT.			NODATA	
							69.00	End of Exploratory Hole.			NODATA	



08 WSP DRILLHOLE/ROTARY LOG 48325 ST HELENA\_LOGS\_TM.GPJ WSPTEMPLATE6.01.GDT 24/5/17

Boring Progress						Rotary Flush					
Date	Time	Depth	Casing Dpt	Core Dia. (mm)	Water Strike	From	To	Type	Return	Depth Casing	Casing Dia
Chiselling				Water Added		General Remarks					
From	To	Hours	Tool	From	To						
Scale 1:843.75		Notes: All dimensions in metres. Logs should be read in accordance with the provided Key. Descriptions are based on visual and manual identification.									



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# ROTARY DRILLHOLE LOG

Hole No.  
**HPSBH01**

Project  
 Saint Helena Island Deep Aquifer Feasibility Study

Sheet  
 1 of 1

Job No  
 48325

Client  
 Connect Saint Helena Ltd

Date  
 23-03-17  
 24-03-17

Contractor / Driller

Method/Plant Used

Logged By

G. Lottreaux

Co-Ordinates (NGR)

E -15.954  
 N -5.716

Ground Level (m AOD)

RUN DETAILS				STRATA								Install / Backfill
Depth	Total CR	Solid CR	RQD	(SPT 'N') Fracture Spacing (mm)	Rock Test Result (MPa) Water Depth	Elev. (mAOD)	Depth (Thickness)	Main Description	Discontinuities	Legend	Geology	Dia. mm
							2.00	TOPSOIL: Reddish-brown gravelly SAND.			NODATA	
							15.00	Brown CLAY.			NODATA	
							17.00					
							12.00	Blue-grey moderately weathered BASALT.			NODATA	
							29.00					
							35.00	Blue-brown highly weathered BASALT.			NODATA	
							47.00	Blue-grey moderately weathered BASALT.			NODATA	
							53.00	Blue-grey BASALT.			NODATA	
							100.00	End of Exploratory Hole.			END	



08 WSP DRILLHOLE/ROTARY LOG 48325 ST HELENA\_LOGS\_TM.GPJ WSPTEMPLATE6.01.GDT 24/5/17

Boring Progress						Rotary Flush					
Date	Time	Depth	Casing Dpt	Core Dia. (mm)	Water Strike	From	To	Type	Return	Depth Casing	Casing Dia
Chiselling				Water Added		General Remarks					
From	To	Hours	Tool	From	To						
Scale 1:843.75		Notes: All dimensions in metres. Logs should be read in accordance with the provided Key. Descriptions are based on visual and manual identification.									



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# ROTARY DRILLHOLE LOG

Hole No.  
**HPSBH02**

Project  
 Saint Helena Island Deep Aquifer Feasibility Study

Sheet  
 1 of 1

Job No  
 48325

Client  
 Connect Saint Helena Ltd

Date  
 25-03-17  
 27-03-17

Contractor / Driller

Method/Plant Used

Logged By

G. Lottreaux

Co-Ordinates (NGR)

E -15.953  
 N -5.717

Ground Level (m AOD)

RUN DETAILS				STRATA								Install / Backfill
Depth	Total CR	Solid CR	RQD	(SPT 'N') Fracture Spacing (mm)	Rock Test Result (MPa) Water Depth	Elev. (mAOD)	Depth (Thickness)	Main Description	Discontinuities	Legend	Geology	Dia. mm
							1.00	TOPSOIL: Reddish-brown SAND.			NODATA	
							4.00	Reddish-brown CLAY.			NODATA	
					1		8.00	Blue-grey highly weathered BASALT.			NODATA	
							12.00	Blue-grey moderately weathered BASALT.			NODATA	
							(24.00)	Blue-grey fresh BASALT.			NODATA	
					2		36.00					
							(8.00)	Blue-grey moderately weathered BASALT.			NODATA	
							44.00					
							(36.00)	Blue-grey fresh BASALT.			NODATA	
							80.00					
					3		85.00	Blue-brown highly weathered BASALT.			NODATA	
							(15.00)	Blue-grey fresh BASALT.			NODATA	
							100.00	End of Exploratory Hole.			END	

08 WSP DRILLHOLE/ROTARY LOG 48523 ST HELENA\_LOGS\_TM.GPJ WSPTEMPLATE6.01.GDT 24/5/17

Boring Progress						Rotary Flush					
Date	Time	Depth	Casing Dpt	Core Dia. (mm)	Water Strike	From	To	Type	Return	Depth Casing	Casing Dia
Chiselling				Water Added		General Remarks					
From	To	Hours	Tool	From	To						
Scale 1:843.75		Notes: All dimensions in metres. Logs should be read in accordance with the provided Key. Descriptions are based on visual and manual identification.									



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# ROTARY DRILLHOLE LOG

Hole No.  
**KFDBH01**

Project  
**Saint Helena Island Deep Aquifer Feasibility Study**

Sheet  
**1 of 1**

Job No  
**48325**

Client  
**Connect Saint Helena Ltd**

Date  
**11-04-17  
 12-04-17**

Contractor / Driller

Method/Plant Used

Logged By

G. Lottreaux

Co-Ordinates (NGR)

E -15.957  
 N -5.724

Ground Level (m AOD)

RUN DETAILS				STRATA								Install / Backfill
Depth	Total CR	Solid CR	RQD	(SPT 'N') Fracture Spacing (mm)	Rock Test Result (MPa) Water Depth	Elev. (mAOD)	Depth (Thickness)	Main Description	Discontinuities	Legend	Geology	Dia. mm
							2.00	Reddish brown SOIL.			NODATA	
							(25.00)	Reddish brown CLAY.			NODATA	
							27.00					
							33.00	Blue/brown, highly weathered, BASALT.			NODATA	
							36.00	Blue/grey, moderately weathered BASALT.			NODATA	
							(21.00)	Blue/grey, fresh BASALT.			NODATA	
							57.00					
							58.00	Blue/grey, moderately weathered BASALT.			NODATA	
							60.00	Blue/grey, fresh BASALT.			NODATA	
							64.00	Blue/brown, highly weathered BASALT.			NODATA	
							(38.00)	Blue/grey, fresh BASALT.			NODATA	
							102.00	End of Exploratory Hole.			NODATA	

08 WSP DRILLHOLE/ROTARY LOG 48325 ST HELENA\_LOGS\_TM.GPJ WSPTEMPLATE6.01.GDT 24/5/17

Boring Progress						Rotary Flush					
Date	Time	Depth	Casing Dpt	Core Dia. (mm)	Water Strike	From	To	Type	Return	Depth Casing	Casing Dia
Chiselling				Water Added		General Remarks					
From	To	Hours	Tool	From	To						
Scale 1:843.75		Notes: All dimensions in metres. Logs should be read in accordance with the provided Key. Descriptions are based on visual and manual identification.									



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# ROTARY DRILLHOLE LOG

Hole No.  
**MGTBH01**

Project  
 Saint Helena Island Deep Aquifer Feasibility Study

Sheet  
 1 of 1

Job No  
 48325

Client  
 Connect Saint Helena Ltd

Date  
 08-04-17  
 09-04-17

Contractor / Driller

Method/Plant Used

Logged By

G. Lottreaux

Co-Ordinates (NGR)

E -15.963  
 N -5.732

Ground Level (m AOD)

RUN DETAILS				STRATA								Install / Backfill
Depth	Total CR	Solid CR	RQD	(SPT 'N') Fracture Spacing (mm)	Rock Test Result (MPa) Water Depth	Elev. (mAOD)	Depth (Thickness)	Main Description	Discontinuities	Legend	Geology	Dia. mm
							2.00	TOPSOIL: Reddish brown SAND.			NODATA	
							10.00	Reddish brown CLAY.			NODATA	
							12.00					
							18.00	Blue brown highly weathered BASALT.			NODATA	
							30.00					
							15.00	Blue grey fresh BASALT.			NODATA	
							45.00					
							25.00	Blue grey fresh BASALT.			NODATA	
							70.00					
							74.00	Blue brown highly weathered BASALT.			NODATA	
								End of Exploratory Hole.			END	

**Boring Progress**

**Rotary Flush**

Date	Time	Depth	Casing Dpt	Core Dia. (mm)	Water Strike	From	To	Type	Return	Depth Casing	Casing Dia
Chiselling				Water Added							
From	To	Hours	Tool	From	To	<b>General Remarks</b> No sample recovery after 74 meters. Hole began to collapse at this depth. Decision taken not to attempt to drill deeper.					

Scale 1:843.75

Notes: All dimensions in metres. Logs should be read in accordance with the provided Key. Descriptions are based on visual and manual identification.

08 WSP DRILLHOLE/ROTARY LOG 48325 ST HELENA\_LOGS\_TM.GPJ WSPTEMPLATE6.01.GDT 24/5/17



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# ROTARY DRILLHOLE LOG

Hole No.  
**PTNBH01**

Project  
 Saint Helena Island Deep Aquifer Feasibility Study

Sheet  
 1 of 1

Job No  
 48325

Client  
 Connect Saint Helena Ltd

Date  
 13-04-17  
 15-04-17

Contractor / Driller

Method/Plant Used

Logged By

G. Lottreaux

Co-Ordinates (NGR)

E -15.956  
 N -5.721

Ground Level (m AOD)

RUN DETAILS				STRATA								Install / Backfill
Depth	Total CR	Solid CR	RQD	(SPT 'N') Fracture Spacing (mm)	Rock Test Result (MPa) Water Depth	Elev. (mAOD)	Depth (Thickness)	Main Description	Discontinuities	Legend	Geology	Dia. mm
							18.00	No sample, ODEX drilling.			NODATA	
							24.00	Grey/brown CLAY.			NODATA	
							45.00	Blue/grey, fresh BASALT.			NODATA	
							69.00					
							72.00	Red/brown, highly weathered BASALT.			NODATA	
							77.00	Blue/grey, fresh BASALT.			NODATA	
							79.00					
							86.00	Blue/grey, moderately weathered BASALT.			NODATA	
							99.00	Blue/grey, fresh BASALT.			NODATA	
							120.00	Red/brown, highly weathered BASALT.			NODATA	
							119.00					
							133.00	Blue/grey, fresh BASALT.			NODATA	
							132.00	End of Exploratory Hole.			NODATA	

08 WSP DRILLHOLE/ROTARY LOG 48325 ST HELENA\_LOGS\_TM.GPJ WSPTEMPLATE6.01.GDT 24/5/17

Boring Progress						Rotary Flush					
Date	Time	Depth	Casing Dpt	Core Dia. (mm)	Water Strike	From	To	Type	Return	Depth Casing	Casing Dia
Chiselling				Water Added		General Remarks					
From	To	Hours	Tool	From	To						
Scale 1:843.75		Notes: All dimensions in metres. Logs should be read in accordance with the provided Key. Descriptions are based on visual and manual identification.									



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# ROTARY DRILLHOLE LOG

Hole No.  
**PTNBH02**

Project  
 Saint Helena Island Deep Aquifer Feasibility Study

Sheet  
 1 of 1

Job No  
 48325

Client  
 Connect Saint Helena Ltd

Date  
 16-04-17  
 16-04-17

Contractor / Driller

Method/Plant Used

Logged By

G. Lottreaux

Co-Ordinates (NGR)

E -15.955  
 N -5.720

Ground Level (m AOD)

RUN DETAILS				STRATA								Install / Backfill
Depth	Total CR	Solid CR	RQD	(SPT 'N') Fracture Spacing (mm)	Rock Test Result (MPa) Water Depth	Elev. (mAOD)	Depth (Thick-ness)	Main Description	Discontinuities	Legend	Geology	Dia. mm
							1.00	Grey SOIL.			NODATA	
							11.00	Grey CLAY.			NODATA	
							12.00					
							27.00	Blue/grey, moderately weathered BASALT.			NODATA	
							39.00					
							45.00	Blue/brown, highly weathered BASALT.			NODATA	
							55.00	Blue/grey, fresh BASALT.			NODATA	
							100.00	End of Exploratory Hole.			NODATA	

08 WSP DRILLHOLE/ROTARY LOG 48325 ST HELENA\_LOGS\_TM.GPJ WSPTEMPLATE6.01.GDT 24/5/17

Boring Progress						Rotary Flush					
Date	Time	Depth	Casing Dpt	Core Dia. (mm)	Water Strike	From	To	Type	Return	Depth Casing	Casing Dia
Chiselling				Water Added		General Remarks					
From	To	Hours	Tool	From	To						
Scale 1:843.75		Notes: All dimensions in metres. Logs should be read in accordance with the provided Key. Descriptions are based on visual and manual identification.									



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# ROTARY DRILLHOLE LOG

Hole No.  
**PVYBH01**

Project  
**Saint Helena Island Deep Aquifer Feasibility Study**

Sheet  
**1 of 1**

Job No  
**48325**

Client  
**Connect Saint Helena Ltd**

Date  
**29-03-17  
 30-03-17**

Contractor / Driller

Method/Plant Used

Logged By

G. Lottreaux

Co-Ordinates (NGR)

E -15.975  
 N -5.685

Ground Level (m AOD)

RUN DETAILS				STRATA								Install / Backfill
Depth	Total CR	Solid CR	RQD	(SPT 'N') Fracture Spacing (mm)	Rock Test Result (MPa) Water Depth	Elev. (mAOD)	Depth (Thickness)	Main Description	Discontinuities	Legend	Geology	Dia. mm
							1.00	TOPSOIL: Reddish brown SAND.			NODATA	
							3.00	Reddish brown CLAY.			NODATA	
							7.00	Blue brown highly weathered BASALT.			NODATA	
							9.00	Blue grey moderately weathered BASALT.			NODATA	
							14.00	Blue grey fresh BASALT.			NODATA	
							12.00	Blue brown highly weathered BASALT.			NODATA	
							26.00					
							32.00	Blue grey moderately weathered BASALT.			NODATA	
							45.00	Blue grey fresh BASALT.			NODATA	
							77.00					
							17.00	Blue grey moderately weathered BASALT.			NODATA	
							94.00					
							100.00	Blue grey moderately weathered BASALT.			NODATA	
								End of Exploratory Hole.			END	

08 WSP DRILLHOLE/ROTARY LOG 48325 ST HELENA\_LOGS\_TM.GPJ WSPTEMPLATE6.01.GDT 24/5/17

Boring Progress						Rotary Flush					
Date	Time	Depth	Casing Dpt	Core Dia. (mm)	Water Strike	From	To	Type	Return	Depth Casing	Casing Dia
Chiselling				Water Added		General Remarks					
From	To	Hours	Tool	From	To						
Scale 1:843.75		Notes: All dimensions in metres. Logs should be read in accordance with the provided Key. Descriptions are based on visual and manual identification.									



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# ROTARY DRILLHOLE LOG

Hole No.  
**RPNBH01**

Project  
 Saint Helena Island Deep Aquifer Feasibility Study

Sheet  
 1 of 1

Job No  
 48325

Client  
 Connect Saint Helena Ltd

Date  
 10-04-17  
 11-04-17

Contractor / Driller

Method/Plant Used

Logged By

G. Lottreaux

Co-Ordinates (NGR)

E -15.957  
 N -5.729

Ground Level (m AOD)

RUN DETAILS				STRATA								Install / Backfill
Depth	Total CR	Solid CR	RQD	(SPT 'N') Fracture Spacing (mm)	Rock Test Result (MPa) Water Depth	Elev. (mAOD)	Depth (Thickness)	Main Description	Discontinuities	Legend	Geology	Dia. mm
							2.00	Reddish brown SOIL.			NODATA	
							10.00	Reddish brown CLAY.			NODATA	
							12.00					
							18.00	Brown, highly weathered BASALT.			NODATA	
							30.00					
							36.00	Blue/grey, moderately weathered BASALT.			NODATA	
							49.00	Blue/grey, fresh BASALT.			NODATA	
							45.00					
							48.00	Blue/grey, moderately weathered BASALT.			NODATA	
							54.00	Blue/grey, fresh BASALT.			NODATA	
							59.00	Blue/brown, highly weathered BASALT.			NODATA	
							64.00	Blue/grey, moderately weathered BASALT.			NODATA	
							73.00	Blue/grey, fresh BASALT.			NODATA	
							87.00					
							90.00	Blue/grey, moderately weathered BASALT.			NODATA	
							12.00	Blue/grey, fresh BASALT.			NODATA	
							102.00				NODATA	

08 WSP DRILLHOLE/ROTARY LOG 48523 ST HELENA\_LOGS\_TM.GPJ WSPTEMPLATE6.01.GDT 24/5/17

Boring Progress						Rotary Flush					
Date	Time	Depth	Casing Dpt	Core Dia. (mm)	Water Strike	From	To	Type	Return	Depth Casing	Casing Dia
Chiselling				Water Added		General Remarks					
From	To	Hours	Tool	From	To						
Scale 1:843.75		Notes: All dimensions in metres. Logs should be read in accordance with the provided Key. Descriptions are based on visual and manual identification.									



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# ROTARY DRILLHOLE LOG

Hole No.  
**SVYBH01**

Project  
**Saint Helena Island Deep Aquifer Feasibility Study**

Sheet  
**1 of 1**

Job No  
**48325**

Client  
**Connect Saint Helena Ltd**

Date  
**28-03-17  
 29-03-17**

Contractor / Driller

Method/Plant Used

Logged By

G. Lottreaux

Co-Ordinates (NGR)

E -15.970  
 N -5.688

Ground Level (m AOD)

RUN DETAILS				STRATA								Install / Backfill
Depth	Total CR	Solid CR	RQD	(SPT 'N') Fracture Spacing (mm)	Rock Test Result (MPa) Water Depth	Elev. (mAOD)	Depth (Thickness)	Main Description	Discontinuities	Legend	Geology	Dia. mm
							1.00	TOPSOIL: Reddish brown SAND.			NODATA	
							7.00	Reddish brown CLAY.			NODATA	
							8.00					
							11.00	Blue grey moderately weathered BASALT.			NODATA	
							15.00	Blue brown highly weathered BASALT.			NODATA	
							26.00					
							29.00	Blue grey moderately weathered BASALT.			NODATA	
							31.00	Blue grey fresh BASALT.			NODATA	
							60.00					
							66.00	Blue brown highly weathered BASALT.			NODATA	
							72.00	Blue brown highly weathered BASALT.			NODATA	
							78.00					
							82.00	Blue grey moderately weathered BASALT.			NODATA	
							100.00	End of Exploratory Hole.			END	

08 WSP DRILLHOLE/ROTARY LOG 48325 ST HELENA\_LOGS\_TM.GPJ WSPTEMPLATE6.01.GDT 24/5/17

Boring Progress						Rotary Flush					
Date	Time	Depth	Casing Dpt	Core Dia. (mm)	Water Strike	From	To	Type	Return	Depth Casing	Casing Dia
Chiselling				Water Added		General Remarks					
From	To	Hours	Tool	From	To						

Scale 1:843.75

Notes: All dimensions in metres. Logs should be read in accordance with the provided Key. Descriptions are based on visual and manual identification.