STOMPNEUS BAY IRDP

STORMWATER MANAGEMENT PLAN

FINAL

P09414

MAY 2024

COMPILED FOR:	COMPILED BY:
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CONTENTS

ANNEXURES

1 INTRODUCTION AND LOCALITY

iX Engineers was appointed to investigate and report on the stormwater management of the proposed development of portion 4 of farm 6 in Stompneus Bay. This report addresses the stormwater attenuation and management for the development.

The site is located along the west coast, between Britannia Bay and St Helena Bay with GPS Coordinates 32°43'43.7" and 17°58'27.1", refer to **Annexure A** - Locality Plan.

The size of the portion of farm is 614.9ha and the area to be developed is 5.92ha. The site is currently vacant and bound by the existing Stompneus Village to the north-east, vacant land to the south and west and with Minor Road 7664 on the northern boundary.

The proposed development will consist of 214 residential erven with sizes varying between 150m^2 and 227m^2. The development will also include public open spaces, a creche and a church.

The full extent of the proposed development shown in **Annexure B** – Proposed Site Development Plan.

2 SCOPE OF THE SWMP

This report details the approach and methodology used to compile the stormwater management plan and provides design peak flow rates, as well as conceptual design details of the conveyances required to effectively manage stormwater runoff generated on the proposed development site and surrounding catchment area.

The stormwater management plan was executed through the following stages:

- Data collection;
- Catchment delineation and determination of catchment parameters;
- Obtain rainfall and evaporation data;
- Hydrological calculations;
- Stormwater management analysis and planning;
- Preliminary layout planning and conceptual design of the major stormwater drainage system including flood escape routes;
- Reporting.

3 DATA AND INFORMATION

The following information was available and collected for this study:

- 1 in 50 000 Topographical Maps and 20m contours (Department of Land Affairs, Chief Directorate of Survey and Mapping): 3217DB & DD Vredenburg from the National Geospatial Information site http://www.cdngiportal.co.za/cdngiportal/;
- Topographical site survey used for design from CK Rumboll & Partners;
- Google Earth Imagery (2024);
- Photos from site visit – 18 April 2024;
- Rainfall Data from South Africa Weather Bureau – Rainfall Station 0060864W Vredenburg;
- Rainfall and Evaporation data from Department of Water and Sanitation Website;
- "The Neighbourhood Planning and Design Guide Part 2 – Planning and Design Guidelines", developed by the Department of Human Settlements, dated July 2019 (Revised Red Book);
- As-built information supplied by Element Engineers, BKS Engineering and Management and iX Engineers;
- Construction drawings of Upgrading of the Main Road 00533 between KM22 and KM23 from Ero Engineers;
- Geotechnical Investigation by Gondwana Geo Solutions.

4 SITE TOPOGRAPHY AND GEOTECHNICAL CONDITIONS

4.1 TOPOGRAPHY

The extent of the proposed development on Portion 4 of Farm 6 is approximately 5.92ha in total. A topographical survey was conducted by CK Rumboll & Partners and 0.5m contours were provided.

Refer to **Annexure C** – Site Survey and Existing Stormwater Infrastructure. The proposed site to be developed is reasonably flat with a natural slope of 1.5% from the south to the north.

The site currently has no building or structures on it and the vegetation consist mainly of grasslands.

Figure 1: Proposed site viewed in a southern direction from Minor Road 7664

Bulk earthworks will allow the site to be free-draining and eliminate localized low points. The earthworks will generally consist of shaping of the existing terrain to slope constantly towards Minor Road 7664 along the northern boundary where the natural low point is.

4.2 GEOTECHNICAL CONDITIONS

A geotechnical investigation was undertaken by Gondwana Geo Solutions in February 2024, and the in-situ material was found to be favourable for the proposed development. The site is underlain by a mantle of dune sands and calcareous sands overlying pedogenic calcrete and/or dorbank cemented horizons, known as “brackish calcareous soil”.

No groundwater seepage was encountered in any of the trail pits which depth ranged between 2.1m and 3. 0m deep. However, perched groundwater flows could be expected between the soil and calcrete interfaces during rainy months. Subsoil drains are proposed for all roads, parking areas and paved areas to protect the structural layers from water ingress during heavy rainfall periods.

Since the permeability rate was not evaluated during the geotechnical investigation laboratory testing, the soil classification according to the SCS Soil Groups were used to determine the permeability of the material on site. According to the Distribution of SCS Soil Groups(Schulzer, 2010), the Stompneus Bay area falls within the Soil Group B region and the material can be classified as soil with a moderate infiltration rate.

A moderate infiltration rate typically varies between 20mm/hour and 63mm/hour. Sand typically has a permeability rate of 180mm/hour and calcrete typically infiltrates at 12mm/h.

See attached geotechnical report in **Annexure D** – Geotechnical Report.

5 EXISTING STORMWATER SYSTEM

There is currently no formal stormwater infrastructure on the proposed development area. The existing Stompneus Bay residential area adjacent to the proposed development area do have stormwater infrastructure which drains in a northern direction and discharges into an existing attenuation facility situated at the intersection of Main Road 00533 and the Minor Road 7664.

Refer to **Annexure C** – Site Survey and Existing Stormwater Infrastructure.

The existing infrastructure consists mainly of kerb inlets, manholes and Ø375mm and Ø450mm stormwater pipes. The attenuation facility of the existing residential area currently has two inlet pipes and no outlet pipe. It is assumed that the pond empties by a combination of infiltration and evaporation.

The footprint of the attenuation facility is ±300m^2 and 1.35m deep and fenced off. The current capacity of the facility is calculated as 405m^3. Refer to figure 2 below for a photo of the facility.

Figure 2: Existing attenuation facility at the intersection of Minor Road 7664 and Main Road 00533

The Main Road 00533 adjacent to the existing Stompneus Bay residential area is currently undergoing construction upgrades. Construction drawings were obtained from ERO Engineers who is the consulting engineers responsible for the design of the upgrading to Main Road 00533.

According to the construction details, the section of road adjacent to the existing Stompneus Bay residential area will have an unlined side drain on the side of the road, adjacent to the existing attenuation facility. A Ø600mm pipe culvert is proposed to cross Minor Road 7664 to drain the road runoff from the side drain in a northern direction towards the ocean. The figure below shows the current state of the Main Road 00533 construction works.

Figure 3: Main Road 00533 adjacent to the existing attenuation facility

6 CATCHMENT DELINEATION

The proposed site forms part of a larger catchment area draining from a high point towards the coastline in a south to north direction. The larger catchment area is 123.7ha in size and have an average slope of 5.3% towards the coastline.

The figure below shows the extent of the catchment area.

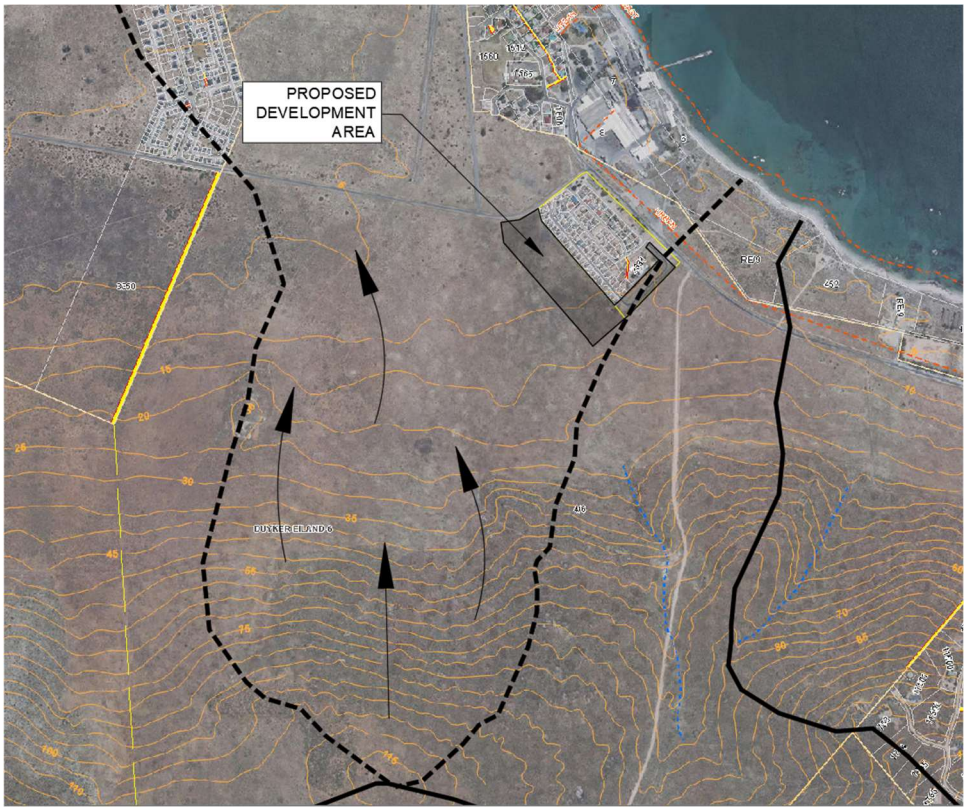

Figure 4: Catchment Area draining towards proposed Stompneus Bay development

The pre-developed stormwater runoff generated within the boundaries of the proposed development currently flows overland towards Minor Road 7664.

It is proposed that an earth berm/cut-off channel be constructed behind the erven along the south-west boundary of the proposed development. This is to prevent runoff from the larger catchment area to enter the development properties, but rather be channelled towards the Minor Road 7664 as it naturally flows.

Due to the limited existing stormwater infrastructure in the area, it was decided to also investigate the existing attenuation facility in the Stompneus Bay residential area.

Therefore, two catchment areas were evaluated, one being the proposed development area(Catchment A) and the other being the existing residential area(Catchment B).

The figure below shows the catchment delineation of the two areas below.

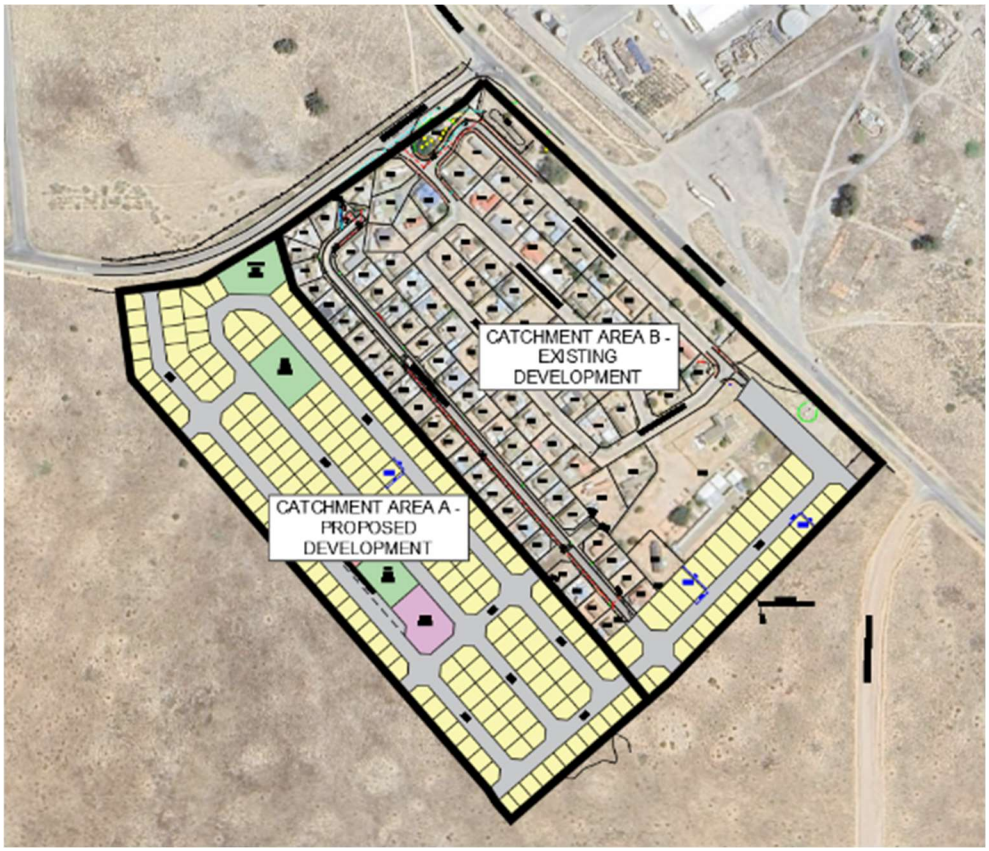

Figure 5: Catchment Areas

7 STORMWATER MANAGEMENT

The “Neighbourhood Planning and Design Guide”, also referred to as the revised Red Book, states that the minor stormwater system for a residential development should be designed to accommodate the 1:5 year stormwater peak flows.

Therefore, the minor drainage system for the proposed Stompneus Bay development will be designed to accommodate the 1:5 year storm runoff generated on site and discharge into the proposed attenuation facility. The minor drainage system will consist of kerb inlets, grid inlets and stormwater pipes conveying the stormwater runoff to proposed attenuation facility.

The following items were considered in the preliminary design stage:

- Bulk earthworks to eliminate any low laying trapped low points in the development;
- Minor stormwater system with sufficient capacity for up to the 1:5 year storm;
- Using the roads to convey the overland runoff from storms larger than 1:5 year return period and up to the 1:50 year return period;
- Attenuation facility to reduce the post-developed flows to pre-developed flows;
- Overland escape routes for the 1:100 year storm.

A stormwater attenuation facility is proposed for the development area to reduce the post-developed peak flows to the pre-developed peak flows for the site. This will ensure that the existing stormwater infrastructure still have sufficient capacity, as the runoff being discharged will not exceed the runoff that was discharged prior to the construction of the new development.

It is proposed that the outflow and emergency overflow from the new attenuation facility be discharged into the downstream existing attenuation facility as this is the natural lowest point and the current pre-developed runoff is also discharged into this pond.

In order to further reduce the volume of runoff being discharged to the existing attenuation facility, it was decided to size the proposed attenuation facility for the 1:100 year storm event and to limit the outflow towards the existing attenuation facility to the 1:2 year pre-developed flows.

The proposed attenuation facility should also be designed with an emergency overflow should a larger storm event occur than the 1:100 year event.

The bulk earthworks design, in combination with the development layout, will ensure that the emergency overflow will drain in an earth channel towards the existing attenuation facility. The overland drainage routes are shown on the drawing in **Annexure E**.

It is proposed that the existing attenuation facility be cleared from grub and rubble and be enlarged to provide more capacity within the facility.

8 STORMWATER RUNOFF VOLUME MANAGEMENT

8.1 STORMWATER RUNOFF

When calculating the peak flows for the two catchment areas, the South African Weather Bureau rainfall station data was used. The closest rainfall station to the site is 0060864W Vredenburg (Pol), with a mean annual precipitation of 275mm. The following table summarizes the rainfall depths of the relevant rainfall station.

Table 1: Rainfall Data for SAWB station 0060780W Saldanha Bay

Recurrence Interval	1:2 Year	1:5	1:10	1:20	1:50	1:100
1 day depth (mm)	26.0	35.0	41.0	47.0	54.0	59.0
24 h depth (mm)	28.9	38.9	45.5	52.2	59.9	65.5

The rational method was then used to determine the pre- and post-development stormwater runoff for the various recurrence intervals of the proposed development area. The peak flows were calculated for the subcatchment areas.

The pre-developed and post-developed peak flows were calculated with a c-values as per the Drainage Manual. The peak flow calculations are shown in **Annexure F** – Peak Flow Calculations with the peak flows summarized in Table 2 below.

Table 2: Storm run-off for the for Stompneus Bay Existing and Proposed Residential Areas

Catchment Area (Figure 5)	1:2 Runoff (m3/s)	1:5 Runoff (m3/s)	1:10 Runoff (m3/s)	1:20 Runoff (m3/s)	1:50 Runoff (m3/s)	1:100 Runoff (m3/s)
Catchment A: Pre-developed	0.041	0.061	0.078	0.100	0.142	0.178
Catchment A: Post-developed	0.211	0.284	0.333	0.382	0.438	0.488
Catchment B: Pre-developed	N/A					
Catchment B: Post-developed	0.323	0.435	0.509	0.584	0.671	0.733

8.2 PROPOSED STORAGE FACILITIES

The required storage capacity to reduce the 1:50 year storm and the 1:100 year storm peak flows to 1:2 year pre-developed peak was calculated for catchment area A and B is summarized in table 3 below.

Table 3: Pond Volumes required for stormwater attenuation

Catchment Area (Figure 5)	1:10 Pond Volume (m^3)	1:50 Pond Volume (m^3)	1:100 Pond Volume (m^3)	Outflow (1:10 pre-developed)
Catchment A (new facility)	466.6	689.3	780.3	41ℓ/s in Ø250mm SW pipe at 1:250 slope
Catchment B (existing facility)	1355.6	1958.8	2195.9	7ℓ/s infiltration & 24hour storm period

Refer to **Annexure G** for the attenuation calculations of the required storage capacities for each catchment area. In **Annexure E** the proposed pond's position and outflow route is shown.

8.3 PROPOSED ATTENUATION FACILITY

Sufficient space was allowed for the new attenuation facility in the site development plan to reduce the 1:100 year post-development peak runoff to the 1:2 year pre-developed peak runoff. An area of 1334m^2 was allowed for in the site development plan.

The proposed facility is shown of the drawing in **Annexure E**. It is proposed that the attenuation facility is 1.1m deep with 1 in 3 side slopes as a safety precaution and to reduce possible erosion along the embankments. The proposed facility will have a capacity of 830m^3 which is more than the required 780m^3 for the 1 in 100 year storm event.

It is further proposed that the pond be fenced around to reduce rubble dumping and prevent people from entering the pond. Safety signage should also be erected around the attenuation facility. Clearview or Betafence type fencing is proposed to match with the fencing at the existing attenuation facility.

To restrict the outflow of the proposed facility, an Ø250mm outlet pipe at a slope of 1:250 to the existing facility is proposed.

The outlet pipe will only discharge the pre-developed 1 in 2 year runoff towards the existing facility.

Although the facility is designed for the 1:100 year storm event, an emergency overflow is also proposed, should a larger storm event occur, or to serve as a backup should the outflow pipe be blocked of damaged. The overflow is proposed as an open channel which could be lined with amorflex to prevent erosion along the Minor Road 7664 up to the existing facility.

8.4 EXISTING ATTENUATION FACILITY

The capacity of the existing attenuation facility is currently calculated as 405m^3 which is not sufficient for the 1 in 10 year storm event. This is mainly due to the absence of an outlet. During the site visit the facility was completely dry, it is evident that between the infiltration and the evaporation the pond does empty between storm events.

It is however proposed that the facility be widened towards the Main Road and also be extended in a southeast direction by approximately 20m. The depth of the facility could also be increased from 1.35m to 2.5m. By extending and deepening the existing facility, the capacity could be increased to 1400m^3. The proposed extended attenuation facility is shown on the drawing in **Annexure E**.

As there is no existing stormwater system to connect to, an outlet pipe for the existing facility will have to be constructed to discharge into the ocean. This will trigger an environmental approval process and since the quality of stormwater might vary between dry periods and wet periods it cannot be guaranteed that the stormwater discharging into the ocean will be pollution free. Therefore, alternative methods were investigated to empty the attenuation facility such as infiltration and evaporation.

Based on an average infiltration rate of 100mm/hour since the in-situ material was classified as sand(180mm/h) and calcrete(12mm/h), the infiltration over the extended surface area of 250m^2(for an almost empty pond) will be 600m^3 per day, or 7ℓ/s.

Evaporation rates from the nearest meteorological station were obtained from the Department of Water and Sanitation. The nearest station is G1E007 at Langebaan Road

with 27 years of data. The graph below summarizes the rainfall and evaporation depths per month for a hydrological year.

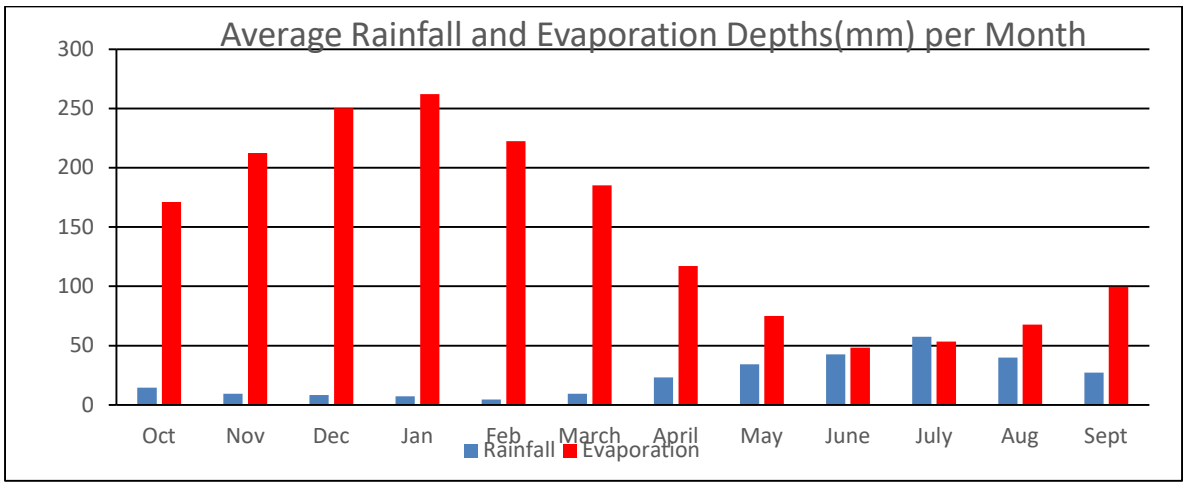

Figure 6: Summary of average rainfall and evaporation at station G1E007

Based on the average evaporation over the surface area of the pond, the annual evaporation per year is calculated as 1552.8m^3. The rainfall and evaporation data from station G1E007 is shown in **Annexure H**.

The extended capacity of the existing facility in combination with the infiltration and evaporation of the facility should provide sufficient storage during storm events. It is recommended that the existing fencing also be extended around the facility to prevent people from entering the area and that safety signage be installed.

The facility currently has no formal overflow. Although the runoff in the facility should infiltrate at a fairly quick rate, an emergency overflow is proposed in the event of a major storm where the runoff rate exceeds the infiltration rate, and the facility is already to full capacity. The overflow is proposed at the northern corner of the facility, as shown in **Annexure E**.

The overflow can be in the form of a shaped open channel towards the unlined side drain of Main Road 00533. The runoff will be conveyed across Minor Road 7664 by means of the new Ø600mm pipe culvert and from there the runoff should be able to drain along the road towards the ocean. This will ensure that the runoff drains away from the existing dwellings adjacent to the facility.

9 ESTIMATE OF PROPOSED BULK STORMWATER INFRASTRUCTURE

The proposed attenuation facility was sized to provide capacity for the 1 in 100 year storm runoff with outflow equivalent to the 1 in 2 year pre-developed flows. The following estimate is a high order cost estimate, a detail design with detailed estimate is recommended before the project continue to construction stage.

The estimate allows for clear and grub as well as rubble clearance at the existing attenuation facility. Allowance was made for the necessary excavation and backfill of the proposed facility and the extended existing facility. Some quantities for gabions were included in the estimate should it be decided at detail design stage to construct the emergency overflow at the proposed attenuation facility with gabions and reno mattresses.

Clearview/Betafence type fencing and access gate was included in the estimate around the new facility in order to match the fencing around the existing facility. Allowance was also made in the estimate for the extension of the existing fencing around the existing attenuation facility.

Table 4: Cost Estimate

DESCRIPTION	AMOUNT R
PRELIMINARY AND GENERAL	R400 077.70
SITE CLEARANCE	R112 860.00
EARTHWORKS	R1 011 010.00
GABIONS AND PITCHING	R75 405.00
STORMWATER DRAINAGE	R619 260.00
SUBTOTAL	R2 218 612.70
10% CONTINGENCIES	R221 861.27
SUBTOTAL	R2 440 473.97
15% VAT	R366 071.10
TOTAL	**R2 806 545.07**

The estimated total cost including VAT and contingencies amounts to R 2 806 545.07 for the construction of the new attenuation facility with outflows and the extension of the existing attenuation facility.

10 STANDARD OPERATING PROCEDURES FOR MAINTENANCE

It is proposed that a maintenance program be implemented to do regular cleaning and maintenance on the stormwater infrastructure. The purpose of such a maintenance program is to organise and coordinate the maintenance and monitoring of all stormwater infrastructure within the proposed development area.

The recommended main actions for stormwater maintenance should include the activities provided in the following table.

Table 5: Stormwater maintenance activities for attenuation pond

Activity	Schedule
Assess kerb inlets, grid inlet, manholes, pipes, and open kerb channels for structural damage and repair all damaged infrastructure	Quarterly
Clean all grid inlets, kerb inlets and manholes from litter and sediment	Monthly in winter months – April to August
Flush pipes to clear sediment	Annually in April, at the beginning of winter the months
Clean open channels from debris and repair erosion, trim grass	Quarterly
Remove sediment and debris from inlet to attenuation pond	Monthly
Assess and clean attenuation facility	Annually in April, at the beginning of winter the months
Stabilize any eroded vegetation areas in attenuation facility	As and when needed

11 CONCLUSIONS AND RECOMMENDATIONS

From this SWMP it can be concluded that the stormwater management of the proposed development will adhere as far as possible to the guidelines as set out in The Neighbourhood Planning and Design Guide (Version 1.1. July 2019) and best practices.

An earth berm/cut-off channel is recommended along the south-west boundary of the proposed development to prevent runoff from the larger catchment area to enter the development properties.

A new attenuation facility is recommended for the new development area which will reduce up to the 1 in 100-year post-developed peak runoff to the 1 in 2-year pre-developed runoff. An emergency overflow will also form part of the design of the storage facility should a storm exceeding the 1 in 100-year storm occur. The new facility should be fenced and safety signage should also be put in place to ensure the safety of residents.

It is recommended that the existing attenuation facility be extended, an emergency overflow be constructed, and the extended facility be fenced off.

It is therefore, recommended that this Stormwater Management Plan be approved for the proposed development of 214 erven on Portion 4 of Farm 6 in Stompneus Bay.

Annexure A – Locality Plan

C:\BNC\BNC Engineering\BNC 24004 -Stompneus Bay SWMP\SWMP\Stompneus Bay SWMP Drawings - Apr 2024.dwg

23/04/2024 3:59:00 Printed By: Esmare Erasmus

FOR INFORMATION

REVISION SCHEDULE

No	DATE	DESCRIPTION
A	26/04/2024	FOR INFORMATION

CONSULTING ENGINEER

Erasmus — SIGNATURE

201370381 — PR No

03/05/2024 — DATE

CLIENT

SIGNATURE

DATE

CLIENT

SALDANHA BAY MUNICIPALITY

CONSULTANT

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PROJECT

STOMPNEUS BAY HOUSING DEVELOPMENT

DRAWING DESCRIPTION

LOCALITY PLAN

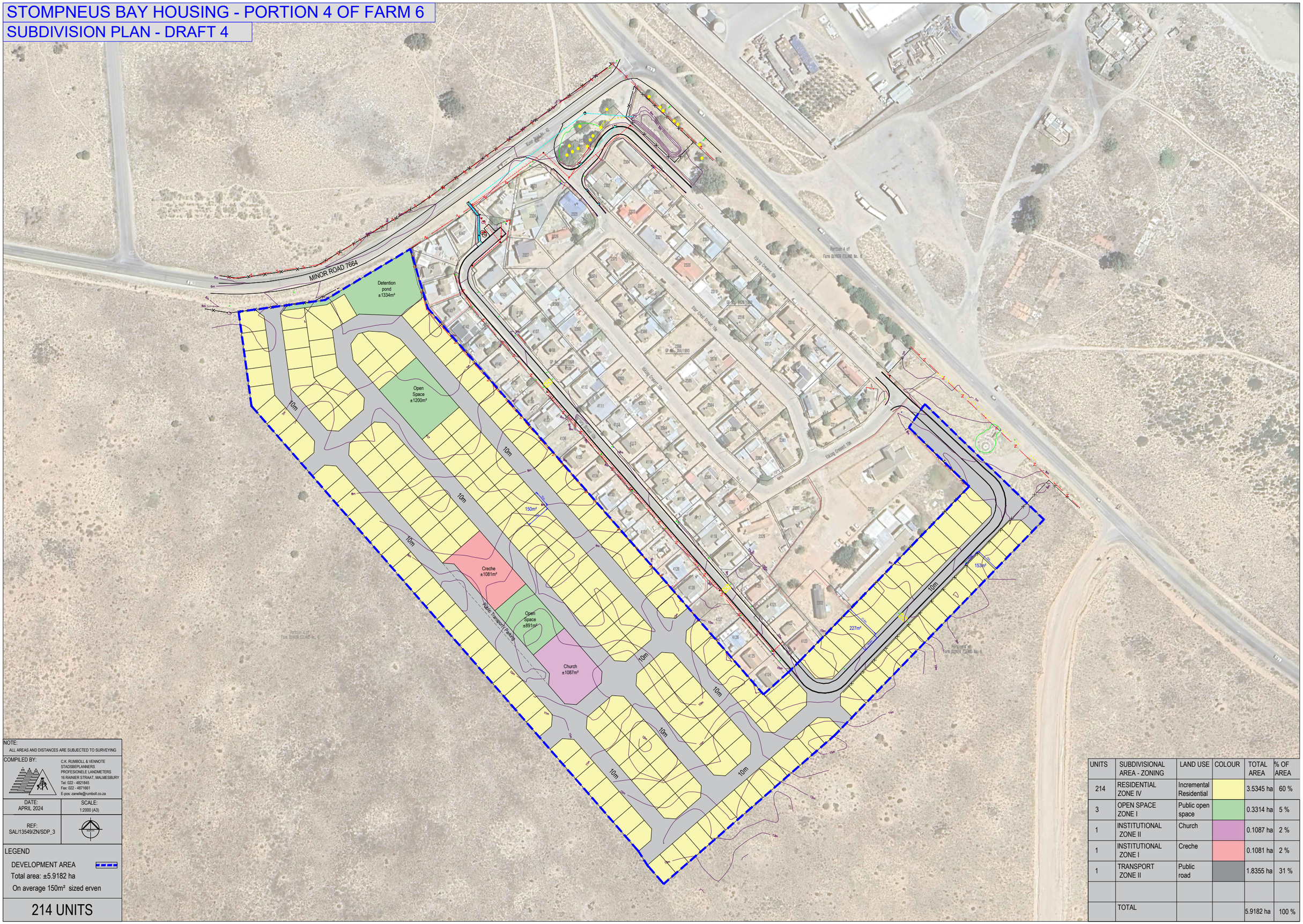
DESIGNED	DRAWN	CHECKED
EE	EE	EE

DATE	SCALE
APRIL 2024	1:20 000

DRAWING NUMBER	REV
P09414-SW-001	A

Annexure B – Proposed Site Development Plan

STOMPNEUS BAY HOUSING - PORTION 4 OF FARM 6
SUBDIVISION PLAN - DRAFT 4



NOTE:
ALL AREAS AND DISTANCES ARE SUBJECTED TO SURVEYING

COMPILED BY:
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DATE:	SCALE:
APRIL 2024	1:2000 (A3)
REF: SAL/13549/ZN/SDP_3	

LEGEND

DEVELOPMENT AREA

Total area: ±5.9182 ha

On average 150m² sized erven

214 UNITS

UNITS	SUBDIVISIONAL AREA - ZONING	LAND USE	COLOUR	TOTAL AREA	% OF AREA
214	RESIDENTIAL ZONE IV	Incremental Residential		3.5345 ha	60 %
3	OPEN SPACE ZONE I	Public open space		0.3314 ha	5 %
1	INSTITUTIONAL ZONE II	Church		0.1087 ha	2 %
1	INSTITUTIONAL ZONE I	Creche		0.1081 ha	2 %
1	TRANSPORT ZONE II	Public road		1.8355 ha	31 %
	TOTAL			5.9182 ha	100 %

Annexure C – Existing Services and Survey

FOR INFORMATION

All dimensions must be verified on site before the works commence. Refer any discrepancies to the Engineer.

REVISION SCHEDULE

No	DATE	DESCRIPTION	DRW	CHK
A	26/04/24	FOR INFORMATION	EE	EE

CONSULTING ENGINEER

Erasmus — SIGNATURE | 201370381 — PR No | 03/05/2024 — DATE

CLIENT

_____ SIGNATURE | _____ DATE

DESIGNED	DRAWN	CHECKED
EE	EE	EE

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CLIENT

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PROJECT

STOMPNEUS BAY HOUSING DEVELOPMENT

DRAWING DESCRIPTION

EXISTING STORMWATER INFRASTRUCTURE AND SURVEY

SCALE FOR REDUCED PLAN

0 5 10 20 30 40 50
50mm ON ORIGINAL PLAN

DATE	SCALE	ORIGINAL SIZE
APRIL 2024	1:1 500	A1

DRAWING NUMBER	REV
P09141-SW-002	A

Annexure D – Geotechnical Investigation

GONDWANA GEO SOLUTIONS

Consulting Geotechnical Engineers & Engineering Geologists

Cape Town Office:
13 Rocklands Road
Simonstown
CAPE TOWN
7975

Report to iX Engineers on a Phase 1 Geotechnical Investigation Stompneus Bay 200 IRDP Housing Project, St. Helena Bay, Western Cape

Project No.: 23-123R01

Date Issued: February 2024

Report to iX Engineers on a Phase 1 Geotechnical Investigation Stompneus Bay 200 IRDP Housing Project, St. Helena Bay, Western Cape

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	PREPARED:
DATE:	**February 2024**
NAME:	**Mark Richter**
SIGNATURE:	

Report to iX Engineers on a Phase 1 Geotechnical Investigation Stompneus Bay 200 IRDP Housing Project, St. Helena Bay, Western Cape

1. INTRODUCTION

At the request of Mr Jean de Klerk of iX Engineers, Gondwana Geo Solutions (Pty) Ltd (or GGS) submitted a cost estimate for a Phase 1 Geotechnical Investigation for the Stompneus Bay 200 IRDP Housing Project in Stompneus Bay near St. Helena Bay, Western Cape, on the 16th November 2023. Mr de Klerk subsequently instructed GGS to proceed with the investigation as proposed on the 5th December 2023.

This report contains the results of the geotechnical investigation, which was carried out in accordance with the guidelines of SANS 634:2012[1] for a Phase 1 Geotechnical Investigation for general township establishment.

The results of the Phase 1 geotechnical investigation are provided. Recommendations are also provided for site stability, earthworks, excavation requirements, materials usage, foundations, subgrade treatment and drainage. The site is zoned in terms of the NBRC foundation class system.

2. INFORMATION SUPPLIED

The following information was provided by Mr De Klerk:

- Google Image of the site titled *" Stompneus Bay IRDP"*
- Document titled *"Stompneus Bay IRDP Layout proposed development"*

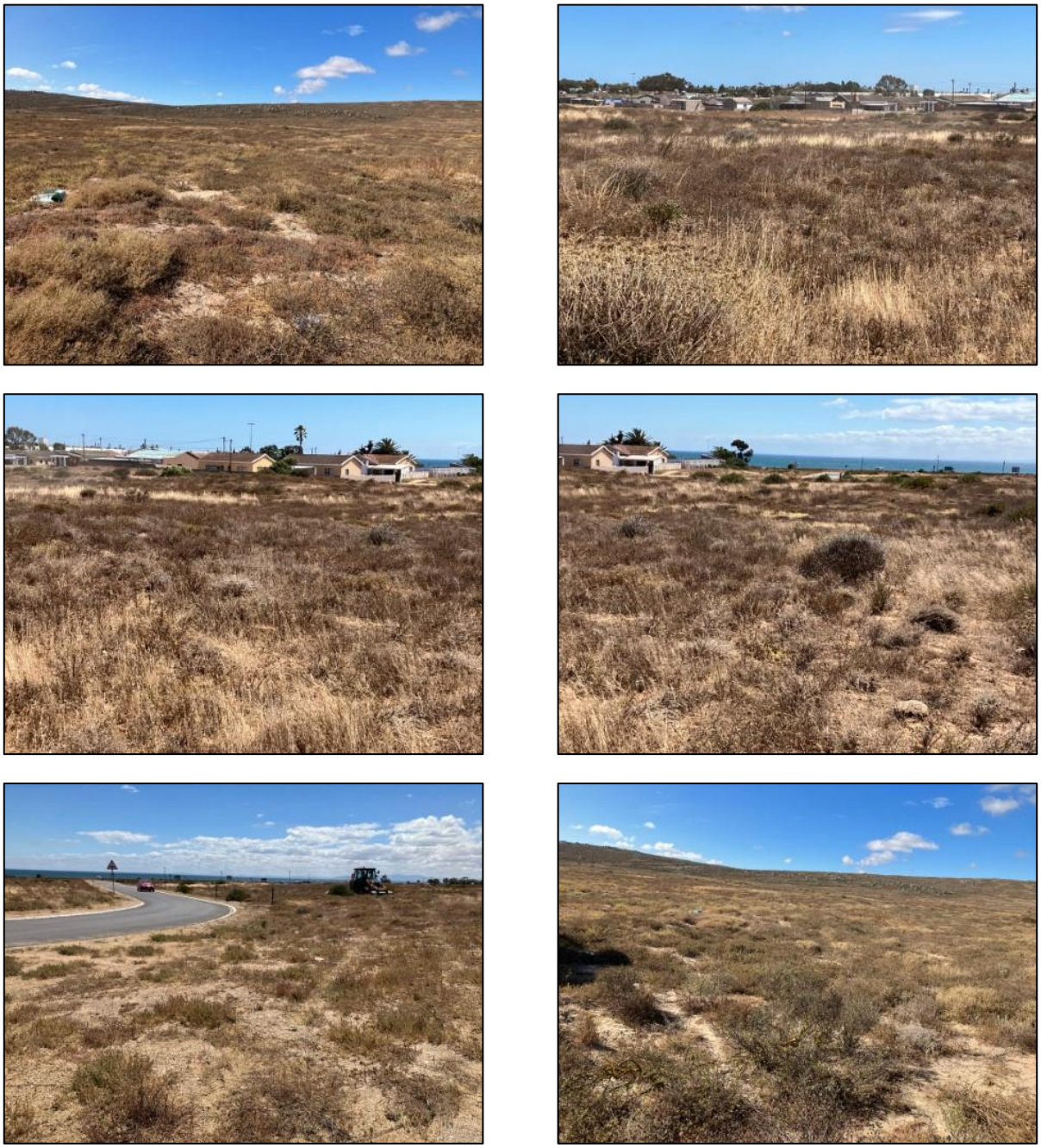
3. SITE DESCRIPTION

The site is situated in a large open area at the north-western side of the established housing area of Stompneus Bay. It is bounded on the northeast by an existing gravel road and established housing area. It extends away from the existing township area towards the southwest and southeast. Access to the site is either off Main Street (MR0053) which connects St Helena with Stompneus, or via Concorde Road on the northwest which comes of Main Street as well.

Topographically, the site slopes downwards from the southeast to Main Street, and in the general direction of the ocean. It Is covered in short wild grass and scattered shrubs. Occasional bare ground areas and mole excavations are found between this vegetation.

The following plates provide a more detailed perspective of the site:

[1] SANS 634: GEOTECHNICAL INVESTIGATIONS FOR TOWNSHIP DEVELOPMENT 2012, pp11-16



Plates 1 to 8: General perspectives of the site taken from the north and east

The site layout is shown in Figure 1 below.

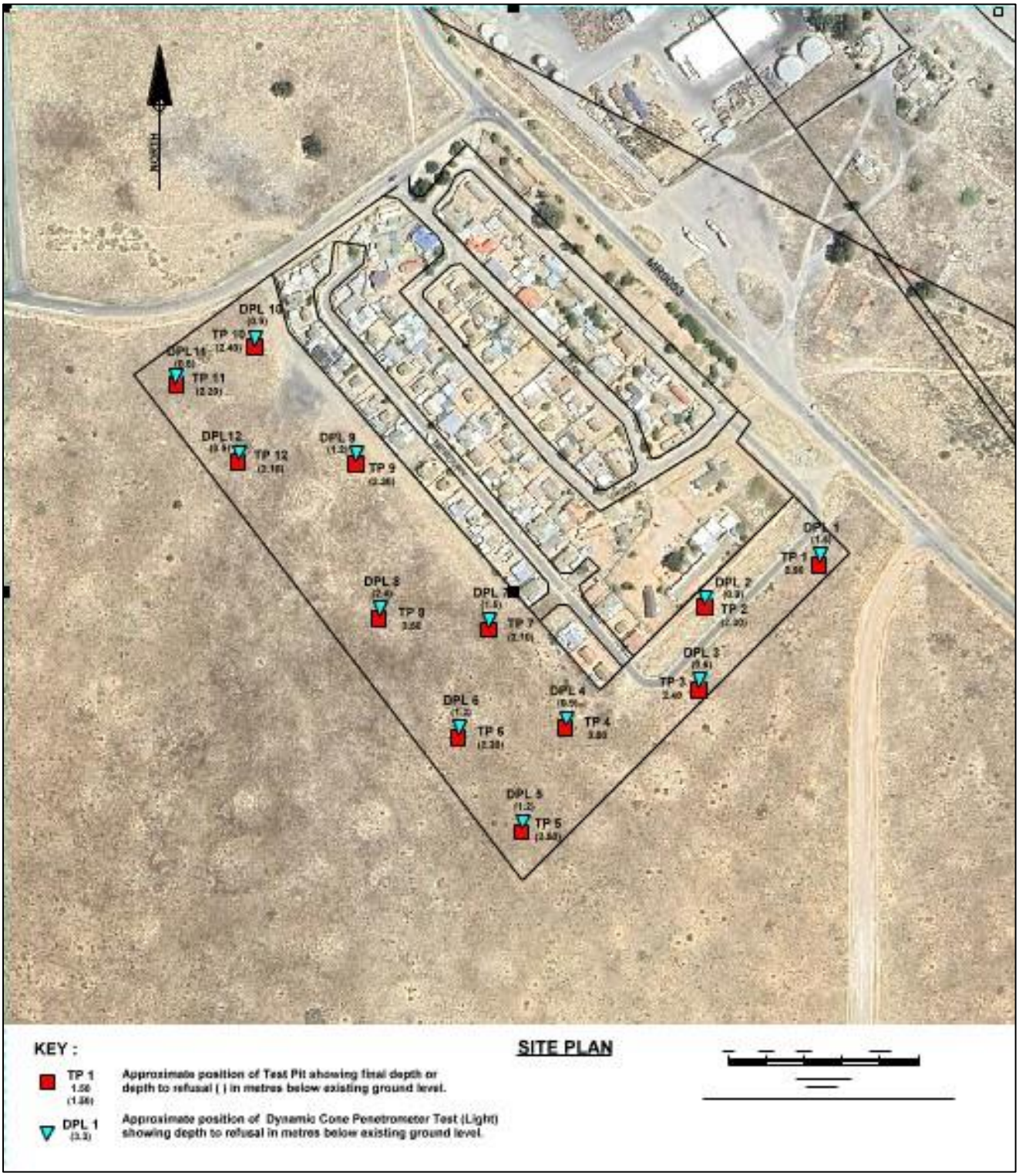


Figure 1: Site Plan showing positions of geotechnical tests

4. FIELDWORK

The fieldwork for the investigation was carried out in December 2023 and comprised the following:

- Test Pits and
- Dynamic Cone Penetrometer (Light) Tests

4.1 Test Pits

Twelve test pits, designated TP1 to TP12, were excavated by a CASE 570T TLB supplied by Superior Plant Hire in St Helena Bay at the approximate positions shown in Figure 1 to allow soil identification and sampling of the subgrade materials.

The test pits were dug to depths ranging between 2.10 and 3.00 metres below existing ground level (mbegl).
The test pits were logged and profiled[2] and representative soil samples were recovered for later laboratory testing.

The detailed logs are given in Appendix A and summarised in Table 1 below.

Table 1
Summary of Test Pit Details

TP No.	Depth (mbegl)	Geology
TP1	2.90	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-2.90m: Dry to slightly moist yellowish brown medium dense to dense becoming dense with depth poorly cemented silty fine SAND with occasional calcrete gravel and nodules. Dune Sand (calcified). **Final depth at 2.90m. No refusal.** **No groundwater seepage.** **No sidewall collapse.**
TP2	2.30	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-0.50m: Dry light brown mottled white very dense gravelly fine medium and coarse SAND. Fill. 0.50-1.90m: Dry light brown dense to very dense with depth poorly to moderately cemented silty fine medium and coarse SAND. Dune Sand. 1.90-2.30m: Dry light and dark brown very dense to very soft rock well cemented Hardpan Dorbank. **Final depth at 2.30m. Refusal.** **No groundwater seepage.** **No sidewall collapse.**
TP3	2.40	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-0.40m: Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium. 0.40-2.40m: Off white to cream mottled grey very dense with zones of very soft rock HARDPAN CALCRETE. **Final depth at 2.40m. No refusal.** **No groundwater seepage.** **No sidewall collapse.**
TP4	3.00	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-3.00m: Dry light brown mottled cream to off white medium dense becoming dense with depth silty SAND with much calcrete gravel (lenses and nodules). Poorly cemented Calcrete. **Final depth at 3.00m. No refusal.** **No groundwater seepage.** **No sidewall collapse.**
TP5	2.50	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-0.60m: Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium. 0.60-2.50m: Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank. **Final depth at 2.50m. Refusal.** **No groundwater seepage.** **No sidewall collapse.**

[2] Geoterminology Workshop (2002) – Guidelines for Soil and Rock Logging - SAIEG-AEG-SAICE (Geotech Div) pp47

TP No.	Depth (mbegl)	Geology
TP6	2.30	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-1.10m: Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium. 1.10-1.60m: Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank. 1.60-2.30m: Dry yellowish brown mottled grey very dense to very soft rock silty gravelly SAND. Residual Granite. **Final depth at 2.30m. Refusal.** **No groundwater seepage.** **No sidewall collapse.**
TP7	2.10	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-1.30m: Dry light brown loose becoming medium dense and dense with depth silty fine and medium SAND. Dune Sand. 1.30-1.80m: Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank. 1.80-2.10m: Dry brown mottled green very dense to very soft rock gravelly SAND. Residual Granite. **Final depth at 2.10m. Refusal.** **No groundwater seepage.** **No sidewall collapse.**
TP8	3.50	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-1.30m: Dry light brown mottled cream to off white medium dense becoming dense with depth silty SAND with much calcrete gravel (lenses and nodules). Poorly cemented Calcrete. 1.30-3.50m: Slightly moist brown apparently loose to medium dense silty fine and medium SAND. Dune Sand. **Final depth at 3.50m. No refusal.** **No groundwater seepage.** **Severe sidewall collapse below 1.30m.**
TP9	2.30	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-1.00m: Dry light brown mottled grey dense poorly cemented silty fine medium and coarse SAND. Colluvium. 1.00-2.30m: Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank. **Final depth at 2.30m Refusal on Dorbank.** **No groundwater seepage.** **No sidewall collapse.**
TP10	2.40	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-0.80m: Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium. 0.80-2.40m: Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank. **Final depth at 2.40m. Refusal on Dorbank.** **No groundwater seepage.** **No sidewall collapse.**
TP11	2.20	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-0.60m: Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium. 0.60-2.20m: Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank. **Final depth at 2.20m. Refusal on Dorbank.** **No groundwater seepage.** **No sidewall collapse.**
TP12	2.10	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-0.80m: Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium. 0.80-2.10m: Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank. **Final depth at 2.10m. Refusal on Dorbank.** **No groundwater seepage.** **No sidewall collapse.**

Note: mbegl = metres below existing ground level

The following plates provide a perspective on the site geology:

Plates 9 & 10: Test pits mostly refused at relatively shallow depths on the very dense dorbank, in some areas beneath the site

4.2 Dynamic Cone Penetrometer (Light) or DPL Tests

Nine Dynamic Cone Penetrometer (Light), or (DPL), tests, designated DPL1 to DPL9, were carried out at the approximate positions shown in Figure 1 to determine the consistency of the soils underlying the site and possible depth to bedrock or a competent founding substrate.

The DPL test comprises a 25mm diameter solid steel retractable cone driven vertically into the ground using a 10 kg hammer dropped through a height of 550mm. The resistance to penetration is measured in terms of number of blowcounts per 300mm advance. It should be noted that material on which DPL tests refuse cannot be accurately determined since the test does not allow any samples to be recovered for identification. Therefore, refusal may occur on very dense / very stiff, cemented or gravelly horizons, as well as on bedrock.

The DPL's were advanced to refusal depths of between 0.60 and 2.40 mbegl.

The results of the DPL tests, consisting of blow count and inferred consistency against depth are attached in Appendix B and summarised in Table 2 below.

Table 2
Summary of DPL Test Results

DPL No.	Depth (mbegl)	Comments
DPL1	1.50	Very loose to 0.30m Loose to 0.60m Medium dense to 1.50m Refusal
DPL2	0.90	Loose to 0.30m Medium dense to 0.90m Refusal
DPL3	0.60	Loose to 0.30m Medium dense to 0.60m Refusal
DPL4	0.90	Medium dense to 0.30m Dense to 0.90m Refusal
DPL5	1.20	Loose to 0.60m Medium dense to 1.20m Refusal

DPL No.	Depth (mbegl)	Comments
DPL6	1.20	Loose to 0.30m Medium dense to 0.60m Loose to 0.90m Medium dense to 1.20m Refusal
DPL7	1.50	Very loose to 0.30m Medium dense to 1.50m Refusal
DPL8	2.40	Loose to 0.30m Medium dense to 2.40m Refusal
DPL9	1.20	Very loose to 0.30m Loose to 1.20m Refusal
DPL10	0.90	Very loose to 0.30m Medium dense to 0.60m Dense to 0.90m Refusal
DPL11	0.60	Very loose to 0.30m Dense to 0.60m Refusal
DPL12	0.90	Loose to 0.30m Medium dense to 0.60m Dense to 0.90m Refusal

Note: mbegl = metres below existing ground level

5. SITE GEOLOGY

As may be inferred from the extract of the 1:250 000 geological map published by the Council for Geo-Sciences, 3218 Clanwilliam, the site geology comprises a mantle of loamy dune sands (Q2) which grade into 'brackish, calcareous soil' (Q4) within shallow depths (Figure 2 below). The Q4 layer generally comprises a *dorbank* which is a poorly to well cemented sandy material where gypsum and calcite are the cementing agents. In smaller, localised areas on the site(i.e. TP3 and TP4) the Q4 layer also comprises a poorly to moderately cemented calcrete or calcified dune sand. The Q4 layer is relatively thick and ranges to an average depth of between 2 and 3 metres below existing ground level (mbegl).

This mantle of soils is underlain by residual soils and porphyritic granite rocks of the Vredenburg Granite suite, which were only encountered in TP6 and TP7 at an average depth of about 1.7mbegl

The TLB either refused or was stopped due to extremely slow excavation progress on either the dorbank or granite.

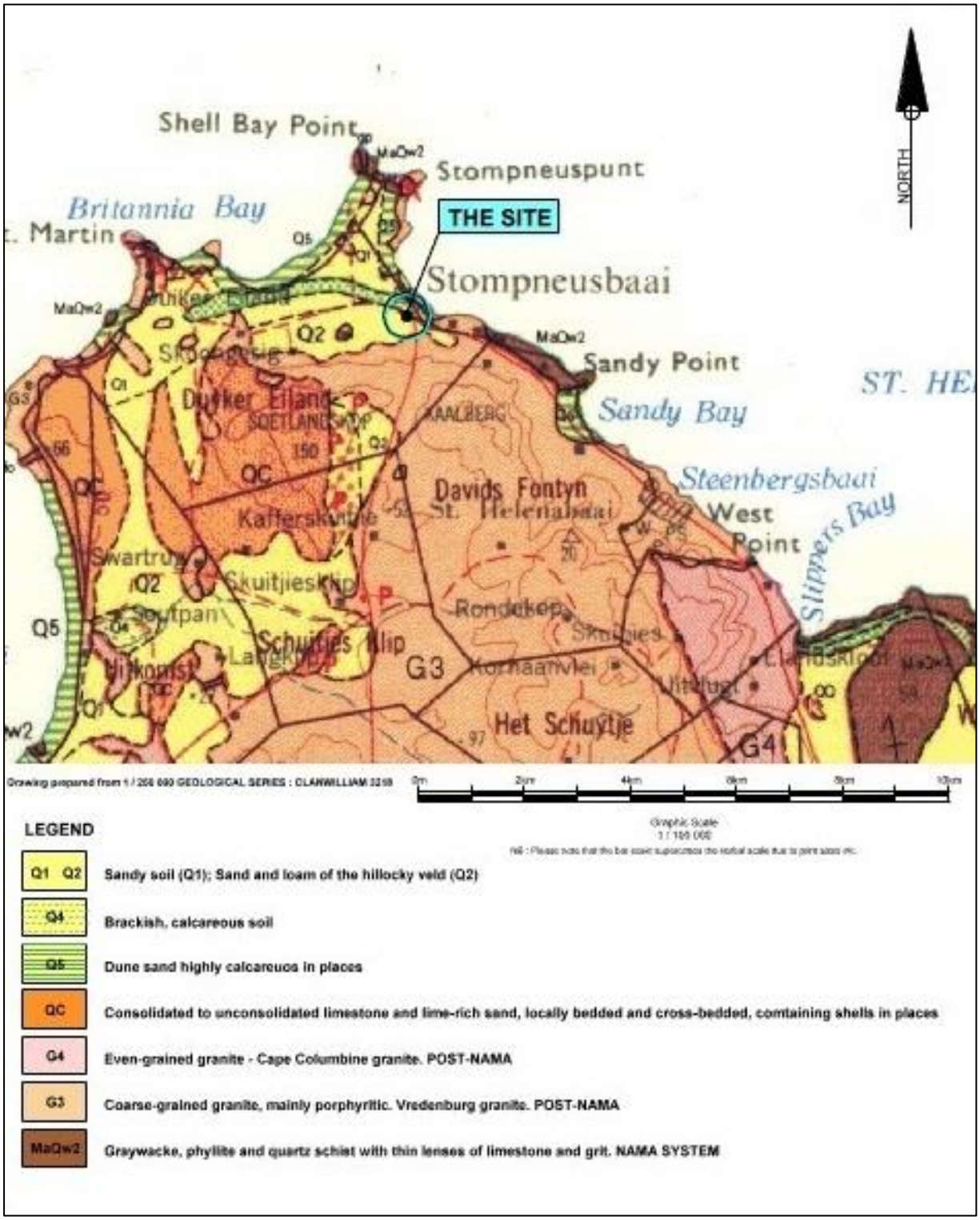


Figure 2: General geology of the Site

6. GROUNDWATER

No groundwater seepage was encountered in any of the trial pits put down. It is expected, however, that perched groundwater flows at the soil / calcrete or dorbank interface may occur in places in the rainy months. Any excavations intercepting this interface may have groundwater seepage at these times.

7. LABORATORY TESTING

Laboratory testing was carried out on soil samples taken during the fieldwork and comprised the following:

- Foundation Indicator tests (Particle Size Analysis, Atterberg Limit Determination and Hydrometer Analysis)
- Mod AASHTO dry density tests,
- California Bearing Ratio tests, and
- pH and Electrical Conductivity (Ec) tests

The laboratory test results are summarised in Table 3 and 4 below, and the detailed results are contained in Appendix C.

Table 3
Summary of Results of Particle Size Distribution Analysis, Atterberg Limit Determinations and CBR tests

TP No	Depth (m)	Description	Particle Size %				Atterberg Limits			GM	Modified AASHTO		CBR Values (%) Compaction MDD (%)					Swell (%)	Classification and Activity
			Clay	Silt	Sand	Gravel	LL	PI	LS %		MDD (kg/m³)	OMC %	90	93	95	98	100		
TP1	0.20-2.90	Dry to slightly moist yellowish brown medium dense to dense becoming dense with depth poorly cemented silty fine SAND with occasional calcrete gravel and nodules. Dune Sand.	1.7	4.6	78.4	15.3	40	10	5.0	1.23									A-2-7(0); SM; Low; anticipate less than G9 quality; Type A Gravel Wearing Course
TP8	0.20-1.30	Dry light brown mottled cream to off white medium dense becoming dense with depth silty SAND with much calcrete gravel (lenses and nodules). Poorly cemented Calcrete.	4.3	7.4	73.3	15.0	27	6	3.0	1.22	1726	15.9	2.7	4.2	5.7	9.0	12	0.25	A-2-4(0); SM-SC; Low; Less than G9 quality; Type A Gravel Wearing Course
TP9	0.20-1.00	Dry light brown mottled grey dense poorly cemented silty fine medium and coarse SAND. Weakly cemented Dorbank/Colluvium.	3.9	6.7	80.2	9.3	32	10	5.0	1.23	1781	14.6	10	12	15	18	21	0.32	A-2-4(0); SC; Low; G8; Type A Gravel Wearing Course

LL - Liquid Limit
PI - Plasticity Index
LS - Linear Shrinkage
GM - Grading Modulus
MDD - Maximum Dry Density
OMC - Optimum Moisture Content

Classification in Terms of:
USPRA[3]
Unified Soil Classification System[4]
Van Der Merwe (1964)[5]
COLTO[6]
TRH20 (1990)[7]

Suitability for Gravel Wearing Course
A - Erodible Materials
B - Ravels and Corrugates
C - Ravels
D - Slippery when Wet
E - Good

[3] US Public Roads Administration Classification (Modified from Allen 1945)
[4] ASTM D 2487-06 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System). June 2006
[5] D.H. Van Der Merwe (1964). The Prediction of Heave from the Plasticity Index and Percentage Clay Fraction of Soils. The Civil Engineer, pp 103-107
[6] COLTO Standard Specifications for Road and Bridge Works for State Road Authorities (1998)
[7] TRH20 (1990) - The Structural Design, Construction and Maintenance of Unpaved Roads, Committee of State Road Authorities

Table 4
Soil Corrosivity Potential

TP No.	Depth (m)	Material	pH	Electrical Conductivity (EC) S/m	Comment[8]
TP8	0.20-1.30	Dry light brown mottled cream to off white medium dense becoming dense with depth silty SAND with much calcrete gravel (lenses and nodules). Poorly cemented Calcrete.	8.35	0.102	• Moderately alkaline • Highly corrosive
TP9	0.20-1.00	Dry light brown mottled grey dense poorly cemented silty fine medium and coarse SAND. Weakly cemented Dorbank/Colluvium.	8.45	0.0980	• Strongly alkaline • Highly corrosive

8. MATERIALS CLASSIFICATION AND USAGE

The *insitu* materials sampled from the site have been classified in terms of their suitability for use in general earthworks and road construction based on field observations and laboratory test results.

8.1 Site Materials

Dune Sands (uncemented)

Two samples of the greyish brown silty fine and medium sand with *partial cementation with calcrete* were selected for laboratory testing. The results of the laboratory tests yielded the following:

Soil Classifications:

- Plasticity Index (PI) ranges from 6 to 10
- Grading Modulus (GM) value 1.22 to 1.23
- Combined silt & clay content of 6.3 to 11.7%, with the remainder comprising fine and medium sand and very small amounts of gravel
- Material classifies as A-2-7(0) to A-2-4(0) in the PRA system and SM to SC in the USC system.
- In terms of COLTO the sample does not satisfy G9 quality
- Type A gravel wearing course – erodible materials

Recommended Usage:

This material will be suitable for use as:

- General subgrade material in the construction of roads and fills
- Compacted backfill behind retaining walls
- Suitable for use as bedding / blanketing material for buried flexible pipelines, consisting of uPVC., HDPE and GRP, as well as steel and ductile iron pipes

Cemented Dune Sands (Dorbank)

One sample of the cemented dune sands, comprising *weakly formed dorbank*, was evaluated:

Soil Classifications:

- PI =10
- GM = 1.23
- Combined silt & clay content of 10.6%, with the remainder comprising fine and medium sand and very small amounts of gravel
- Material classifies as A-2-4(0) in the PRA system and SC in the USC system.
- Material classifies as G8 quality material
- Type A gravel wearing course – erodible materials

[8] Stapelberg, PDJ (2005); The Engineering Geology of Cape Town and Environs: Western Cape, South Africa

Recommended Usage:

This material will be suitable for use as:

- Selected material in the construction of roads and paved areas,
- Compacted backfill behind retaining walls
- Suitable for use as bedding / blanketing material for buried flexible pipelines, consisting of uPVC., HDPE and GRP, as well as steel and ductile iron pipes

8.2 Soil Corrosivity and pH

A summary of the pH and Electrical Conductivity (EC) values for the laboratory tests on the soil materials are given in Table 4 above.

The soil materials are *moderately to strongly alkaline and highly corrosive* in nature. It is recommended that this be considered in the design of concrete foundations and buried steel and concrete pipes.

9. GENERAL SITE STABILITY

The shows no signs of general ground instability in the form of unstable landforms such as tension cracks, slope deformation, hummocky land, slip surfaces, excessive groundwater emissions, or similar characteristics of potentially unstable ground. Therefore, given its relatively gentle level gradient, the site is considered generally stable and suitable for general township development provided the recommendations in this report are adhered to.

10. DEVELOPMENT RECOMMENDATIONS

10.1 Proposed Development

The site for the Stompneus Bay 200 IRDP Housing Project will consist of 200 low-cost single storey housing units. The development will be serviced with sewer, water supply, electricity, roads, parking and public open space areas.

10.2 Excavatability & Trenching

An indication of the depth to which Soft Excavation[9] material occurs is obtained from the final depths of the Test Pits. These depths are shown in Figure 1. Excavations will classify as Soft Excavation to at least 2.20m depth on average. Advancing below this depth will require Soft to Intermediate Excavation.

Trench side sidewalls of up to maximum depth 1.2m may be constructed vertically. Such trenches should not be open for more than 24 hours, otherwise should be constructed to a batter not steeper than 1V:1.5H, or should be laterally supported if left open indefinitely. Where saturation of the soils occurs either during rainy periods or by high ambient groundwater conditions, they will need to be battered to a slope not steeper than 1V:2H.

All excavations must be inspected daily by a competent person to confirm that they are safe for entry.

10.3 Pipe Bedding

All dune sands, excavated dorbank and calcrete materials, will be suitable for use as bedding and blanketing for steel, ductile iron and flexible pipes such as HDPE, GRP and uPVC. They will however, not meet the strict grading requirements of Selected Granular Fill material for concrete pipes as per SABS1200LB, which if required, will need to be imported to site.

10.4 General Earthworks

Given the gentle to moderate slope across the site it is expected that earthworks will be limited to cuts and fills not exceeding 1.5m in height. It is recommended that all earthworks be carried out in accordance with SABS 1200 (DM).

[9] SANS634:2012: Geotechnical Investigations for Townships: pp16, Table 5 - Classification of material for machine excavation

10.5 Drainage

10.5.1 Surface Water Drainage

An important factor in the promotion of a stable site is the control and removal of surface water from the site. It is important that the design of the stormwater management system allow for the drainage of accumulated surface water towards the existing stormwater infrastructure. Disposal of stormwater should in any case conform to the Local Authority's requirements.

10.5.2 Subsurface Drainage

While no groundwater seepage was observed in any of the trial pits, it is recommended that all roads, parking and paved areas have subsoil drainage to protect the structural layers from water ingress which may occur during periods of heavy rainfall.

10.6 Foundations

From the results of the DPL tests the Q2 dune soils generally show the following trend in consistency:

Very loose to 0.30m
Loose to 0.60m
Medium dense to 1.50m

The very loose and loose soils occurring to an average depth of 0,6m beneath existing ground level are not considered a suitable founding horizon for the proposed structures in their natural form. All foundations for houses should be taken through this layer to a minimum depth of 0.6mbegl, where the more competent partially cemented horizon of at least medium dense consistency is found.

Where houses are constructed on cut-to-fill platforms the house should be positioned in cut to facilitate founding. Should houses be placed over the cut-fill line of platforms, or in fill, the soils should be properly engineered to ensure that differential settlements are minimised.

The NHBRC[10] site class **S**, given in Table 5 below, which provides the foundation design, building procedures and precautionary measures for single storey residential structures where consolidation settlement is expected to be less than 10mm, is considered applicable to the entire site, as shown in Figure 3 below.

The requirements for Site Class **S** are provided in Table 5 below.

Table 5
Foundation design, building procedures and precautionary measures for single storey residential structures founded on soil horizons subject to settlement

Site Class	Estimated Total Settlement (mm)	Construction Type	Foundation Design and Building Procedures (Expected damage limited to Category 1)
S	<10	Normal	• Normal construction (strip footing or slab-on-the-ground) foundation • Foundation bearing pressure not exceeded 50kPa • Good site drainage

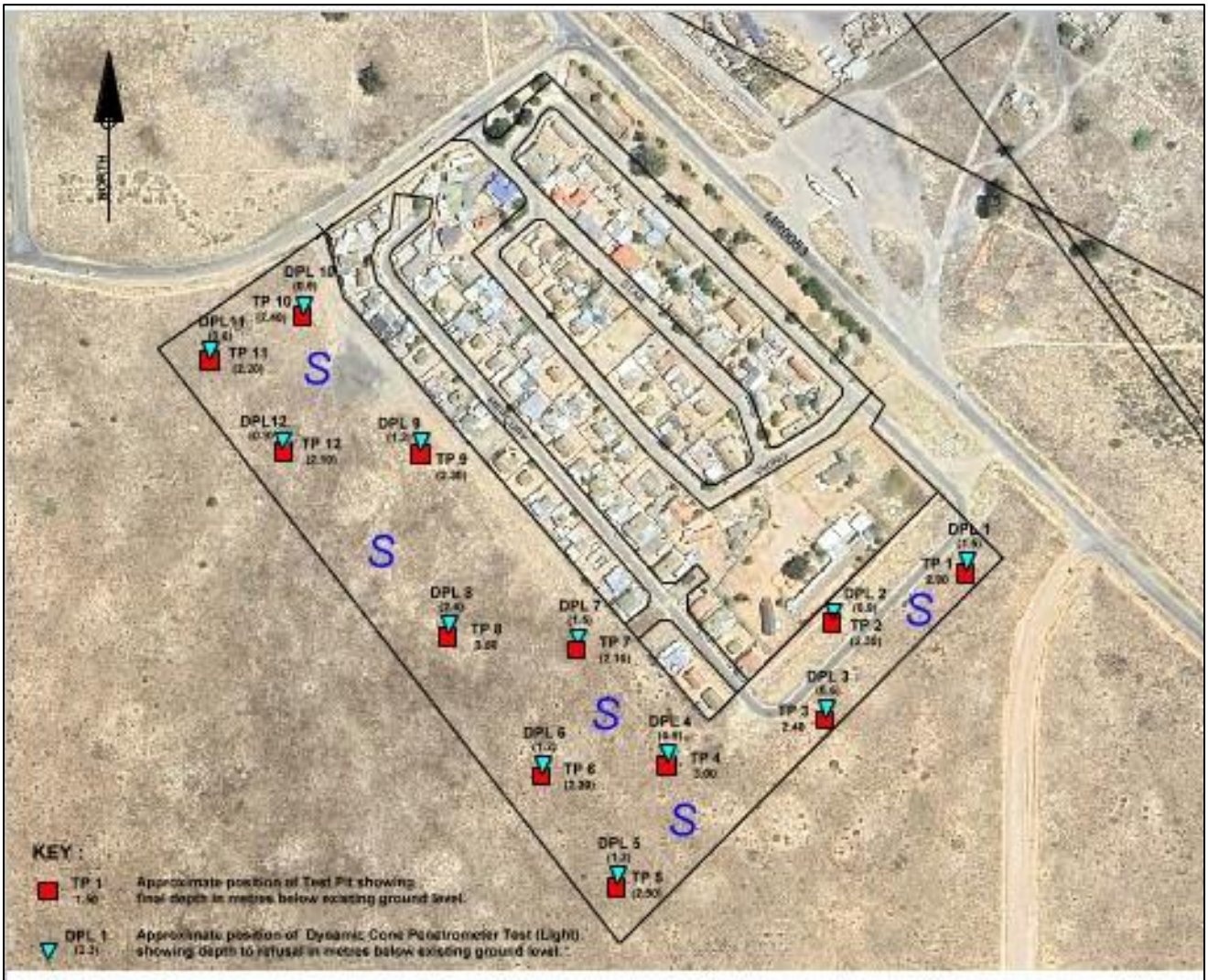
Notes:
- **Differential heave assumed to equal 50% of total**
- **The relaxation of some of these requirements, e.g. the reduction or omission of steel or articulation joints, may result in a Category 2 level of expected damage.**

In addition to the information given in Table 5, the following is recommended:

- Foundations to comprise normal 600mm wide strip foundations (maximum allowable bearing pressure 50kPa)
- Minimum founding depth 0,6m below existing ground level

[10] NHBRC House Building Manual Parts 1 & 2; Revision No. 1, February 1999

- Provided this is carried out the anticipated total settlement will be less than 10mm, with differential settlement 50% of this value
- Note that the slab-on-the-ground foundation option in Table 5 is not recommended for this site unless designed as a raft foundation with thickened (reinforced) edge beams under external walls and thickened beam sections under internal walls. Compaction of the subgrade to be minimum 95% MDD to minimum depth 300mm before constructing the raft foundation.
- No foundations should be founded in fill unless it is specifically engineered for this purpose.
- It is recommended that GGS inspect and approve all foundations before concrete is cast.



Foundation design, building procedures and precautionary measures for single storey residential structures founded on soil horizons subject to consolidation settlement. (NHBRC 1999)

SITE CLASS	ESTIMATED TOTAL SETTLEMENT (mm)	CONSTRUCTION TYPE	FOUNDATION DESIGN AND BUILDING PROCEDURES (Expected damage limited to Category 1)
S	<10	Normal	• Normal construction (strip footing or slab-on-the-ground) foundation • Foundation bearing pressure not exceeded 50kPa • Good site drainage

Figure 3: NHBRC site classification: Stompneus Bay 200 IRDP Housing Project

10.7 Recommended Good Building Practice

The following good building practice is recommended to limit cracking of walls due to moisture change in the foundation soils:

- All houses should have a concrete surround minimum width 1m with falls to promote drainage away from the house and thus prevent surface water gaining ingress into the foundation soils.
- No effluent, sewage or stormwater soak pits should be positioned within 3m of the dwelling.
- No trees or flower beds should be established within 3m of the building.

10.8 Subgrade Treatment - Roads and Parking Areas

The dune soils and those weakly cemented with calcrete are less than G9 quality on average and, as such, of relatively poor to fair subgrade quality. However, the more cemented variety comprising weakly to well cemented dorbank, is expected to classify as G8 material.

The dune sands cemented with calcrete proved disappointing and did not meet G9 quality.

As a general observation, the *cemented dorbank materials* will provide the better road building materials and should be selected in areas of cut or imported from borrow areas either on the site or elsewhere.

Where roads and paving are to be constructed directly on the uncemented or calcretised dune sands, it is recommended that the insitu material to top of subgrade, or road formation level, be ripped to a depth of 300mm, or as determined by the Design Engineer, wet and recompacted to minimum 93% MDD where a CBR of 3 may be adopted for design.

Where the dorbank infused dune soils are exposed at the top of road subgrade level by earthworks, they should be ripped be ripped to a depth of 300mm, or as determined by the Design Engineer, wet and recompacted to minimum 93% MDD where a CBR of 8 may be adopted for design.

11. CONCLUSIONS

This report contains the results of a Phase 1 Geotechnical Investigation carried out for the proposed Stompneus Bay 200 IRDP Housing Project near St Helena Bay, Western Cape.

The site is underlain by a mantle of dune sands (Q2) and calcareous sands overlying pedogenic calcrete and /or dorbank cemented horizons (Q4), known as .'brackish calcareous soil"

It is considered that conditions prevailing at the site are generally favourable for the proposed development, provided the recommendations given in this report are adhered to.

Recommendations for earthworks and drainage to promote the stable development are given. The site has been classified as Site Class **S** in terms of the NHBRC. The proposed houses must be founded according to the criteria laid down by the NHBRC, summarised in Table 5 above.

Recommendations for subgrade treatment beneath roads, paved and parking areas are provided.

Finally, the ground conditions described in this report refer specifically to those encountered in the test pits and DPL tests done on site. It is therefore quite possible that conditions at variance with those discussed above can be encountered elsewhere. It is therefore important GGS carry out periodic inspections of the earthworks and open foundation excavations. Any change from the anticipated ground conditions could then be considered to avoid unnecessary expense.

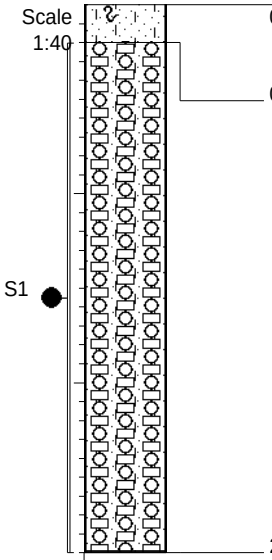
APPENDIX A

iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP1**
Sheet 1 of 1

JOB NUMBER: 23-123

Scale 1:40



0.00 Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.

0.20 Dry to slightly moist yellowish brown medium dense to dense becoming dense with depth poorly cemented silty fine SAND with occasional calcrete gravel and nodules. Dune Sand (calcified).

2.90

NOTES

1) Final depth at 2.90m. No refusal.
2) No groundwater seepage.
3) No sidewall collapse.
4) Samples taken :
   S1 0.20--2.90m (1 x Bulk)

CONTRACTOR :
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DRILLED BY :
PROFILED BY : MVR
TYPE SET BY : MC
SETUP FILE : GGS-ST~1.SET

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DIAM :
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DATE : December 2023
DATE : 07/02/2024 10:17
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ELEVATION :
X-COORD :
Y-COORD :

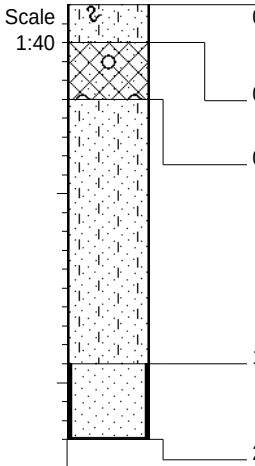
HOLE No: **TP1**

GONDWANA GEO SOLUTIONS

iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP2**
Sheet 1 of 1

JOB NUMBER: 23-123



0.00 Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.

0.20 Dry light brown mottled white very dense gravelly SAND. Fill.

0.50 Dry light brown dense to very dense with depth poorly to moderately cemented silty fine medium and coarse SAND. Dune Sand.

1.90 Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank.

2.30

NOTES

1) Final depth at 2.30m. Refusal.
2) No groundwater seepage.
3) No sidewall collapse.
4) No samples taken.
5) DPL2 done below fill layer.

CONTRACTOR :
MACHINE : Case 570T
DRILLED BY :
PROFILED BY : MVR

INCLINATION :
DIAM :
DATE : December 2023
DATE : December 2023

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **TP2**

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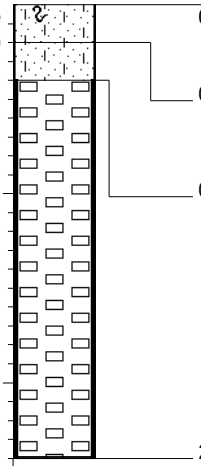
iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP3**
Sheet 1 of 1

JOB NUMBER: 23-123

Scale 1:40



0.00	Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.
0.20	Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium.
0.40	Off white to cream mottled grey very dense with zones of very soft rock HARDPAN CALCRETE.
2.40	

NOTES

1) Final depth at 2.40m. No refusal.
2) No groundwater seepage.
3) No sidewall collapse.
4) No samples taken.

CONTRACTOR :
MACHINE : Case 570T
DRILLED BY :
PROFILED BY : MVR

INCLINATION :
DIAM :
DATE : December 2023
DATE : December 2023

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **TP3**

TYPE SET BY : MC
SETUP FILE : GGS-ST~1.SET

DATE : 07/02/2024 10:17
TEXT : ..Project\Logs\TP1TP12.doc

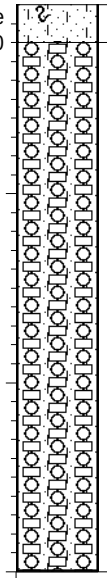
GONDWANA GEO SOLUTIONS

iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP4**
Sheet 1 of 1

JOB NUMBER: 23-123

Scale 1:40



0.00	Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.
0.20	Dry light brown mottled cream to off white medium dense becoming dense with depth silty SAND with much calcrete gravel (lenses and nodules). Poorly cemented Calcrete.
3.00	

NOTES

1) Final depth at 3.00m. No refusal.
2) No groundwater seepage.
3) No sidewall collapse.
4) No samples taken.

CONTRACTOR :
MACHINE : Case 570T
DRILLED BY :
PROFILED BY : MVR
TYPE SET BY : MC
SETUP FILE : GGS-ST~1.SET

INCLINATION :
DIAM :
DATE : December 2023
DATE : December 2023
DATE : 07/02/2024 10:17
TEXT : ..Project\Logs\TP1TP12.doc

ELEVATION :
X-COORD :
Y-COORD :

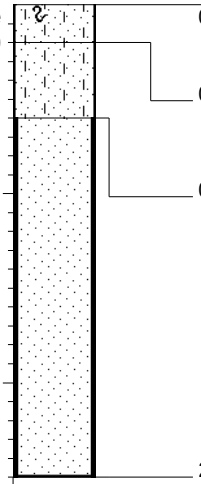
HOLE No: **TP4**

iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP5**
Sheet 1 of 1

JOB NUMBER: 23-123

Scale 1:40



0.00 Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.

0.20 Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium.

0.60 Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank.

2.50

NOTES

1) Final depth at 2.50m. Refusal.
2) No groundwater seepage.
3) No sidewall collapse.
4) No samples taken.

CONTRACTOR :
MACHINE : Case 570T
DRILLED BY :
PROFILED BY : MVR
TYPE SET BY : MC
SETUP FILE : GGS-ST~1.SET

INCLINATION :
DIAM :
DATE : December 2023
DATE : December 2023
DATE : 07/02/2024 10:17
TEXT : ..Project\Logs\TP1TP12.doc

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **TP5**

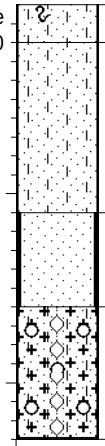
GONDWANA GEO SOLUTIONS

iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP6**
Sheet 1 of 1

JOB NUMBER: 23-123

Scale 1:40



0.00	Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.
0.20	Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium.
1.10	Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank.
1.60	Dry yellowish brown mottled grey very dense to very soft rock silty gravelly SAND. Residual Granite.
2.30	

NOTES

1) Final depth at 2.30m. Refusal.
2) No groundwater seepage.
3) No sidewall collapse.
4) No samples taken.

CONTRACTOR :
MACHINE : Case 570T
DRILLED BY :
PROFILED BY : MVR

INCLINATION :
DIAM :
DATE : December 2023
DATE : December 2023

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **TP6**

TYPE SET BY : MC
SETUP FILE : GGS-ST~1.SET

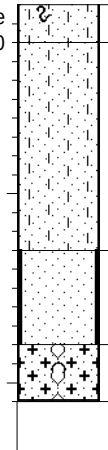
DATE : 07/02/2024 10:17
TEXT : ..Project\Logs\TP1TP12.doc

iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP7**
Sheet 1 of 1

JOB NUMBER: 23-123

Scale 1:40



0.00	Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.
0.20	Dry light brown loose becoming medium dense and dense with depth silty fine and medium SAND. Dune Sand.
1.30	Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank.
1.80	Dry brown mottled green very dense to very soft rock gravelly SAND. Residual Granite.
2.10	

NOTES

1) Final depth at 2.10m. Refusal.
2) No groundwater seepage.
3) No sidewall collapse.
4) No samples taken.

CONTRACTOR :
MACHINE : Case 570T
DRILLED BY :
PROFILED BY : MVR

INCLINATION :
DIAM :
DATE : December 2023
DATE : December 2023

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **TP7**

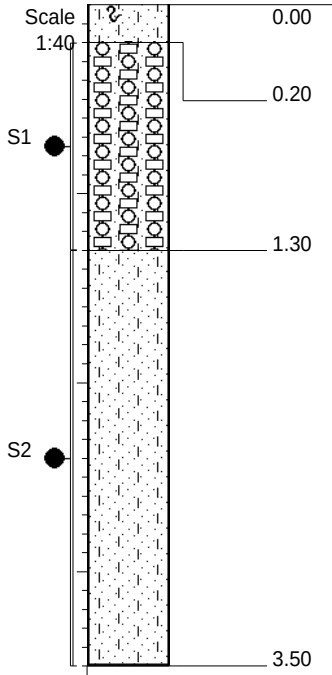
TYPE SET BY : MC
SETUP FILE : GGS-ST~1.SET

DATE : 07/02/2024 10:17
TEXT : ..Project\Logs\TP1TP12.doc

iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP8**
Sheet 1 of 1

JOB NUMBER: 23-123



Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.

Dry light brown mottled cream to off white medium dense becoming dense with depth silty SAND with much calcrete gravel (lenses and nodules). Poorly cemented Calcrete.

Slightly moist brown apparently loose to medium dense silty fine and medium SAND. Dune Sand.

NOTES

1) Final depth at 3.50m. No refusal.
2) No groundwater seepage.
3) Severe sidewall collapse below 1.30m.
4) Samples taken :
   S1 0.20--1.30m (3 x Bulk)
   S2 1.30--3.50m (3 x Bulk)

CONTRACTOR :
MACHINE : Case 570T
DRILLED BY :
PROFILED BY : MVR
TYPE SET BY : MC
SETUP FILE : GGS-ST~1.SET

INCLINATION :
DIAM :
DATE : December 2023
DATE : December 2023
DATE : 07/02/2024 10:17
TEXT : ..Project\Logs\TP1TP12.doc

ELEVATION :
X-COORD :
Y-COORD :

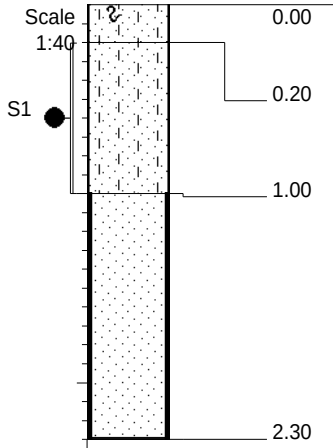
HOLE No: **TP8**

GONDWANA GEO SOLUTIONS

iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP9**
Sheet 1 of 1

JOB NUMBER: 23-123



Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.

Dry light brown mottled grey dense poorly cemented silty fine medium and coarse SAND. Colluvium.

Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank.

NOTES

1) Final depth at 2.30m Refusal on Dorbank.
2) No groundwater seepage.
3) No sidewall collapse.
4) Samples taken :
   S1 0.20--1.00m (3 x Bulk)

CONTRACTOR :
MACHINE : Case 570T
DRILLED BY :
PROFILED BY : MVR
TYPE SET BY : MC
SETUP FILE : GGS-ST~1.SET

INCLINATION :
DIAM :
DATE : December 2023
DATE : December 2023
DATE : 07/02/2024 10:17
TEXT : ..Project\Logs\TP1TP12.doc

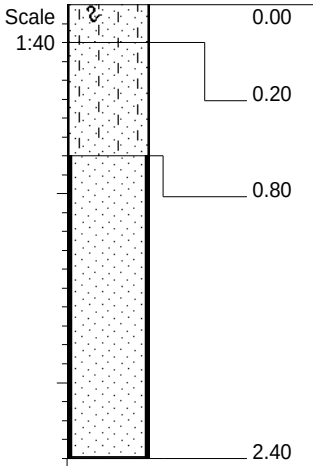
ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **TP9**

iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP10**
Sheet 1 of 1

JOB NUMBER: 23-123



Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.

Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium.

Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank.

NOTES

1) Final depth at 2.40m. Refusal on Dorbank.
2) No groundwater seepage.
3) No sidewall collapse.
4) No samples taken.

CONTRACTOR :
MACHINE : Case 570T
DRILLED BY :
PROFILED BY : MVR
TYPE SET BY : MC
SETUP FILE : GGS-ST~1.SET

INCLINATION :
DIAM :
DATE : December 2023
DATE : December 2023
DATE : 07/02/2024 10:17
TEXT : ..Project\Logs\TP1TP12.doc

ELEVATION :
X-COORD :
Y-COORD :

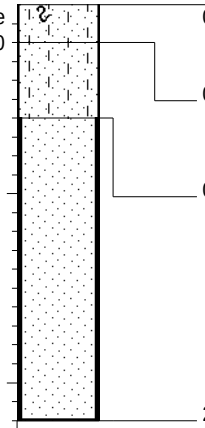
HOLE No: **TP10**

iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP11**
Sheet 1 of 1

JOB NUMBER: 23-123

Scale 1:40



0.00	Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.
0.20	Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium.
0.60	Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank.
2.20	

NOTES

1) Final depth at 2.20m. Refusal on Dorbank.
2) No groundwater seepage.
3) No sidewall collapse.
4) No samples taken.

CONTRACTOR :
MACHINE : Case 570T
DRILLED BY :
PROFILED BY : MVR

TYPE SET BY : MC
SETUP FILE : GGS-ST~1.SET

INCLINATION :
DIAM :
DATE : December 2023
DATE : December 2023

DATE : 07/02/2024 10:17
TEXT : ..Project\Logs\TP1TP12.doc

ELEVATION :
X-COORD :
Y-COORD :

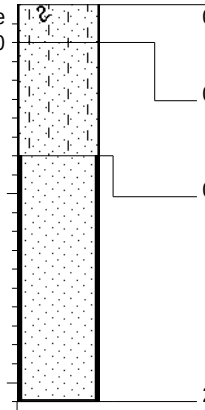
HOLE No: **TP11**

iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP12**
Sheet 1 of 1

JOB NUMBER: 23-123

Scale 1:40



0.00	Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.
0.20	Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium.
0.80	Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank.
2.10	

NOTES

1) Final depth at 2.10m. Refusal on Dorbank.
2) No groundwater seepage.
3) No sidewall collapse.
4) No samples taken.

CONTRACTOR :
MACHINE : Case 570T
DRILLED BY :
PROFILED BY : MVR
TYPE SET BY : MC
SETUP FILE : GGS-ST~1.SET

INCLINATION :
DIAM :
DATE : December 2023
DATE : December 2023
DATE : 07/02/2024 10:17
TEXT : ..Project\Logs\TP1TP12.doc

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **TP12**

APPENDIX B

GONDWANA GEO SOLUTIONS

Consulting Geotechnical Engineers & Engineering Geologists

Cape Town Office:
13 Rocklands Road
Simonstown
CAPE TOWN
7975

Client:	**iX ENGINEERS**	**Ref.No. 23-123**
Project:	**Stompneus Bay IRDP Housing Project**	**Date: December 2023**
Section:	**St Helena Bay**	**Operator: PT**

Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 1***

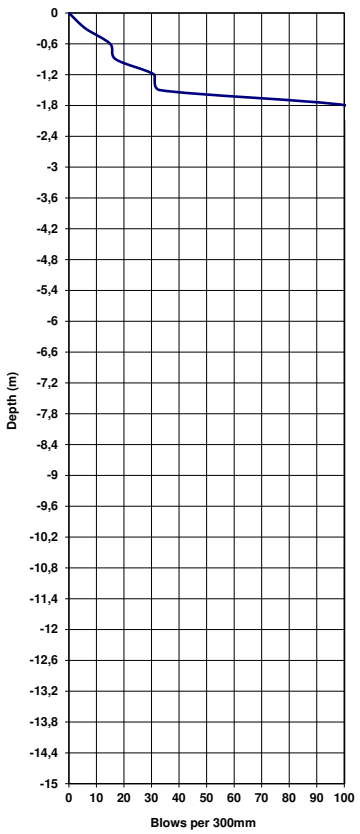
Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 2***

Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 3***

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

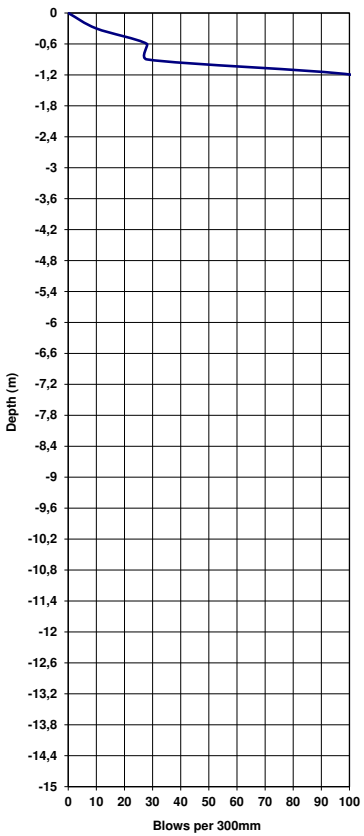
Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings
C=1
Phi=0

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	6	Very Loose
0,6	15	Loose
0,9	17	Med.Dense
1,2	31	Med.Dense
1,5	33	Med.Dense
	Ref	



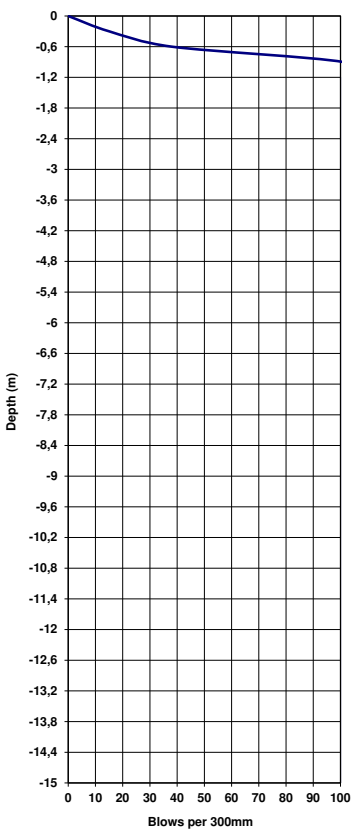
Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings
C=1
Phi=0

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	10	Loose
0,6	28	Med.Dense
0,9	28	Med.Dense
	Ref	



Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings
C=1
Phi=0

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	15	Loose
0,6	38	Med.Dense
	Ref	



GONDWANA GEO SOLUTIONS

Consulting Geotechnical Engineers & Engineering Geologists

Cape Town Office:
13 Rocklands Road
Simonstown
CAPE TOWN
7975

Client:	**iX ENGINEERS**	**Ref.No. 23-123**
Project:	**Stompneus Bay IRDP Housing Project**	**Date: December 2023**
Section:	**St Helena Bay**	**Operator: PT**

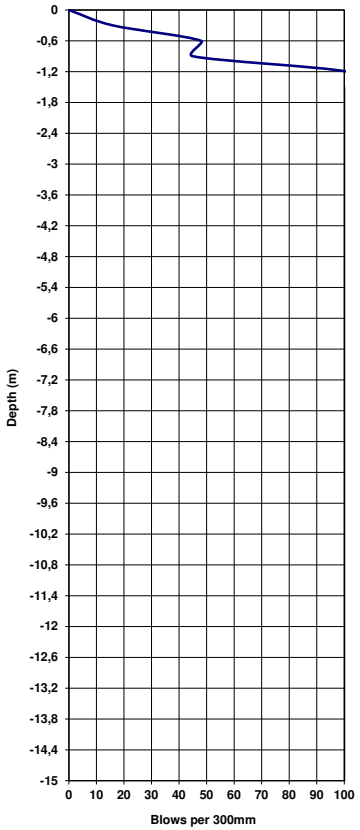
Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 4***

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings

C=1
Phi=0

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	16	Med.Dense
0,6	48	Dense
0,9	45	Dense
	Ref	

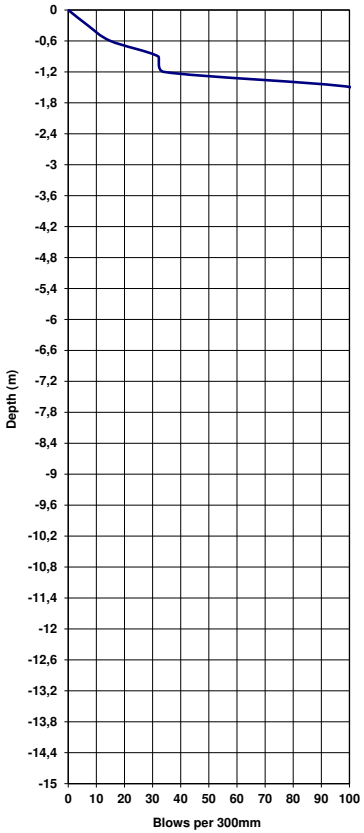


Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 5***

Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings

C=1
Phi=0

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	7	Loose
0,6	15	Loose
0,9	32	Med.Dense
1,2	34	Med.Dense
	Ref	

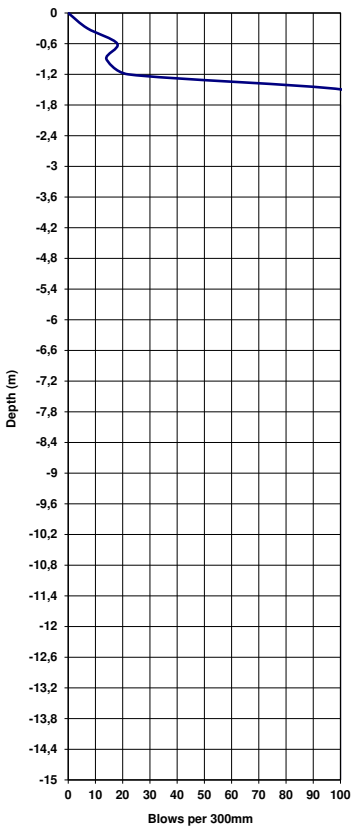


Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 6***

Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings

C=1
Phi=0

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	7	Loose
0,6	18	Med.Dense
0,9	14	Loose
1,2	22	Med.Dense
	Ref	



GONDWANA GEO SOLUTIONS

Consulting Geotechnical Engineers & Engineering Geologists

Cape Town Office:
13 Rocklands Road
Simonstown
CAPE TOWN
7975

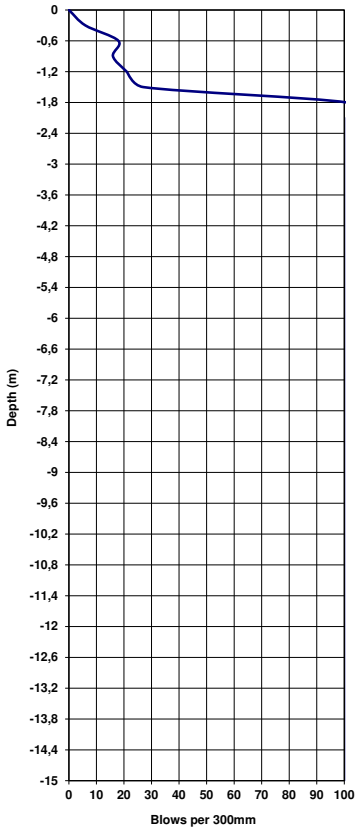
Client:	**iX ENGINEERS**	**Ref.No. 23-123**
Project:	**Stompneus Bay IRDP Housing Project**	**Date: December 2023**
Section:	**St Helena Bay**	**Operator: PT**

Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 7***

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	6	Very Loose
0,6	18	Med.Dense
0,9	16	Med.Dense
1,2	21	Med.Dense
1,5	27	Med.Dense
	Ref	

Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings

C=1
Phi=0

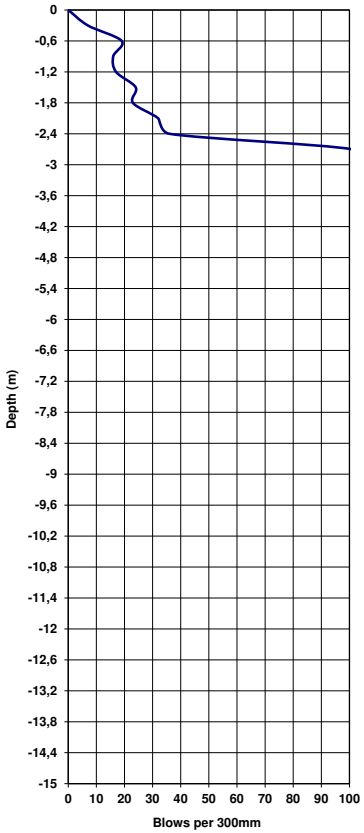


Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 8***

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	7	Loose
0,6	19	Med.Dense
0,9	16	Med.Dense
1,2	17	Med.Dense
1,5	24	Med.Dense
1,8	23	Med.Dense
2,1	32	Med.Dense
2,4	36	Med.Dense
	Ref	

Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings

C=1
Phi=0

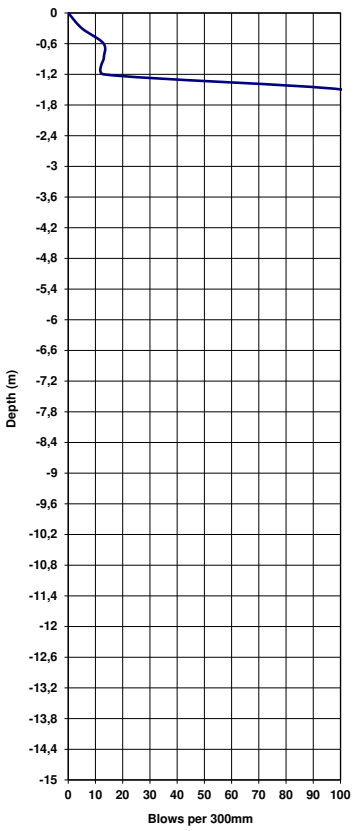


Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 9***

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	5	Very Loose
0,6	13	Loose
0,9	13	Loose
1,2	13	Loose
	Ref	

Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings

C=1
Phi=0



THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

GONDWANA GEO SOLUTIONS

Consulting Geotechnical Engineers & Engineering Geologists

Cape Town Office:
13 Rocklands Road
Simonstown
CAPE TOWN
7975

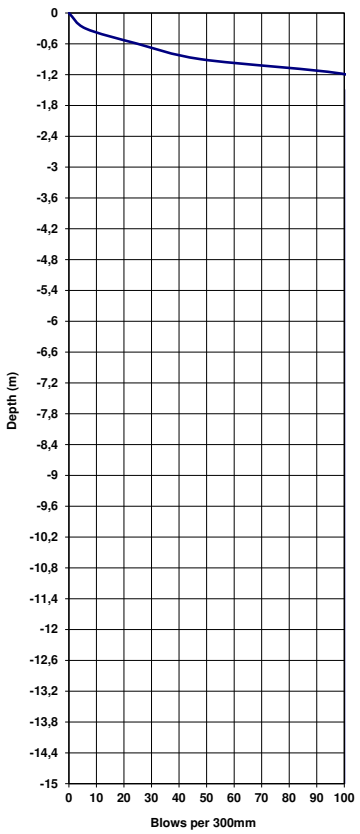
Client:	**iX ENGINEERS**	**Ref.No. 23-123**
Project:	**Stompneus Bay IRDP Housing Project**	**Date: December 2023**
Section:	**St Helena Bay**	**Operator: PT**

Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 10***

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	6	Very Loose
0,6	25	Med.Dense
0,9	48	Dense
	Ref	

Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings

C=1
Phi=0

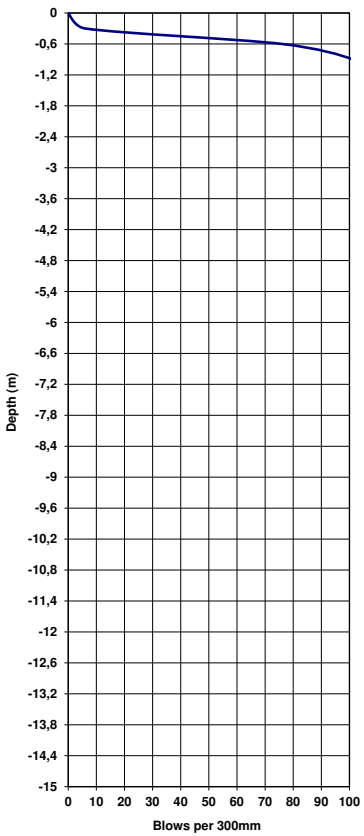


Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 11***

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	6	Very Loose
0,6	76	Dense
	Ref	

Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings

C=1
Phi=0

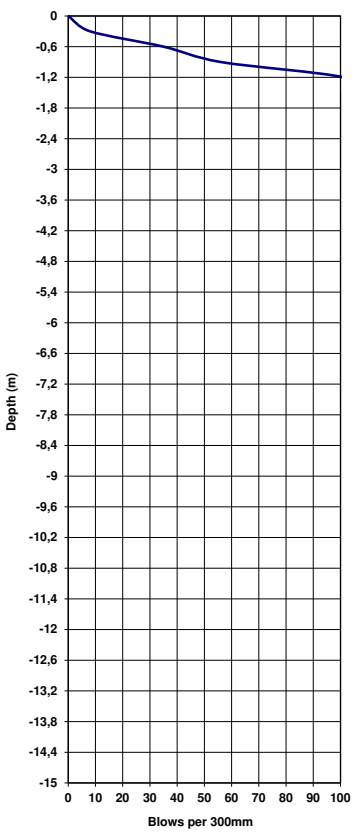


Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 12***

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	8	Loose
0,6	35	Med.Dense
0,9	56	Dense
	Ref	

Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings

C=1
Phi=0



THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

APPENDIX C

SGS MATROCAST (PTY) LTD
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a SANAS Accredited Testing Laboratory, No. T0245

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P.O.BOX 1106 , BRACKENFELL
Tel. : 021 9815558/9
Fax : 021 9816724
Email : gregory.bell@sgs.com

CLIENT :	GONDWANA GEOSOLUTIONS	OUR REF.:	59005
ADDRESS :	17 KINGSMEAD DRIVER WESTVILLE DURBANVILLE	YOUR REF.:	23-123/1
ATTENTION :	MR M.RICHTER	DATE :	29.01.2024

PROJECT : STOMPNEUS BAY IRDP HOUSING PROJECT

SGS MATROCAST

a SANAS Accredited Testing Laboratory, No. T0245

Tests marked * "Not SANAS Accredited" in this Report are not included in the SANAS Schedule of Accreditation for the laboratory.

TEST REPORT / RESULTS

Sample/s:

Sampled by :	Client
Date Received / Sampled :	08.01.2024
Date Tested :	08.01.2024-29.01.2024
Tested at :	SGS MATROCAST (PTY) LTD

Sampling method : Sampled by client and results apply to the sample as received

Section / Position tested identified by : CUSTOMER

Number of pages in this Report : 10

General : CBR CLASSIFICATION & FOUNDATION INDICATOR TEST RESULTS

Technical Signatory : Mr Gregory Bell (N.DIP Civ.Eng)

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SANAS Testing Laboratory T0245

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Technical Signatory : Mr Gregory Bell (N.DIP Civ.Eng)

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TEST RESULTS

GONDWANA GEOSOLUTIONS
17 KINGSMEAD DRIVER
WESTVILLE
DURBANVILLE
Attention: MR M.RICHTER

Project : STOMPNEUS BAY IRDP HOUSING PROJECT

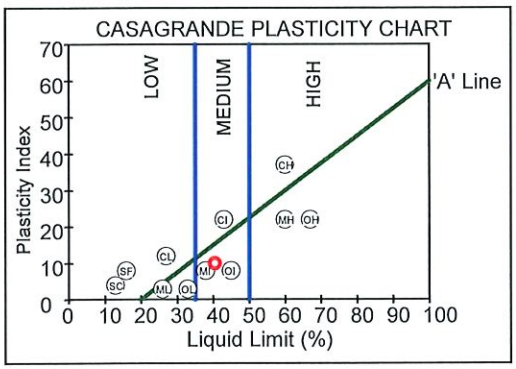
Your Ref : 23-123/1
Our Ref : 59005
Date Reported : 29.01.2024

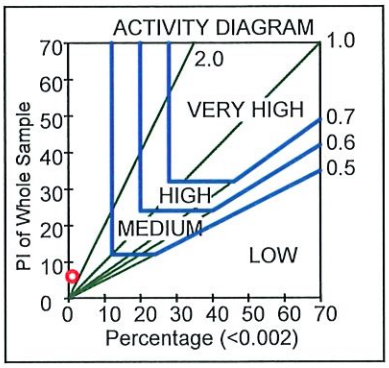
FOUNDATION INDICATOR (ASTM: D422)

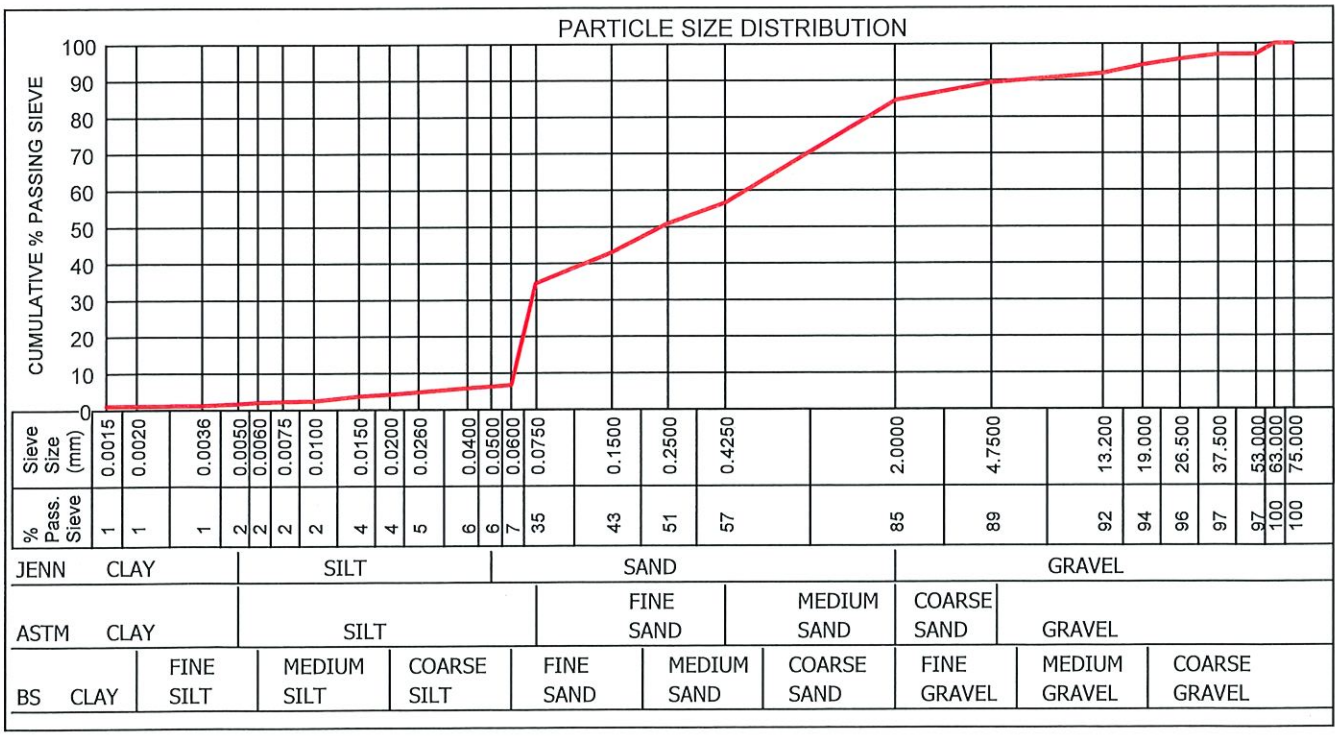
Sample No.	: D 02701
Hole No.	: TP.1
Depth	: 0.20-2.90
Liquid Limit (%)	: 40
Plasticity Index	: 10
Linear Shrinkage (%)	: 5,0
PI of Whole Sample	: 6
P.R.A. Classification	: A-2-7(0)
Unified Soil Classificati	: SM
Activity	: 6,00
Heave Classification	: LOW
Grading Modulus	: 1,23
Percentage (<0.002)	: 1,0
Moisture Content (%)	: 8,6
Relative Density	: 2,324

Material Description : LIGHT BROWN SILTY SAND

	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Classification
Jennings	1,7	4,6	78,4	15,3	SAND
Astm	1,7	32,8	54,9	10,6	SILTY SAND
British Standard	1,1	5,6	77,9	15,3	SAND







Sieve Size (mm)	0.0015	0.0020	0.0036	0.0050	0.0060	0.0075	0.0100	0.0150	0.0200	0.0260	0.0400	0.0500	0.0600	0.0750	0.1500	0.2500	0.4250	2.0000	4.7500	13.200	19.000	26.500	37.500	53.000	63.000	75.000
% Pass. Sieve	1	1	1	2	2	2	2	4	4	5	6	6	7	35	43	51	57	85	89	92	94	96	97	97	100	100

JENN	CLAY	SILT			SAND			GRAVEL		
ASTM	CLAY	SILT			FINE SAND	MEDIUM SAND	COARSE SAND	GRAVEL		
BS	CLAY	FINE SILT	MEDIUM SILT	COARSE SILT	FINE SAND	MEDIUM SAND	COARSE SAND	FINE GRAVEL	MEDIUM GRAVEL	COARSE GRAVEL

Remarks : SAMPLED AND DELIVERED BY CUSTOMER IN A GOOD CONDITION

FORM: A6

4.5.0(SGS)(2021.05.05)

Technical Signatory : Mr Gregory Bell (N.DIP Civ.Eng)

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TEST RESULTS

GONDWANA GEOSOLUTIONS
17 KINGSMEAD DRIVER
WESTVILLE
DURBANVILLE
Attention: MR M.RICHTER

Project : STOMPNEUS BAY IRDP HOUSING PROJECT

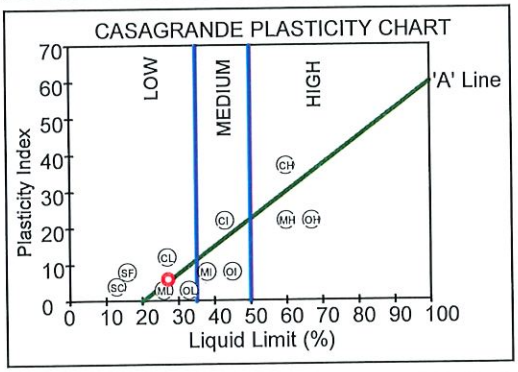
Your Ref : 23-123/1
Our Ref : 59005
Date Reported : 29.01.2024

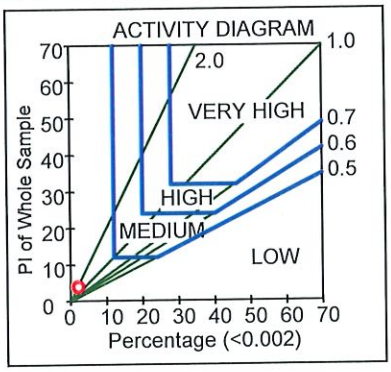
FOUNDATION INDICATOR (ASTM: D422)

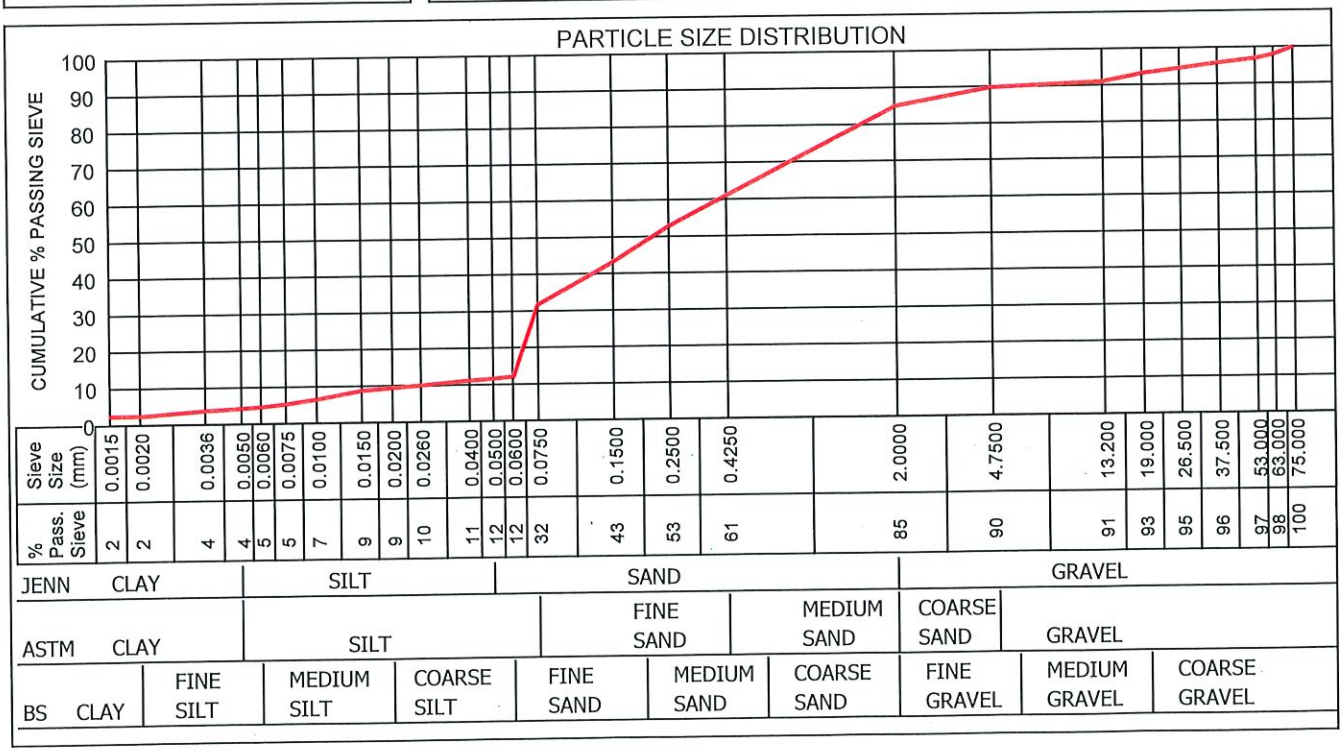
Sample No.	: D 02702
Hole No.	: TP.8
Depth	: 0.2-1.3
Liquid Limit (%)	: 27
Plasticity Index	: 6
Linear Shrinkage (%)	: 3,0
PI of Whole Sample	: 4
P.R.A. Classification	: A-2-4(0)
Unified Soil Classificati	: SM-SC
Activity	: 2,00
Heave Classification	: LOW
Grading Modulus	: 1,22
Percentage (<0.002)	: 2,0
Moisture Content (%)	: 7,2
Relative Density	: 2,473

Material Description : LIGHT BROWN SILTY SAND + CALCRETE GRAVEL

	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Classification
Jennings	4,3	7,4	73,3	15,0	SAND
Astm	4,3	27,4	58,1	10,2	SILTY SAND
British Standard	2,4	9,7	72,9	15,0	SAND







Sieve Size (mm)	0.0015	0.0020	0.0036	0.0050	0.0060	0.0075	0.0100	0.0150	0.0200	0.0260	0.0400	0.0500	0.0600	0.0750	0.1500	0.2500	0.4250	2.0000	4.7500	13.200	19.000	26.500	37.500	53.000	63.000	75.000
% Pass. Sieve	2	2	4	4	5	5	7	9	9	10	11	12	12	32	43	53	61	85	90	91	93	95	96	97	98	100

JENN	CLAY	SILT		SAND			GRAVEL			
ASTM	CLAY	SILT			FINE SAND	MEDIUM SAND	COARSE SAND	GRAVEL		
BS	CLAY	FINE SILT	MEDIUM SILT	COARSE SILT	FINE SAND	MEDIUM SAND	COARSE SAND	FINE GRAVEL	MEDIUM GRAVEL	COARSE GRAVEL

Remarks : SAMPLED AND DELIVERED BY CUSTOMER IN A GOOD CONDITION

FORM: A6

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Technical Signatory : Mr Gregory Bell (N.DIP Civ.Eng)

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TEST RESULTS

GONDWANA GEOSOLUTIONS
17 KINGSMEAD DRIVER
WESTVILLE
DURBANVILLE
Attention: MR M.RICHTER

Project : STOMPNEUS BAY IRDP HOUSING PROJECT

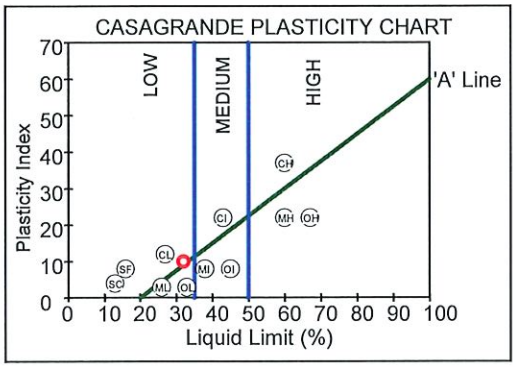
Your Ref : 23-123/1
Our Ref : 59005
Date Reported : 29.01.2024

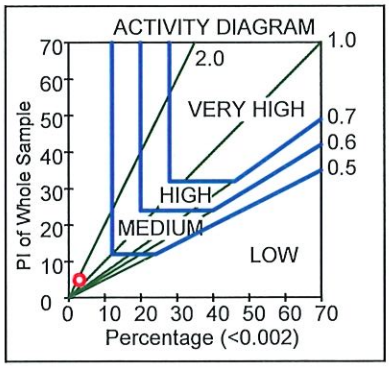
FOUNDATION INDICATOR (ASTM: D422)

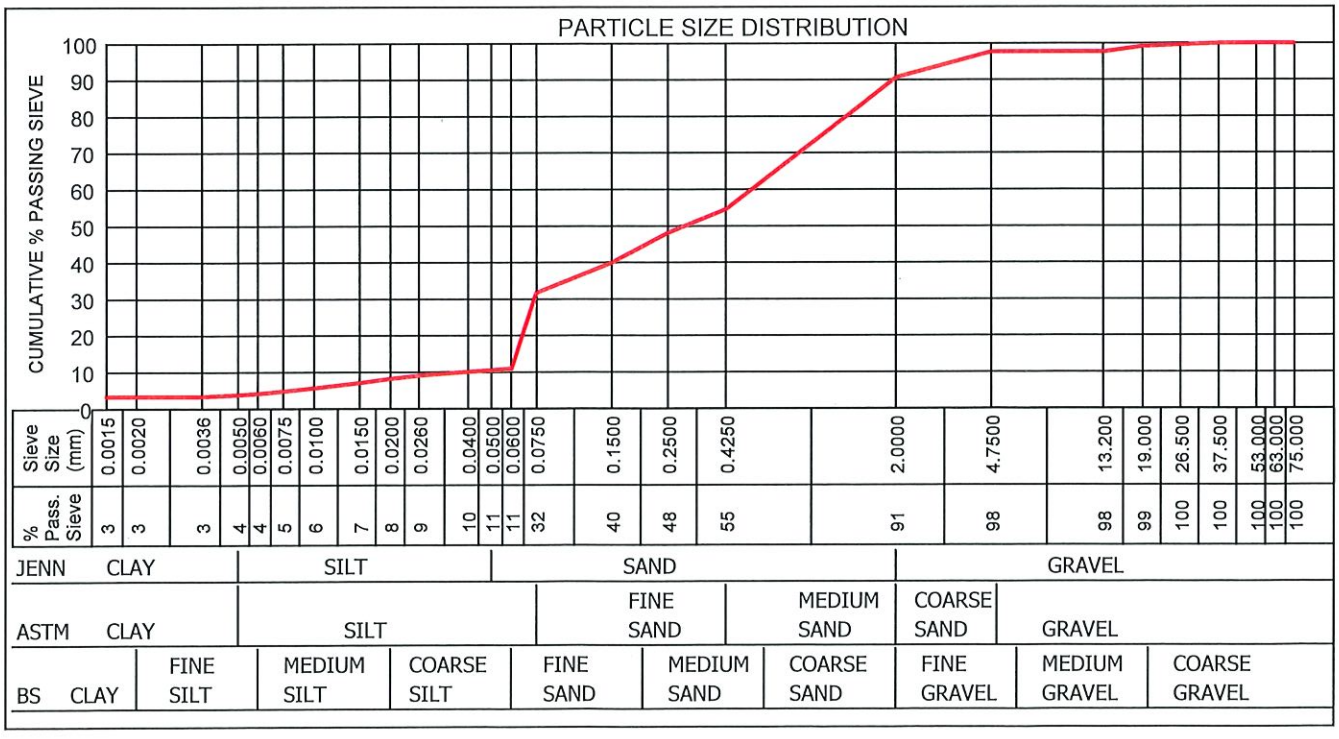
Sample No.	: D 02703
Hole No.	: TP.9
Depth	: 0.2-1.0
Liquid Limit (%)	: 32
Plasticity Index	: 10
Linear Shrinkage (%)	: 5,0
PI of Whole Sample	: 5
P.R.A. Classification	: A-2-4(0)
Unified Soil Classificati	: SC
Activity	: 1,67
Heave Classification	: LOW
Grading Modulus	: 1,22
Percentage (<0.002)	: 3,0
Moisture Content (%)	: 7,8
Relative Density	: 2,482

Material Description : LIGHT BROWN SILTY SAND

	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Classification
Jennings	3,9	6,7	80,2	9,3	SAND
Astm	3,9	27,7	66,0	2,4	SILTY SAND
British Standard	3,3	7,7	79,7	9,3	SAND







Sieve Size (mm)	0.0015	0.0020	0.0036	0.0050	0.0060	0.0075	0.0100	0.0150	0.0200	0.0260	0.0400	0.0500	0.0600	0.0750	0.1500	0.2500	0.4250	2.0000	4.7500	13.200	19.000	26.500	37.500	53.000	63.000	75.000
% Pass. Sieve	3	3	3	4	4	5	6	7	8	9	10	11	11	32	40	48	55	91	98	98	99	100	100	100	100	100

JENN	CLAY		SILT		SAND			GRAVEL		
ASTM	CLAY		SILT		FINE SAND		MEDIUM SAND	COARSE SAND	GRAVEL	
BS	CLAY	FINE SILT	MEDIUM SILT	COARSE SILT	FINE SAND	MEDIUM SAND	COARSE SAND	FINE GRAVEL	MEDIUM GRAVEL	COARSE GRAVEL

Remarks : SAMPLED AND DELIVERED BY CUSTOMER IN A GOOD CONDITION

FORM: A6

4.5.0(SGS)(2021.05.05)

Technical Signatory : Mr Gregory Bell (N.DIP Civ.Eng)

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TEST RESULTS

GONDWANA GEOSOLUTIONS
17 KINGSMEAD DRIVER
WESTVILLE
DURBANVILLE
Attention: MR MARK RICHTER

Project : STOMPNEUS BAY IRDP HOUSING PROJECT

Your Ref : 23-123/1
Our Ref : 59005
Date Reported : 29.01.2024

SIEVE ANALYSIS, CONSTANTS, CBR(SANS 3001:GR1,GR10,GR12,GR20,GR30,GR40)

SAMPLE NO.	D 02702	D 02703			Preparation Method:
HOLE NO.	TP.8	TP.9			Sample was scalped on the 37.5mm sieve
ROAD NO.	-	-			
DEPTH	0.2-1.3	0.2-1.0			
CHAINAGE	On Site	On Site			
LAYER TYPE	-	-.			
STABILISED WITH	Neat	Neat			
SUPPLIER	N/a	N/a			
CURING METHOD	N/a	N/a			
DATE TESTED					
DESCRIPTION	Light Brown Sity Sand+Calcrete Gravel	Light Brown Sity FMC Sand			- Specification
SIEVE ANALYSIS (% PASSING)					
100.0 mm					
75.00 mm	100				
63.00 mm	98				
50.00 mm	97				
37.50 mm	96	100			
28.00 mm	95	100			
20.00 mm	93	99			
14.00 mm	91	99			
5.000 mm	90	98			
2.000 mm	85	91			
0.425 mm	61	55			
0.075 mm	32	32			
SOIL MORTAR					
COARSE SAND <2.0mm >0.425mm	28	39			
FINE SAND <0.425mm >0.075mm	35	26			
MATERIAL <0.075mm	37	35			
CONSTANTS					
GRADING MODULUS	1,22	1,23			
PRA CLASSIFICATION	A-2-4(0)	A-2-4(0)			
UNIFIED SOIL CLAS.	SM-SC	SC			
COLTO CLASSIFICATION	---	G8			
LIQUID LIMIT (%)	27	32			
PLASTICITY INDEX (0.425mm)	6	10			
LINEAR SHRINKAGE (%)	3,0	5,0			
MDD					
MAXIMUM DRY DENSITY (kg/m^3)	1726	1781			
OPTIMUM MOISTURE CONTENT(%)	15,9	14,6			
MOULDING MOISTURE (%)	16,0	14,4			
TYPE OF TEST	CBR	CBR			
CBR-UCS @ 100% MDD	12	21			
CBR-UCS @ 98% MDD	9,0	18			
CBR-UCS @ 97% MDD	7,8	17			
CBR-UCS @ 95% MDD	5,7	15			
CBR-UCS @ 93% MDD	4,2	12			
CBR-UCS @ 90% MDD	2,7	10			

CBR-UCS @ % MDD derived from calculation.

% SWELL MOULD [A][B][C]	0,19	0,26	0,31	0,24	0,31	0,40							

Remarks : SAMPLED AND DELIVERED BY CUSTOMER IN A GOOD CONDITION

FORM: GR40

4.5.0(SGS)(2021.05.05)

Technical Signatory : Mr Gregory Bell (N.DIP Civ.Eng)

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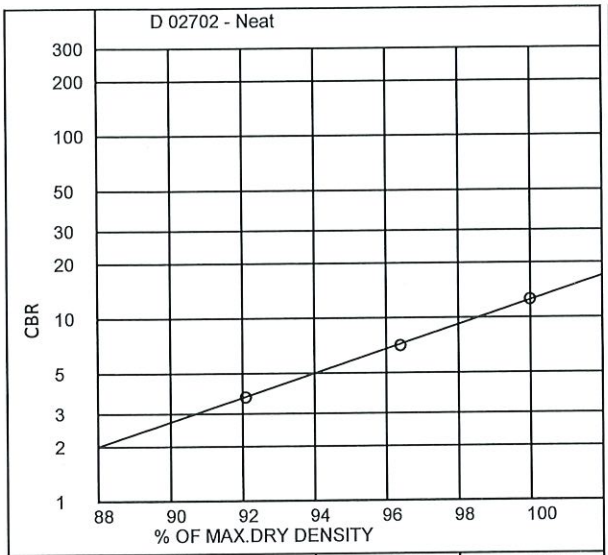
TEST RESULTS

GONDWANA GEOSOLUTIONS
17 KINGSMEAD DRIVER
WESTVILLE
DURBANVILLE
Attention: MR MARK RICHTER

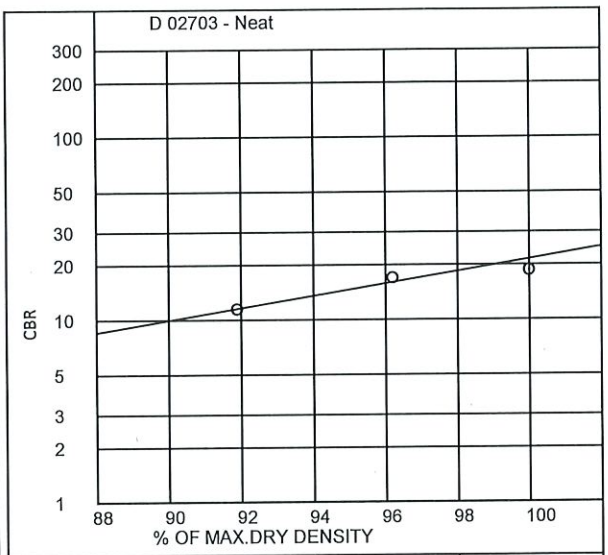
Project : STOMPNEUS BAY IRDP HOUSING PROJECT

Your Ref : 23-123/1
Our Ref : 59005
Date Reported : 29.01.2024

CBR-UCS GRAPH/S (OPTIONAL INFORMATION)



	PROC	NRB	MOD
COMPACTION (%)	92,1	96,4	100,0
CBR	3,7	7,0	13



	PROC	NRB	MOD
COMPACTION (%)	91,9	96,2	100,0
CBR	12	17	19

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Email : Nico.Engelbrecht@sgs.com

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TEST RESULTS

GONDWANA GEOSOLUTIONS
17 KINGSMEAD DRIVE
WESTVILLE
3630
Attention: MR M.RICHTER

Project : STOMPNEUS BAY IRDP HOUSING PROJECT

Your Ref : 23-123/1
Our Ref : 59005
Date Reported : 24.01.2024

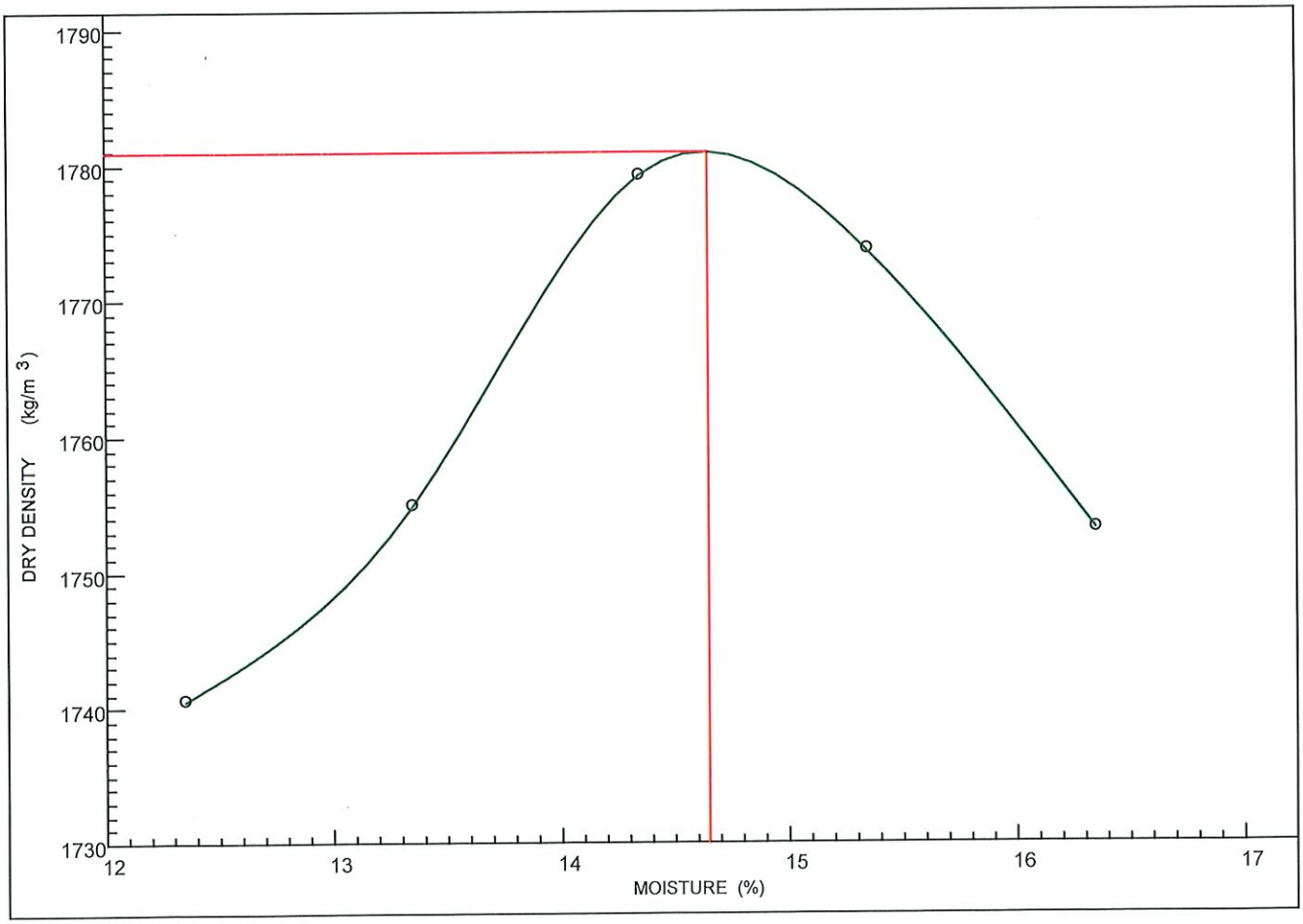
MOISTURE / DENSITY RELATIONSHIP(SANS 3001: GR30(MOD))

Sample No.: D 02703	Hole No. : TP.9	Depth (mm) : 0.2-1.0
Origin : -	Stabilized With : Neat	Compaction Energy : MOD
Material Description : Light Brown Silty FMC Sand		

Maximum Dry Density (kg/m^3): 1781

Optimum Moisture Content (%) : 14,6

Point No.	1	2	3	4	5			
Moisture (%)	12,3	13,3	14,3	15,3	16,3			
Density (kg/m^3)	1741	1755	1779	1774	1753			



Remarks :

FORM: GR30

4.4.1(SGS)(2019.12.04)

Technical Signatory : Mr Gregory F.Bell (N.Dip Civ.Eng)

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TEST RESULTS

GONDWANA GEOSOLUTIONS
17 KINGSMEAD DRIVE
WESTVILLE
3630
Attention: MR M.RICHTER

Project : STOMPNEUS BAY IRDP HOUSING PROJECT

Your Ref : 23-123/1
Our Ref : 59005
Date Reported : 24.01.2024

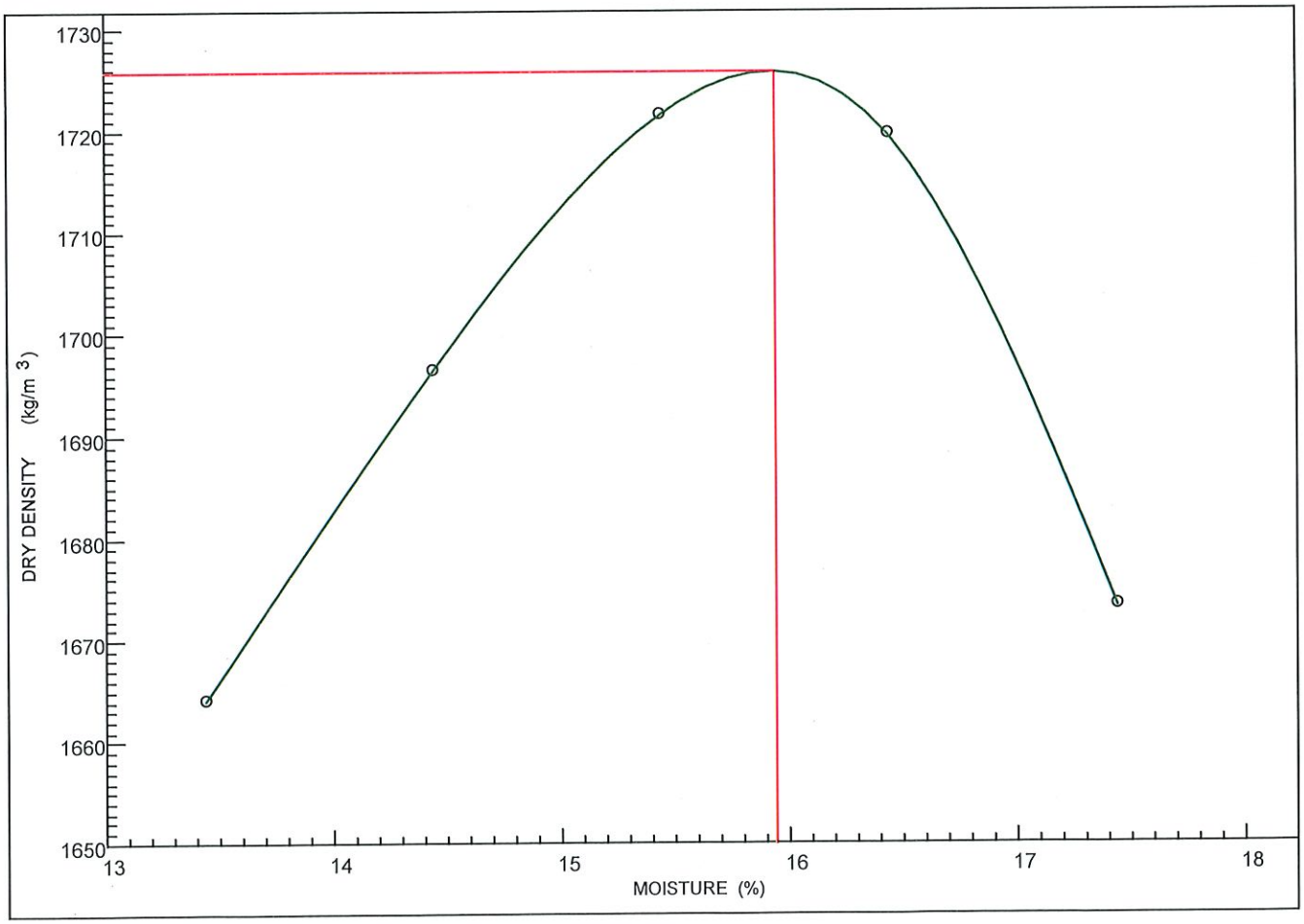
MOISTURE / DENSITY RELATIONSHIP(SANS 3001: GR30(MOD))

Sample No.: D 02702	Hole No. : TP.8	Depth (mm) : 0.2-1.3
Origin : -	Stabilized With : Neat	Compaction Energy : MOD
Material Description : Light Brown Sand + Calcrete Gravel		

Maximum Dry Density (kg/m^3): 1726

Optimum Moisture Content (%) : 15,9

Point No.	1	2	3	4	5			
Moisture (%)	13,4	14,4	15,4	16,4	17,4			
Density (kg/m^3)	1664	1697	1722	1720	1673			



Remarks :

FORM: GR30

4.4.1(SGS)(2019.12.04)

Technical Signatory : Mr Gregory F.Bell (N.Dip Civ.Eng)

SGS MATROCAST

CIVIL ENG.LABORATORY SERVICES
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a SANAS Accredited Testing Laboratory,No.T0245

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P.O BOX 1106 , BRACKENFELL
Tel : 021 981 5558/9
Fax 021 981 6724
Email : Gregory.bell@sgs.com

GONDWANA GEOSOLUTIONS (PTY)LTD
17 KINGSMEAD DRIVER
WESTVILLE
DURBAN , 3629
Attention : MR M.RICHTER

Project : STOMPNEUS BAY IRDP HOUSING PROJECT

You're Ref. : 23-123/1
Our Ref : 59005
Date Reported : 19.01.2024

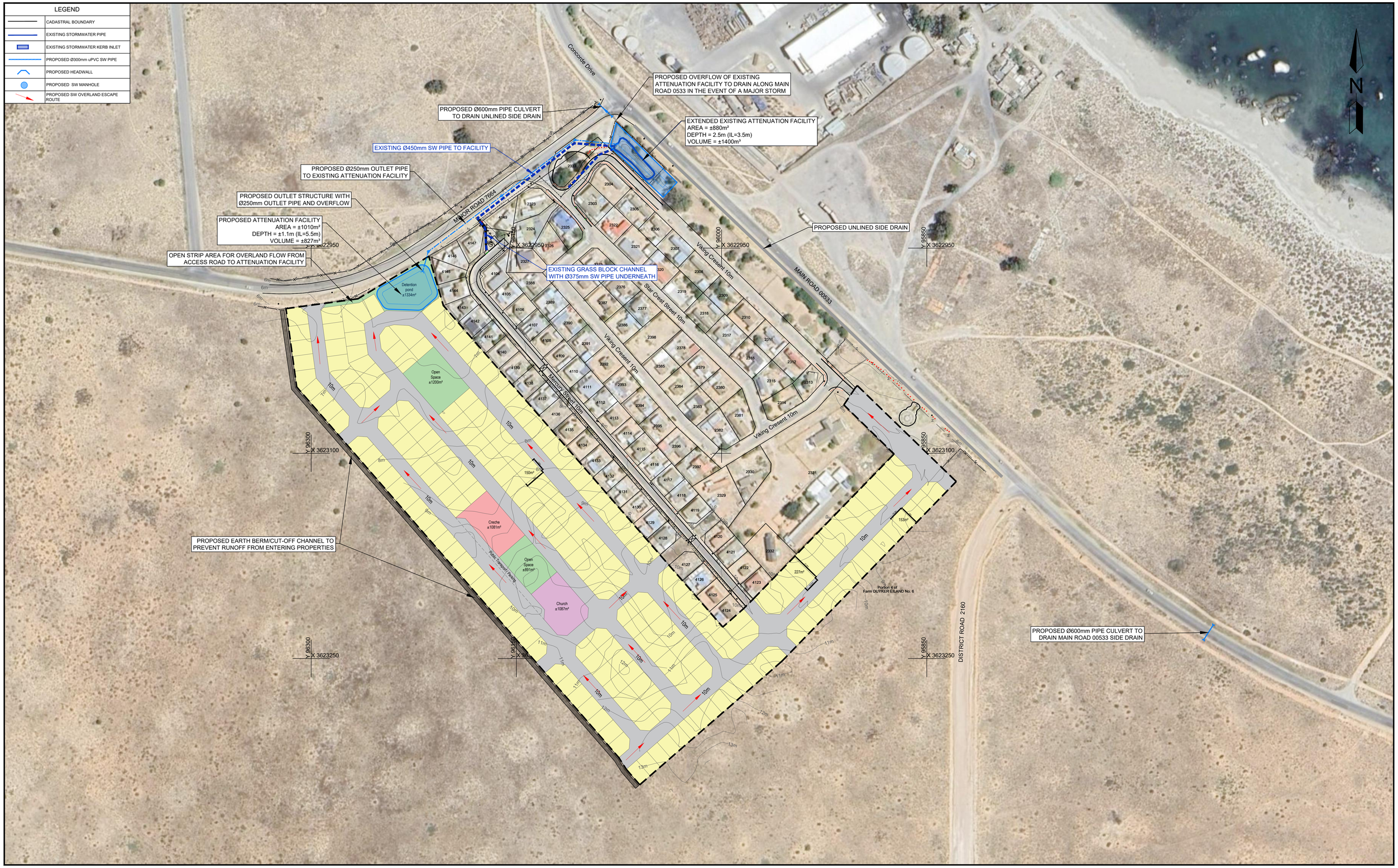
TEST RESULTS
CHEMICAL PROPERTIES OF SOILS

LABORATORY TECHNICIAN		GILMORE ZIMRI (N.DIP. CHEM.ENG.)	
Material Description		Light Brown Sand + Calcrete	Light Brown Silty Fine Sand
SGS Lab. Number	UOM	D 02702	D 02703
Client Sample Number		TP8	TP.9
Depth	mm	0.20-1.30	0.20-1.00
pH (Sans 5854)	%	8.35	8.45
Conductivity (SANS 6240)	Sm-1	0.102	0.0980

Technical Signatory: Gregory Belll

End of report

Annexure E – Proposed Stormwater Infrastructure



FOR INFORMATION

REVISION SCHEDULE

No	DATE	DESCRIPTION	DRW	CHK
A	26/04/24	FOR INFORMATION	EE	EE

CONSULTING ENGINEER

Erasmus — SIGNATURE | 201370381 — PR No | 03/05/2024 — DATE

CLIENT

SIGNATURE | DATE

DESIGNED	DRAWN	CHECKED
EE	EE	EE

CONSULTANT

iX engineers — Infrastructure Excellence

31 Allen Drive | Loevenstein | Cape Town | 7530
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CLIENT

SALDANHA BAAI BAY
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www.sbm.gov.za

PROJECT

STOMPNEUS BAY HOUSING DEVELOPMENT

DRAWING DESCRIPTION

PROPOSED STORMWATER INFRASTRUCTURE

SCALE FOR REDUCED PLAN

0 5 10 20 30 40 50
50mm ON ORIGINAL PLAN

DATE	SCALE	ORIGINAL SIZE
APR 2024	1:1 500	A1

DRAWING NUMBER	REV
P09414-SW-003	A

Annexure F – Peak Flow Calculations

Farm 4/6 Stompneus Bay Housing Development
Summary

Run-off							
Sub-catchment	**Area (m2)**	**1:2 Runoff (m^3/s)**	**1:5 Runoff (m^3/s)**	**1:10 Runoff (m^3/s)**	**1:20 Runoff (m^3/s)**	**1:50 Runoff (m^3/s)**	**1:100 Runoff (m^3/s)**
Catchment A: Pre-developed	49285.0	0.041	0.061	0.078	0.100	0.142	0.178
Catchment A: Post-developed	49285.0	0.211	0.284	0.333	0.382	0.438	0.488
Catchment B: Pre-developed	75387.0	N/A					
Catchment B: Post-developed	75387.0	0.323	0.435	0.509	0.584	0.671	0.733

Pond Sizing						
1:10 Pond Volume (m^3)	**1:50 Pond Volume (m^3)**	**1:100 Pond Volume (m^3)**	**Outflow (=1:10 Pre)**	**Pond Invert Level**	**Emergency Overflow Level**	**Capacity (m^3)**
466.6	689.3	780.3	41ℓ/s in Ø250mm pipe at 1:250 slope	±6.0m	±7.1m	827.3
1355.6	1958.5	2195.9	24h storm & 7ℓ/s infiltration	±4.65m	N/A	1400

FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT
CATCHMENT A
RATIONAL METHOD FOR PRE-DEVELOPED FLOWS

Physical characteristics

Size of catchment (A)	0.0490	km^2
Longest watercourse (L)	0.367	km
Average slope(S_{av})	0.0150	m/m
Mean Annual Rainfall (MAR)	275	mm

Area distribution facto

Rural	100.00%
Urban	0.00%
Lakes	0.00%
Rainfall Region	Coastal

Surface slope, permeability, vegetation & land use

Rural

Surface slope	**%**	**Factor**	**C_s**
Vleis, pans (<3%)	100.00%	0.01	0.01
Flat areas (3-10%)	0.00%	0.06	0.00
Hilly (10-30%)	0.00%	0.12	0.00
Steep areas (>30%)	0.00%	0.22	0.00
Total	100.00%	-	0.01
Permeability	**%**	**Factor**	**C_p**
Very permeable	0.00%	0.03	0.00
Permeable	50.00%	0.06	0.03
Semi-permeable	50.00%	0.12	0.06
Impermeable	0.00%	0.21	0.00
Total	100.00%	-	0.09
Vegetation	**%**	**Factor**	**C_v**
Thick bush, plantation	0.00%	0.03	0.00
Light bush, farmlands	0.00%	0.07	0.00
Grasslands	50.00%	0.17	0.09
No vegetation	50.00%	0.26	0.13
Total	100.00%	-	0.22

Urban

Lawns	**%**	**Factor**	**C_s**
Sandy, flat (<2%)	0.00%	0.10	0.00
Sandy, steep (>7%)	0.00%	0.20	0.00
Heavy soil, flat (<2%)	0.00%	0.17	0.00
Heavy soil,steep (>7%)	0.00%	0.35	0.00
Residential Areas			
Houses	0.00%	0.50	0.00
Flats	0.00%	0.70	0.00
Industry			
Light Industry	0.00%	0.80	0.00
Heavy Industry	0.00%	0.90	0.00
Business			
City Centre	0.00%	0.95	0.00
Suburban	0.00%	0.70	0.00
Streets	0.00%	0.95	0.00
Maximum Flood	0.00%	1.00	0.00
Total (C_2)	0.00%	-	0.00

Time of Concentration (T_c)

Tc (overland flow)	0.57	hours
Tc (watercourse)	**0.15**	**hours**
Tc total	0.73	hours
Tc (select value)	**0.50**	**hours**

30 min

r Value to use: 0.3
(Clean soil: 0.1; Paved area: 0.02; Sparse grass: 0.3; Mod. grass: 0.4; Thick grass: 0.8)

Run-off coefficient

Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**
Run-off coefficient, C_1	0.315	0.315	0.315	0.315	0.315	0.315
Adjustment factor (F_t)	0.500	0.550	0.600	0.670	0.830	1.000
Adjustment run-off (C_{1T})	0.158	0.173	0.189	0.211	0.261	0.315
Combined run-off (C_T)	0.158	0.173	0.189	0.211	0.261	0.300

Rainfall

Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**
Point Rainfall(mm), P_T	26.0	35.0	41.0	47.0	54.0	59.0
Point Intensity(mm/h),P_{iT}	19.2	25.8	30.3	34.7	39.8	43.5
Area Reduction Factor (ARF)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Average Intensity(mm/h), I_T	19.2	25.8	30.3	34.7	39.8	43.5
PEAK FLOW (m^3/s)	0.041	0.061	0.078	0.100	0.142	0.178
PEAK FLOW (ℓ/s)	41.1	60.9	77.8	99.6	141.8	177.8

FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT
CATCHMENT A
RATIONAL METHOD FOR POST-DEVELOPED FLOWS

Physical characteristics

Size of catchment (A)	0.0490	km^2
Longest watercourse (L)	0.367	km
Average slope(S_{av})	0.0150	m/m
Mean Annual Rainfall (MAR)	275	mm

Area distribution facto

Rural	0.00%
Urban	100.00%
Lakes	0.00%
Rainfall Region	Coastal

Surface slope, permeability, vegetation & land use

Rural

Surface slope	**%**	**Factor**	**C_s**
Vleis, pans (<3%)	0.00%	0.01	0.00
Flat areas (3-10%)	0.00%	0.06	0.00
Hilly (10-30%)	0.00%	0.12	0.00
Steep areas (>30%)	0.00%	0.22	0.00
Total	0.00%	-	0.00
Permeability	**%**	**Factor**	**C_p**
Very permeable	0.00%	0.03	0.00
Permeable	0.00%	0.06	0.00
Semi-permeable	0.00%	0.12	0.00
Impermeable	0.00%	0.21	0.00
Total	0.00%	-	0.00
Vegetation	**%**	**Factor**	**C_v**
Thick bush, plantation	0.00%	0.03	0.00
Light bush, farmlands	0.00%	0.07	0.00
Grasslands	0.00%	0.17	0.00
No vegetation	0.00%	0.26	0.00
Total	0.00%	-	0.00

Urban

Lawns	**%**	**Factor**	**C_s**
Sandy, flat (<2%)	25.00%	0.10	0.03
Sandy, steep (>7%)	0.00%	0.20	0.00
Heavy soil, flat (<2%)	0.00%	0.17	0.00
Heavy soil,steep (>7%)	0.00%	0.35	0.00
Residential Areas			
Houses	44.00%	0.50	0.22
Flats	0.00%	0.70	0.00
Industry			
Light Industry	0.00%	0.80	0.00
Heavy Industry	0.00%	0.90	0.00
Business			
City Centre	0.00%	0.95	0.00
Suburban	0.00%	0.70	0.00
Streets	31.00%	0.95	0.29
Maximum Flood	0.00%	1.00	0.00
Total (C_2)	100.00%	-	0.54

Time of Concentration (T_c)

Tc (overland flow)	0.16	hours
Tc (watercourse)	**0.15**	**hours**
Tc total	0.32	hours
Tc (select value)	**0.25**	**hours**

15 min

r Value to use: 0.02
(Clean soil: 0.1; Paved area: 0.02; Sparse grass: 0.3; Mod. grass: 0.4; Thick grass: 0.8)

Run-off coefficient

Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**
Run-off coefficient, C_1	0.000	0.000	0.000	0.000	0.000	0.000
Adjustment factor (F_t)	0.500	0.550	0.600	0.670	0.830	1.000
Adjustment run-off (C_{1T})	0.000	0.000	0.000	0.000	0.000	0.000
Combined run-off (C_T)	0.540	0.540	0.540	0.540	0.540	0.550

Rainfall

Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**
Point Rainfall(mm), P_T	26.0	35.0	41.0	47.0	54.0	59.0
Point Intensity(mm/h),P_{iT}	28.7	38.7	45.3	52.0	59.7	65.2
Area Reduction Factor (ARF)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Average Intensity(mm/h), I_T	28.7	38.7	45.3	52.0	59.7	65.2
PEAK FLOW (m^3/s)	0.211	0.284	0.333	0.382	0.438	0.488
PEAK FLOW (ℓ/s)	211.1	284.1	332.8	381.6	438.4	488.3

FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT
CATCHMENT B
RATIONAL METHOD FOR POST-DEVELOPED FLOWS

Physical characteristics

Size of catchment (A)	0.0750	km^2
Longest watercourse (L)	0.4	km
Average slope(S_{av})	0.0125	m/m
Mean Annual Rainfall (MAR)	275	mm

Area distribution facto

Rural	0.00%
Urban	100.00%
Lakes	0.00%
Rainfall Region	Coastal

Surface slope, permeability, vegetation & land use

Rural

Surface slope	**%**	**Factor**	**C_s**
Vleis, pans (<3%)	0.00%	0.01	0.00
Flat areas (3-10%)	0.00%	0.06	0.00
Hilly (10-30%)	0.00%	0.12	0.00
Steep areas (>30%)	0.00%	0.22	0.00
Total	0.00%	-	0.00
Permeability	**%**	**Factor**	**C_p**
Very permeable	0.00%	0.03	0.00
Permeable	0.00%	0.06	0.00
Semi-permeable	0.00%	0.12	0.00
Impermeable	0.00%	0.21	0.00
Total	0.00%	-	0.00
Vegetation	**%**	**Factor**	**C_v**
Thick bush, plantation	0.00%	0.03	0.00
Light bush, farmlands	0.00%	0.07	0.00
Grasslands	0.00%	0.17	0.00
No vegetation	0.00%	0.26	0.00
Total	0.00%	-	0.00

Urban

Lawns	**%**	**Factor**	**C_s**
Sandy, flat (<2%)	25.00%	0.10	0.03
Sandy, steep (>7%)	0.00%	0.20	0.00
Heavy soil, flat (<2%)	0.00%	0.17	0.00
Heavy soil,steep (>7%)	0.00%	0.35	0.00
Residential Areas			
Houses	44.00%	0.50	0.22
Flats	0.00%	0.70	0.00
Industry			
Light Industry	0.00%	0.80	0.00
Heavy Industry	0.00%	0.90	0.00
Business			
City Centre	0.00%	0.95	0.00
Suburban	0.00%	0.70	0.00
Streets	31.00%	0.95	0.29
Maximum Flood	0.00%	1.00	0.00
Total (C_2)	100.00%	-	0.54

Time of Concentration (T_c)

Tc (overland flow)	0.18	hours
Tc (watercourse)	**0.18**	**hours**
Tc total	0.35	hours
Tc (select value)	**0.25**	**hours**

15 min

r Value to use: 0.02
(Clean soil: 0.1; Paved area: 0.02; Sparse grass: 0.3; Mod. grass: 0.4; Thick grass: 0.8)

Run-off coefficient

Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**
Run-off coefficient, C_1	0.000	0.000	0.000	0.000	0.000	0.000
Adjustment factor (F_t)	0.500	0.550	0.600	0.670	0.830	1.000
Adjustment run-off (C_{1T})	0.000	0.000	0.000	0.000	0.000	0.000
Combined run-off (C_T)	0.540	0.540	0.540	0.540	0.540	0.540

Rainfall

Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**
Point Rainfall(mm), P_T	26.0	35.0	41.0	47.0	54.0	59.0
Point Intensity(mm/h),P_{iT}	28.7	38.7	45.3	52.0	59.7	65.2
Area Reduction Factor (ARF)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Average Intensity(mm/h), I_T	28.7	38.7	45.3	52.0	59.7	65.2
PEAK FLOW (m^3/s)	0.323	0.435	0.509	0.584	0.671	0.733
PEAK FLOW (ℓ/s)	323.1	434.9	509.5	584.0	671.0	733.1

Annexure G – Attenuation Calculations

FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT
CATCHMENT A
DETENTION VOLUME FOR 1:10 YEAR RETURN PERIOD

Catchment:

Total catchment	5.9	ha
Attenuated catchment	5.9	ha
Unattenuated catchment	0	ha
Area to be developed	5.9	ha
Pre-developed area	5.9	ha
Time of concentration Tc	0.25	h

Storm rainfall:	RI (yrs)	Duration (h)	Rain depth (mm)	Rain int. (mm/h)
Minor RI; 1 day rain	5	1 day	35.00	
Major RI; 1 day rain	10	1 day	41.00	
Minor RI; 24h rain	5	24	38.5	
Major RI; 24h rain	10	24	45.1	
Minor RI; critical storm intensity	5	0.25		38.3
Major RI; critical storm intensity	10	0.25		44.9

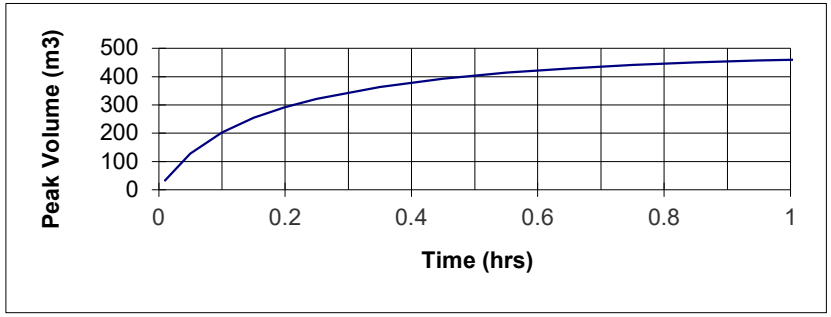
Rational method: Runoff coefficients

C before development	0.189
C after development	0.540

Peak flows	Natural catchment:		Developed catchment without attenuation:	
Minor RI (1 in 5)	61	l/s	284	l/s
Major RI (1 in 10)	78	l/s	333	l/s

Developed, attenuated catchment:

Recurrence interval 1:	10	yrs
Q :- dam outflow	41	l/s
Req'd attenuation vol.	**466.6**	**m3**



FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT
CATCHMENT A
DETENTION VOLUME FOR 1:50 YEAR RETURN PERIOD

Catchment:

Total catchment	5.9	ha
Attenuated catchment	5.9	ha
Unattenuated catchment	0	ha
Area to be developed	5.9	ha
Pre-developed area	5.9	ha
Time of concentration Tc	0.25	h

Storm rainfall:	RI (yrs)	Duration (h)	Rain depth (mm)	Rain int. (mm/h)
Minor RI; 1 day rain	5	1 day	35.00	
Major RI; 1 day rain	50	1 day	54.00	
Minor RI; 24h rain	5	24	38.5	
Major RI; 24h rain	50	24	59.4	
Minor RI; critical storm intensity	5	0.25		38.3
Major RI; critical storm intensity	50	0.25		59.2

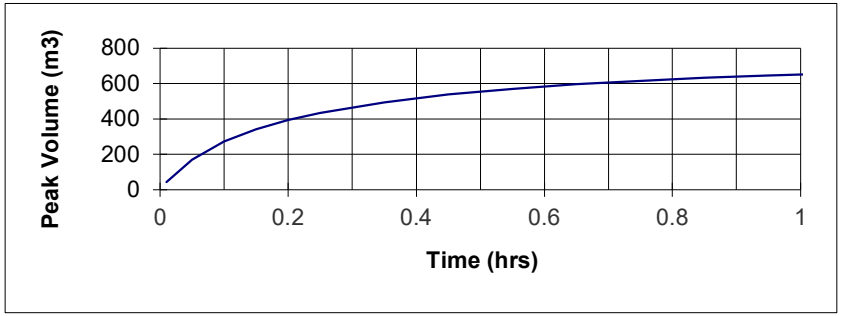
Rational method: Runoff coefficients

C before development	0.261
C after development	0.540

Peak flows	Natural catchment:		Developed catchment without attenuation:	
Minor RI (1 in 5)	61	l/s	284	l/s
Major RI (1 in 50)	142	l/s	438	l/s

Developed, attenuated catchment:

Recurrence interval 1:	50	yrs
Q :- dam outflow	41	l/s
Req'd attenuation vol.	**689.3**	**m3**



FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT
CATCHMENT A
DETENTION VOLUME FOR 1:100 YEAR RETURN PERIOD

Catchment:

Total catchment	5.9	ha
Attenuated catchment	5.9	ha
Unattenuated catchment	0	ha
Area to be developed	5.9	ha
Pre-developed area	5.9	ha
Time of concentration Tc	0.25	h

Storm rainfall:	RI (yrs)	Duration (h)	Rain depth (mm)	Rain int. (mm/h)
Minor RI; 1 day rain	5	1 day	35.00	
Major RI; 1 day rain	100	1 day	59.00	
Minor RI; 24h rain	5	24	38.5	
Major RI; 24h rain	100	24	64.9	
Minor RI; critical storm intensity	5	0.25		38.3
Major RI; critical storm intensity	100	0.25		64.6

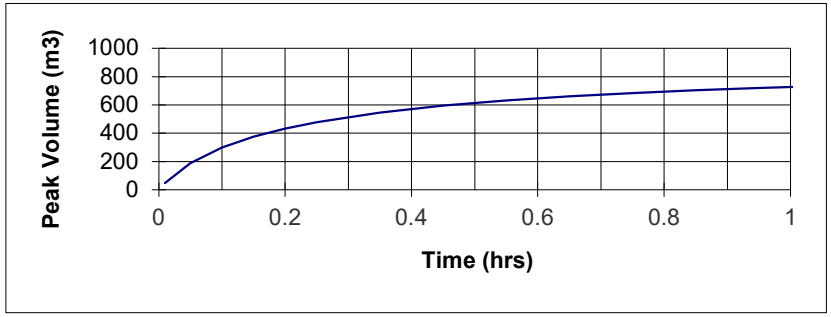
Rational method: Runoff coefficients

C before development	0.300
C after development	0.540

Peak flows	Natural catchment:		Developed catchment without attenuation:	
Minor RI (1 in 5)	61	l/s	284	l/s
Major RI (1 in100)	178	l/s	488	l/s

Developed, attenuated catchment:

Recurrence interval 1:	100	yrs
Q :- dam outflow	41	l/s
Req'd attenuation vol.	**780.3**	**m3**



FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT
CATCHMENT B
DETENTION VOLUME FOR 1:10 YEAR RETURN PERIOD

Catchment:

Total catchment	7.992	ha
Attenuated catchment	7.992	ha
Unattenuated catchment	0	ha
Area to be developed	7.992	ha
Pre-developed area	7.992	ha
Time of concentration Tc	0.25	h

Storm rainfall:	RI (yrs)	Duration (h)	Rain depth (mm)	Rain int. (mm/h)
Minor RI; 1 day rain	5	1 day	35.00	
Major RI; 1 day rain	10	1 day	41.00	
Minor RI; 24h rain	5	24	38.5	
Major RI; 24h rain	10	24	45.1	
Minor RI; critical storm intensity	5	0.25		38.3
Major RI; critical storm intensity	10	0.25		44.9

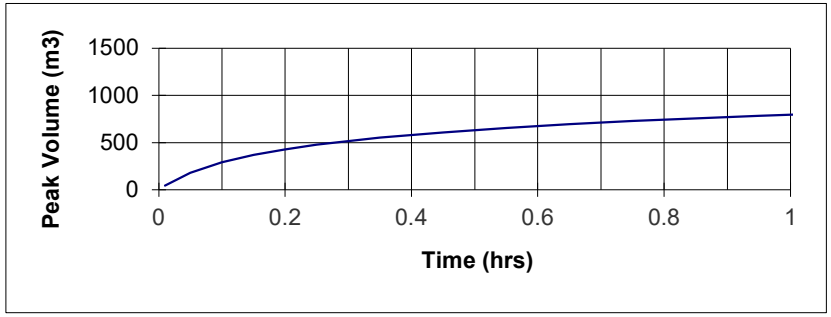
Rational method: Runoff coefficients

C before development	
C after development	0.540

Peak flows	Natural catchment:		Developed catchment without attenuation:	
Minor RI (1 in 5)		l/s	435	l/s
Major RI (1 in 10)		l/s	509	l/s

Developed, attenuated catchment:

Recurrence interval 1:	10	yrs
Q :- dam outflow	7	l/s
Req'd attenuation vol.	**1355.6**	**m3**



FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT
CATCHMENT B
DETENTION VOLUME FOR 1:50 YEAR RETURN PERIOD

Catchment:

Total catchment	7.992	ha
Attenuated catchment	7.992	ha
Unattenuated catchment	0	ha
Area to be developed	7.992	ha
Pre-developed area	7.992	ha
Time of concentration Tc	0.25	h

Storm rainfall:	RI (yrs)	Duration (h)	Rain depth (mm)	Rain int. (mm/h)
Minor RI; 1 day rain	5	1 day	35.00	
Major RI; 1 day rain	50	1 day	54.00	
Minor RI; 24h rain	5	24	38.5	
Major RI; 24h rain	50	24	59.4	
Minor RI; critical storm intensity	5	0.25		38.3
Major RI; critical storm intensity	50	0.25		59.2

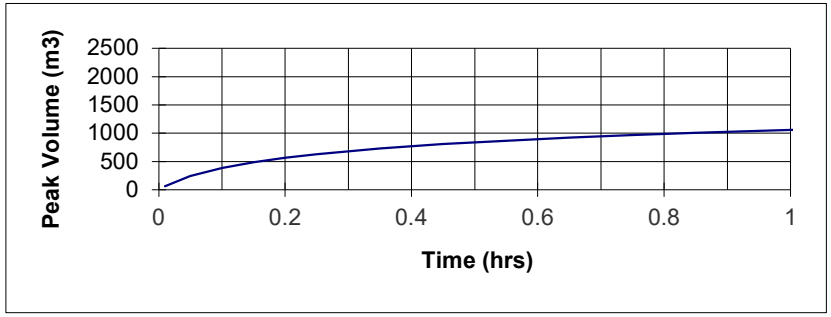
Rational method: Runoff coefficients

C before development	
C after development	0.540

Peak flows	Natural catchment:		Developed catchment without attenuation:	
Minor RI (1 in 5)		l/s	435	l/s
Major RI (1 in 50)		l/s	671	l/s

Developed, attenuated catchment:

Recurrence interval 1:	50	yrs
Q :- dam outflow	7	l/s
Req'd attenuation vol.	**1958.5**	**m3**



FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT
CATCHMENT B
DETENTION VOLUME FOR 1:100 YEAR RETURN PERIOD

Catchment:

Total catchment	7.992	ha
Attenuated catchment	7.992	ha
Unattenuated catchment	0	ha
Area to be developed	7.992	ha
Pre-developed area	7.992	ha
Time of concentration Tc	0.25	h

Storm rainfall:	RI (yrs)	Duration (h)	Rain depth (mm)	Rain int. (mm/h)
Minor RI; 1 day rain	5	1 day	35.00	
Major RI; 1 day rain	100	1 day	59.00	
Minor RI; 24h rain	5	24	38.5	
Major RI; 24h rain	100	24	64.9	
Minor RI; critical storm intensity	5	0.25		38.3
Major RI; critical storm intensity	100	0.25		64.6

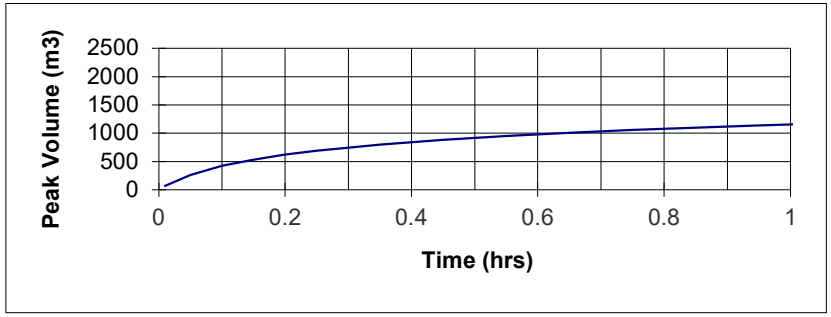
Rational method: Runoff coefficients

C before development	
C after development	0.540

Peak flows	Natural catchment:		Developed catchment without attenuation:	
Minor RI (1 in 5)		l/s	435	l/s
Major RI (1 in100)		l/s	733	l/s

Developed, attenuated catchment:

Recurrence interval 1:	100	yrs
Q :- dam outflow	7	l/s
Req'd attenuation vol.	**2195.9**	**m3**



Annexure H – Rainfall and Evaporation Data

FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT

Rainfall @ Station G1E007

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1978/79	0.0	0.0	0.0	9.3	10.4	4.0	0.9	47.1	37.8	30.4	28.8	28.8	0.0
1979/80	22.0	3.9	1.2	9.3	2.6	0.0	20.7	66.7	48.6	10.9	40.0	10.8	236.7
1980/81	2.6	65.8	12.6	6.1	0.0	30.4	8.7	5.4	21.1	70.2	61.3	35.5	319.7
1981/82	8.6	7.2	2.9	21.8	1.6	14.7	37.1	17.9	47.7	50.6	41.3	3.6	255.0
1982/83	11.5	4.2	19.6	13.8	17.0	11.3	6.2	82.2	56.3	47.5	18.9	26.7	315.2
1983/84	2.0	5.6	9.0	0.6	1.3	9.9	12.2	101.8	15.4	38.5	20.1	56.5	272.9
1984/85	67.5	0.0	33.7	10.0	4.6	46.6	44.2	16.6	49.1	90.9	51.2	32.9	447.3
1985/86	2.3	2.3	1.9	7.5	1.3	18.0	13.5	13.9	92.7	55.3	48.0	52.3	309.0
1986/87	16.4	14.7	1.7	15.2	5.4	1.2	29.1	69.5	47.7	80.7	66.3	23.1	371.0
1987/88	7.2	3.7	22.5	0.6	0.0	10.3	58.5	19.1	59.4	48.1	56.1	27.3	312.8
1988/89	6.9	7.5	2.1	1.3	6.5	25.9	33.6	34.7	20.8	77.7	49.2	58.1	324.3
1989/90	19.2	7.0	0.8	10.6	5.4	0.3	90.5	60.9	56.5	74.1	14.9	5.2	345.4
1990/91	0.9	4.8	17.8	0.9	0.0	0.0	0.0	0.0	52.5	240.3	10.4	68.4	0.0
1991/92	34.4	7.4	4.0	0.5	8.3	4.5	14.2	22.2	53.4	37.8	14.9	22.5	224.1
1992/93	37.2	2.4	0.0	0.0	0.0	0.0	47.4	12.1	59.7	38.1	54.9	4.5	0.0
1993/94	1.5	0.4	8.9	3.2	0.0	1.6	31.4	12.6	0.0	30.2	6.2	17.7	113.7
1994/95	10.7	4.7	2.2	4.7	2.0	19.6	5.0	16.5	49.9	67.2	42.7	0.0	225.2
1995/96	1.6	0.0	8.2	0.0	29.0	0.0	21.3	28.9	29.2	38.0	45.4	47.1	248.7
1996/97	9.9	17.0	12.6	1.2	0.0	8.0	14.8	27.6	67.0	14.4	20.9	0.0	193.4
1997/98	3.0	20.0	2.2	4.2	0.0	3.8	10.8	39.4	30.2	37.4	23.0	6.4	180.4
1998/99	6.2	35.5	15.6	0.4	0.0	0.4	14.8	47.2	45.4	59.3	71.6	46.4	342.8
1999/00	0.0	9.8	0.0	3.2	0.0	0.0	5.0	27.6	11.2	35.0	21.6	32.2	145.6
2000/2001	2.2	2.8	0.0	9.2	4.4	0.2	21.2	59.2	26.4	116.3	63.8	34.0	339.7
2001/2002	22.4	15.3	3.4	41.2	10.9	5.4	11.0	53.4	49.8	53.9	47.9	26.7	341.3
2002/2003	24.4	3.8	17.0	0.0	0.0	7.6	8.0	4.8	4.8	18.0	80.8	29.8	199.0
2003/2004	7.8	0.0	15.8	9.2	0.0	4.1	14.2	0.8	52.6	35.4	34.8	11.2	185.9
2004/2005	48.2	2.0	3.8	6.0	2.4	3.8	26.8	36.2	64.0	0.0	0.0	0.0	0.0
Avg:	**14.5**	**9.5**	**8.4**	**7.3**	**4.5**	**9.3**	**23.1**	**34.2**	**42.6**	**57.5**	**39.8**	**27.2**	**271.7**

FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT

Evaporation @ Station G1E007

	Oct	Nov	Dec	Jan	F0b	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1978/79	0.0	0.0	0.0	357.1	263.5	226.9	138.0	95.2	57.3	58.3	80.3	118.5	**1395.1**
1979/80	151.0	216.9	271.6	266.9	210.3	171.7	101.1	71.6	58.2	55.2	71.9	117.0	**1763.4**
1980/81	175.1	176.8	224.6	247.1	226.5	178.4	119.2	81.9	48.8	47.7	85.3	104.5	**1715.9**
1981/82	181.1	215.7	279.9	235.3	232.6	207.2	123.4	70.4	38.7	42.6	59.0	121.1	**1807.0**
1982/83	195.0	192.0	228.1	251.3	189.5	168.3	125.7	65.5	37.4	55.1	73.9	80.7	**1662.5**
1983/84	167.0	198.1	0.0	255.1	239.3	199.9	131.7	70.7	57.6	56.0	68.1	80.0	**1523.5**
1984/85	142.5	244.5	225.7	231.5	216.8	157.6	104.2	77.9	44.2	53.7	74.4	95.9	**1668.9**
1985/86	172.3	238.8	259.9	284.0	226.3	176.0	109.5	72.5	56.5	48.3	66.2	104.3	**1814.6**
1986/87	168.4	221.7	284.7	239.2	195.4	177.7	104.1	72.5	58.4	47.1	62.3	93.1	**1724.6**
1987/88	162.2	202.2	210.1	245.0	238.0	167.3	119.4	81.9	43.9	38.7	64.9	97.3	**1670.9**
1988/89	163.4	235.0	288.6	258.3	231.5	172.9	124.1	63.8	44.1	46.5	56.7	90.0	**1774.9**
1989/90	168.2	226.0	259.8	265.1	213.9	186.8	102.3	65.4	42.7	39.4	71.9	110.7	**1752.2**
1990/91	196.9	211.3	242.3	251.9	0.0	0.0	0.0	0.0	0.0	55.7	71.6	91.8	**1121.5**
1991/92	148.3	199.4	263.5	280.5	210.3	190.7	100.2	59.3	0.0	0.0	0.0	0.0	**1452.2**
1992/93	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	94.8	**94.8**
1993/94	178.7	223.6	253.0	273.1	241.3	182.1	108.5	59.5	0.0	44.0	73.2	93.5	**1730.5**
1994/95	192.9	219.2	274.7	257.1	206.1	191.8	125.7	82.3	41.3	50.6	48.5	0.0	**1690.2**
1995/96	147.5	213.0	215.2	248.0	206.5	167.1	120.3	83.3	35.5	86.0	60.6	64.5	**1647.5**
1996/97	140.0	172.5	189.9	243.3	204.0	154.3	106.8	79.8	50.3	71.8	53.7	131.0	**1597.4**
1997/98	220.0	196.6	239.7	257.1	201.5	181.3	105.3	60.9	32.1	52.1	80.2	113.7	**1740.5**
1998/99	168.3	199.5	259.1	262.4	220.0	197.4	137.2	85.8	53.5	59.3	65.3	81.9	**1789.7**
1999/00	209.8	190.8	248.0	241.8	241.0	215.0	133.0	83.2	53.6	59.6	61.2	101.1	**1838.1**
2000/2001	203.2	217.2	258.5	265.2	233.4	190.2	118.2	61.4	60.1	34.1	0.0	77.4	**1718.9**
2001/2002	153.5	228.1	259.3	261.3	229.7	174.9	118.5	89.8	42.6	45.3	77.0	113.8	**1793.8**
2002/2003	170.9	227.3	273.5	283.5	221.5	189.1	117.0	87.8	60.3	65.5	66.8	82.6	**1845.8**
2003/2004	148.3	229.5	226.8	271.2	227.0	199.1	110.2	84.3	49.7	49.9	55.3	114.7	**1766.0**
2004/2005	150.0	213.0	269.8	281.0	237.4	204.8	126.8	69.6	44.4	0.0	0.0	0.0	**1596.8**
Avg:	**171.0**	**212.3**	**250.3**	**262.1**	**222.5**	**185.1**	**117.2**	**75.1**	**48.3**	**52.6**	**67.3**	**98.9**	**1742.9**

FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT
Evaporation Pond Volume Calculation

Month	Average Rainfall		Average Evaporation		Pond capacity		Capacity	
	mm	m3	mm	m3	In	Out	needed	
Oct	14.5	591.3	171	150.5	591.3	150.5	440.9	
Nov	9.5	387.4	212.3	186.8	387.4	186.8	641.5	
Dec	8.4	342.6	250.3	220.3	342.6	220.3	763.8	
Jan	7.3	297.7	262.1	230.6	297.7	230.6	830.9	
Feb	4.5	183.5	222.5	195.8	183.5	195.8	818.6	
March	9.3	379.3	185.1	162.9	379.3	162.9	1035.0	
April	23.1	942.1	117.2	103.1	942.1	103.1	1873.9	
May	34.2	1394.8	75	66.0	1394.8	66.0	3202.7	
June	42.6	1737.3	48.3	42.5	1737.3	42.5	4897.5	
July	57.5	2345.0	53.4	47.0	2345.0	47.0	7195.5	
Aug	39.8	1623.2	67.7	59.6	1623.2	59.6	8759.1	
Sept	27.2	1109.3	99.7	87.7	1109.3	87.7	**9780.7**	**m3**
Oct	14.5	591.3	171	150.5	591.3	150.5	10221.5	
Nov	9.5	387.4	212.3	186.8	387.4	186.8	10422.2	
Dec	8.4	342.6	250.3	220.3	342.6	220.3	10544.5	
Jan	7.3	297.7	262.1	230.6	297.7	230.6	10611.5	
Feb	4.5	183.5	222.5	195.8	183.5	195.8	10599.3	
March	9.3	379.3	185.1	162.9	379.3	162.9	10815.6	
April	23.1	942.1	117.2	103.1	942.1	103.1	11654.6	
May	34.2	1394.8	75	66.0	1394.8	66.0	12983.4	
June	42.6	1737.3	48.3	42.5	1737.3	42.5	14678.2	
July	57.5	2345.0	53.4	47.0	2345.0	47.0	16976.2	
Aug	39.8	1623.2	67.7	59.6	1623.2	59.6	18539.8	
Sept	27.2	1109.3	99.7	87.7	1109.3	87.7	**19561.4**	**m3**
Tot vol/year:		11333.5		1552.8				

C factor	0.54	
Rainfall Area	75523.6	m2
Evaporation Area	880	m2