



GEOTECHNICAL REPORT

***NEW FIRE WATER INSTALLATION
TRANSNET PIPELINES
HOWICK DEPOT
KWAZULU-NATAL***

***Requested by
GreyJones (Pty) Ltd***

***Project GA1063/2025
September 2025***

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- Certification mark for Ex Equipment • Testing & Certification • Training • Area Classifications • Inspecting new or in-service Ex Equipment • Management systems for Ex Installations (EXPLOSTOP) • Consultation • Presentations, Workshops and Articles •

CLIENT DETAILS

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Client order no:
TPL/EXP/HAZ-141003-02
Enquiries: J Venter
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Date: 02/10/2014

Client contact person: Mr. Bernard Burger.

HAZARDOUS AREA CLASSIFICATION GUIDELINES REPORT FOR TRANSNET PIPELINE (TPL) INFRASTRUCTURE

Explolabs report no XPS/1015/13013Rev3

Revision	Details
-	First edition of report.
1	Changes made as requested by Mr. Chris Murray.
2	Addition of the test rooms on request of Bernard Burger.
3	Addition of the Additives Dosing Gantry.

INDEX

In co-operation with:



T0104

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DIRECTOR: JG AURET

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1 SCOPE

This area classification guide covers infrastructure used on the TPL including:

1. Pig Receivers
2. Pig Launchers
3. Mainline Pump sets
4. Booster Pump sets
5. Sumps
6. Strainers
7. Storage Tanks
8. Provers
9. LP Delivery manifolds
10. HP Routing manifolds
11. Density Huts
12. Oily and Storm Water Separators/Spill Basins
13. Motorised Block Valve Chambers
14. Road Loading and Offloading Gantries
15. Test facilities
16. Additives Dosing Gantry

This area classification was done in terms of and complies with **SANS 10108 Edition 5: 2005 “The classification of hazardous locations and the selection of apparatus for use in such locations”**. Compliance with this standard is legally required.

The following standard:

Edition 3: 2005 of Part 15 of the IP Model Code of Safe Practice in the Petroleum Industry, “Area Classification Code for Installations Handling Flammable Fluids”, IP Part 15 for short;

was used as the basis for the classification. (Such a classification complies with SANS 10108.)

The following conclusions were drawn in deriving the classification results:

- That the properties of flammable materials applicable to this project are within the scope of IP Part 15;
- That the facilities and operational conditions are within the scope of IP Part 15;

2 BACKGROUND

Transnet Pipelines currently maintains and operates pipeline infrastructure within the Republic of South Africa. This infrastructure comprises refined multi-product pipelines, avtur pipelines, crude oil pipelines, natural gas pipelines and associated intake, pumping, storage and delivery depots.

The information that was used in this guide was obtained from the NMPP (New Multiproduct Pipe Line) and the original assessments were captured in a series of reports with reference number: XPS/0253/08194 and are therefore typical “worst case” values for the pipe transfer system. (XPS/1012/13010 for NMPP TM2 test facility)

In order to cover all existing pipeline infrastructure, a Hazardous Classification exercise was originally completed by De Villiers & Khan in 1999. More recently, a Hazardous Classification exercise was completed by ExploLabs(Pty) Ltd for all pipeline infrastructure installed as part of the New Multi-products Pipeline (Ref: ExploLabs Report no XPS/0253/08194AtoD).

Because all the TPL sites handle the same product ⁽¹⁾ as detailed in the NMPP Report at similar process conditions ⁽²⁾, using similar equipment, it was deemed acceptable to produce a generic report covering all remaining installations not covered by the NMPP Report.

[⁽¹⁾ Crude Oil is also handled on these sites, in addition to the products listed in the NMPP Report, ⁽²⁾ Sites do differ in terms of the volume of product stored in accumulator and intermix tanks]

TPL is desirous of updating existing Hazardous Area Classification documentation for existing infrastructure (excluding NMPP), comprising of approx. 25 intake and delivery depots and pump stations. This generic report can be used by TPL as a basis for reviewing and updating of site specific Hazardous Area Classification drawings in the future.

An Additives Dosing Gantry was added to the report in 2014.

3 SOURCES OF INFORMATION

Information on the plant examined was gathered from project documentation, particularly the following:

- Transnet/NMPP Alliance/Uhde Piping and Instrumentation Diagrams.
- Scope of Work issued by Mr. Chris Murray.(Email format)
- NMPP Area Classification reports.
- Detailed information was sent via Email from Mr. Chris Murray on the processes of the Additives Dosing Gantry as well as an layout drawing.

4 FLAMMABLE MATERIALS LIST

Generally, fluids (a) with flash points within the ambient temperature range (eg $\leq 55^{\circ}\text{C}$) or within the operational temperature range and (b) being used in significant quantities i.e.

Material state	Ventilation	
	Open Air	Inside Building
Liquefied gas	100 litres	5 litres
Liquid	200 litres	25 litres
Gas	1000 litres	50 litres

are considered capable of forming explosive atmospheres.

The Table below lists the flammable fluids currently handled by TPL within their infrastructure and their explosive properties are listed below (as obtained from the NMPP reports):

No.	Material	Composition	Relative density (air=1)	Flash point (°C)	LEL % (v/v)	UEL % (v/v)	Boiling Point (°C)	Vapour pressure at operating T (kPa) ¹	Auto-ignition temperature (°C)	Gas group ²	Temperature Class ³
1	95 ULP	Natural Gasoline; Low boiling point naphtha	>1	-20	1.3	7.1	38.05-200	45-75	250	IIA	T3
2	93 ULP	Natural Gasoline; Low boiling point naphtha	>1	-20	1.3	7.1	38.05-200	45-75	250	IIA	T3
3	LSD	Fuel, diesel gas oil – unspecified. Sulphur content 0-0.05% (m/m)	>1	55	1.3	6.0	160-380	0.5	225	IIA	T3
4	ULSD	Fuel, diesel gas oil – unspecified. Sulphur content 0-0.005% (m/m)	>1	55	1.3	6.0	160-380	0.5	225	IIA	T3
5	Jet Fuel (Avtur)	Hydrodesulphurized heavy naphtha; kerosene; methylcyclohexane; heptane; octane; xylene; toluene, cyclohexane	>1	>46	1.0	6.0	158	<0.1	210	IIA	T3
6	Seal and Lubricating Oil	Heavy hydrocarbons	>1	>100			171-371			IIA	T3
7	Additives ⁴	HiTEC 4646 SDS	>1	65	-	-	-	-	-	IIA (Typical Value)	T3 (Typical Value)
		HiTec6421		65	1	8	-	-	>200		
		Keropur 3597		65	-	-	-	-	>200		
		Nemo2011		68	-	-	-	-	-		
		Nemo 2041		78	-	-	-	-	-		
		Optimise D3037 SDS		63	0.6	7	-	-	425		
		Optimise G2003 SDS		63	0.6	7	-	-	425		
		Ultrazol 9013S (2)		75	-	-	-	-	-		
		Ultrazol 9013S		75	-	-	-	-	-		

NOTES	1. Vapour pressure is taken from Fluor NMPP Operating Philosophy Rev. 1. Jet Fuel LEL and UEL are taken from the Sapref MSDS. Rest of flammability data is taken from Sasol MSDSs for Sasol products.													
	2. Flammable gases and liquids are generally divided into groups to distinguish their ignition properties, as follows: – Group I: mines susceptible to firedamp; – Group II: explosive gas atmospheres occurring in areas other than mines susceptible to firedamp (surface applications). – Group III: explosive dust atmospheres occurring in areas mines susceptible to firedamp (surface applications). Group II is applicable here. The explosive gas atmospheres are divided based on spark ignition energies into IIA, IIB and IIC, IIC gases having the lowest ignition energies.													
	3. Likewise, Group II gases are divided into the following 6 temperature classes based on their auto-ignition temperatures													
	<table border="1"> <thead> <tr> <th>Temperature class</th><th>Auto ignition temp. range of gas (°C)</th></tr> </thead> <tbody> <tr> <td>T1</td><td>>450</td></tr> <tr> <td>T2</td><td>>300 to 450</td></tr> <tr> <td>T3</td><td>>200 to 300</td></tr> <tr> <td>T4</td><td>>135 to 200</td></tr> <tr> <td>T5</td><td>>100 to 135</td></tr> <tr> <td>T6</td><td>>85 to 100</td></tr> </tbody> </table>	Temperature class	Auto ignition temp. range of gas (°C)	T1	>450	T2	>300 to 450	T3	>200 to 300	T4	>135 to 200	T5	>100 to 135	T6
Temperature class	Auto ignition temp. range of gas (°C)													
T1	>450													
T2	>300 to 450													
T3	>200 to 300													
T4	>135 to 200													
T5	>100 to 135													
T6	>85 to 100													
	4. Typical values were used where not indicated on MSDSs. The flash points for Nemo4006 and Nemo6101 were obtained for Kerosene that was only 39% of the volume of the material and this value can possibly be much higher if better data is available.													

5 TRANSNET PIPE LINE INFRASTRUCTURE

5.1 Equipment and Process Overview

Transnet Pipeline infrastructure included the following equipment, operated under the following process conditions:

- Maximum Allowable Operating Pressure (MAOP): 10 200 kPa(g)
 - Maximum Pipeline Design Pressure: 95% MAOP
 - Minimum Design Temperature: -20 °C
 - Maximum Design Temperature: 50 °C
 - Design velocity for the pipelines is 2 m/s with a maximum of 3 m/s.
- a. Receivers –Sources of release include:vents, drains (inclusive of free draining and with use of pump), and TRVs (thermal relief valves), which were all piped to buried sump tanks i.e. a closed system. The Receiver had a barrel door which was routinely opened to permit the removal of spheres/batching pigs etc. The door was mechanically interlocked to prevent the door from being opened while the system was under pressure. Product was not present during normal operations.
 - b. Launchers - Sources of release include: vents, drains (inclusive of free draining and with use of pump), and TRVs (thermal relief valves), which were all piped to buried sump tanks i.e. a closed system. The Launcher has a barrel and magazine door which was routinely opened to permit the insertion of spheres/batching pigs etc. The door was mechanically interlocked to prevent the door from being opened while the system is under pressure. Product was not present during normal operations.

- c. Mainline Pump sets and associated Lube Oil systems - Sources of release include: pump seals, vents and drains. Pump seals were fitted with either pressure or level switches/transmitters to detect seal failure.
- d. Booster Pump sets - Sources of release include: pump seals, vents and drains. Pump seals are fitted with either pressure or level switches/transmitters to detect seal failure.
- e. Sumps - sumps comprised of buried tank systems used to capture product from routine maintenance activities such as draining of receivers, launchers, strainers etc. Drain lines routed to these sumps consisted of pressurised and non-pressurised drain lines. A mixture of products may be present in these sumps during normal operations. Sump vents were fitted with flame arrestors.
- f. Strainers and De-aerators - were installed to remove foreign particles from the product. Sources of release include: strainer and de-aerator drains and vents. Strainer lids were routinely opened to facilitate cleaning of strainer baskets. Product was not present during normal operations.
- g. Storage Tanks (accumulator and intermix) of varying storage capacities and designs. The tanks vented to atmosphere.
- h. Provers - Sources of release include: vents, drains (inclusive of free draining and with use of pump), and TRVs (thermal relief valves), which are all piped to buried sump tanks i.e. a closed system. The Prover has a barrel door which is routinely opened to permit the removal of spheres for inspection purposes. The door is mechanically interlocked to prevent the door from being opened while the system is under pressure. Product is not present during normal operations.
- i. LP Delivery manifolds - Sources of release include: TRVs, high point vents and low point drains.
- j. HP Routing manifolds - Sources of release the same as for LP Delivery manifolds (for the purpose of Explosion Prevention Hazardous Area Classification according to IP 15, the zoning accommodates pressures up to 100Bar and LP and HP can therefore be considered to be the same).
- k. Density Huts and Sample Points. Density Huts contained hydrometers and sample points, and were used for taking regular samples of product during normal operations. A mixture of products was expected to be present in these Density Huts during normal operations. Sample points are also located at various points on the manifolds. Excess product is routed via open top tung-dishes and drain piping to the waste collection sumps or buried tanks.
- l. Oily Water and Storm Water Separators/Spill Basins (Oil/Water separators). Storm water (and product during a loss of containment situation) was drained via open concrete trenches installed under manifolds and in tank bunds to the Oil/Water separator and to the spill basin for containment purposes. A mixture of products was expected in the Oil/Water Separator and Spill Basin during normal operations.
- m. Motorised Block Valve Chambers (Buried below ground). These chambers contained flanged isolation valves, both inline and for instrument process connections.
- n. Road Loading and offloading gantries. These gantries were used for loading and offloading of product to road tankers. Loading Arms with API couplers, flexible hoses,

strainer/de-aerators, vents drains and EPVs were all located within these facilities. Some gantries were equipped with roofs, all were naturally ventilated.

- o. Test and product sample rooms. Product samples were received from sample points on the plant and stored in the Product Sample Store Room. The room was ventilated by an extraction ventilation system and equipped with spillage containment by means of a lowered floor that acted as a spillage containment sump. No decanting was done in the sample room. The samples were retrieved from the store room and transferred to the Test Room where it were prepared and analyzed. Only small volumes of solvent and samples were handled in the test room (<25 liter). Flammable waste was discharged into a sink that drained to an open top waste collection sump outside the room. *As extracted from test facility on the NMPP.*
- p. An Additives Dosing Gantry was added to the table and was based on the following processes: The additives were received from road tankers and transferred with centrifugal pumps (Decanting Pumps) to Storage tanks. From the tanks positive displacement pumps were used to dose the additives to road tankers. The Storage tanks were installed in an open well naturally ventilated area with a solid roof and had a spillage containment bund around them. Spillage in the offloading bay and tank bund was collected in a sump and was transferred to an oil/water separator pit with a pipe (information was captured from a provided drawing and should be verified, Fluor Igoda drawing, A4XY-001/65/AC/001R1). Large volumes of additives were not dosed to road tankers in this are but the additives were received, stored and transferred from this facility.

5.2 Zoning

Equipment		SOR	Grade of release (C/P/S)	Flammable Material				Ventilation			Hazardous Area			Reference
ID	Item			Material No.	P (kPa)	T (°C)	State (S/A/B/C/G (I)/G(ii))	Type (N/A)	Degree (Open-air/Adq/Inadq)	Availa= bility (G/F/P)	Zone	Horiz (m)	Vert (m)	
Receiver and launcher														
	Pig launcher/ receiver doors.	Opening and seals	P	1-6	10 000 (max)	Amb	C	N	O	G	1	3	3	IP 15 Section5.4.6. <i>Pig launchers.</i>
	Pig launcher/ receiver doors.	Spreading of vapours.	S	1-6	<10 000 (max)	Amb	C	N	O	G	1	6	6	IP 15 Section5.4.6. <i>Pig launchers. (release on hatch <2mm hole)</i>
	Pig Launcher/ receiver drain pump.	Single mechanical seal, flanged joints	S	1-6	5 500 (obtained from process engineer on NMPP)	Amb	C	N	O	G	2	4	4	IP 15 Table C9. SD <20mm, throttle bush (if SD< 10mm).
	Pig Launcher/ receiver drain.	Refer to Drains.												
	Pig Launcher/ receiver vent.	Vent opening	P	1-6	N/A	Amb	C	N	O	G	2	3	3	IP 15 Table 5.5 (vent diameter of <50mm; release of <250m³/hr) and section 5.4.4.5.
												1m if only pressure relief valve vents		

Equipment		SOR	Grade of release (C/P/S)	Flammable Material				Ventilation			Hazardous Area			Reference
ID	Item			Material No.	P (kPa)	T (°C)	State (S/A/B/C/G (I)/G(ii))	Type (N/A)	Degree (Open-air/Adq/Inadq)	Availability (G/F/P)	Zone	Horiz (m)	Vert (m)	
Mainline and Booster Pump sets														
	Mainline/Booster pump.	High integrity double seal.	S	1-6	<50 000	Amb	C	N	O	G	2	5	5	IP 15 Table C6 and Table C9 (refer to Note 4 below this table).
	Mainline/Booster pump.	Single mechanical seal	S	1-6	<50 000	Amb	C	N	O	G	2	Were considered open with no vapour barriers such as walls/buildings (radius of 22m for 10 000kPa)		IP 15 Table C6 and Table C9 (shaft diameter of <10mm, shaft located >1m above floor level).
Sumps and drains														
	Open drain.	Liquid surfaces	S	1-6	Atm	Amb	C	N	O	G	1	Interior of drains up to sides.		IP 15 Section 5.4.2. Sample points and equipment drains and section 5.4.10.
	Closed drain.	Liquid surfaces	S	1-6	Atm	Amb	C	N	O	F	1	Interior (if closed).		IP 15 Section 5.4.2. Sample points and equipment drains
Strainers and De-aerators														
	Strainer.	Manhole covers, flanged joints and screwed joints	S	1-6	<10 000	Amb	C	N	O	G	2	2.5	2.5	IP 15 table 5.6.
	De-aerator.	Flanged and screwed joints	S	1-6	<10 000	Amb	C	N	O	G	2	2.5	2.5	IP 15 table 5.6.
	Strainer.	Liquid surfaces	C	3	N/A	Amb	C	N	I	G	0	Interior		IP 15 Section 3.2.
	De-aerator.	Liquid surfaces	C	3	N/A	Amb	C	N	I	G	0	Interior		IP 15 Section 3.2.
	Strainer.	Vents	S	1-6	<10 000	Amb	C	N	O	G	2	3	3	IP 15 table 5.5 (for vent with diameter of 50mm and release of <10m³/hr) and section 5.4.4.5.
												1m if only pressure relief valve vents		

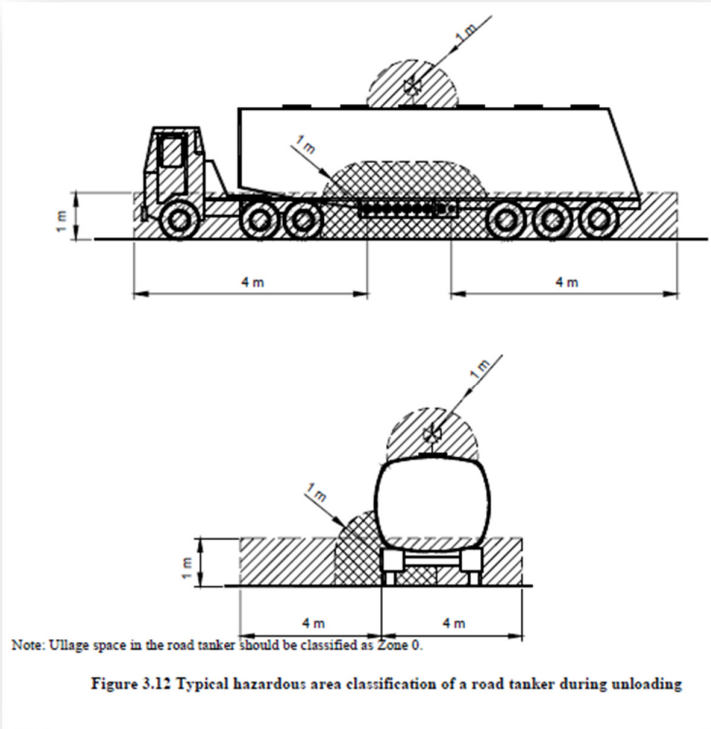
Equipment		SOR	Grade of release (C/P/S)	Flammable Material				Ventilation			Hazardous Area			Reference
ID	Item			Material No.	P (kPa)	T (°C)	State (S/A/B/C/G(i)/G(ii))	Type (N/A)	Degree (Open-air/Adq/Inadq)	Availa=bility (G/F/P)	Zone	Horiz (m)	Vert (m)	
	De-aerator.	Vents	S	1-6	<10 000	Amb	C	N	O	G	2	3	3	IP 15 table 5.5 (for vent with diameter of 50mm and release of <10m ³ /hr) and section 5.4.4.5.
Storage Tanks (accumulator and intermix, not bulk storage tanks)														
	Accumulator/intermix tank.	Openings on tank cover and vents	P	1-6	Atm	Amb	C	N	O	G	1	4	4	IP 15 Section 5.4.4.2. Table 5.4. (vent diameter ≤250mm and vent rate of ≤500Nm ³ /hr)
	Accumulator/intermix tank.	Release from floating cover (if used)	P	1-6	Atm	Amb	C	N	O	G	1	Interior.		IP 15 Section 3.2.2. <i>Floating roof tankage.</i>
	Accumulator/intermix tank.	Liquid surfaces	C	1-6	Atm	Amb	C	N	I	P	0	Interior.		IP 15 Section 1.
	Accumulator/intermix tank transfer pump.	Single mechanical seal, flanged joints	S	1-6	<500	Amb	C	N	O	G	2	5	5	IP 15 Table C9. SD 30mm, throttle bush.
Provers														
	Prover transfer tanks.	Liquid surfaces	C	1-6	Atm	Amb	C	N	I	P	0	Interior		IP 15 Section 3.2.
	Prover transfer tanks.	Manhole covers.	P	1-6	Atm	Amb	C	N	O	G	2	2.5	2.5	IP 15 Section 5.4.5.
	Prover transfer tanks.	Vent.	P	1-6	Atm	Amb	C	N	O	G	1	2	2	IP 15 Section 5.4.4. (flow assumed to be <250Nm ³ /h)
LP Delivery manifolds														
	Pipes and instrumentation.	Valve stems, flanged and threaded joints.	S	1-6	<10 000 (Assumed Maximum as from NMPP)	Amb	C	N	O	G	2	2.5	2.5	IP 15 Section 5.4.5. (located in open well naturally ventilated area).

Equipment		SOR	Grade of release (C/P/S)	Flammable Material				Ventilation			Hazardous Area			Reference
ID	Item			Material No.	P (kPa)	T (°C)	State (S/A/B/C/G (i)/G(ii))	Type (N/A)	Degree (Open-air/Adq/Inadq)	Availability (G/F/P)	Zone	Horiz (m)	Vert (m)	
	Manifold.	High point vents (limited data available).	P	1-6	<10 000	Amb	C	N	O	G	1	2.5	2.5	IP 15 table C9(a), for release hole diameter of 2mm. Section (5.4.4.4. suggest instrumentation vents should be limited to release of <10m³/h).
HP Routing manifolds														
Same as above for pressures of <10 000kPa.														
Density Huts and Sample Points														
	Sampling cabinet.	Sample point outlet	P	1-6	<2 000	Amb	C	N	A	G	1	4.5	4.5	IP 15 Section 5.4.2. (Sampling opening diameter ø9mm, linear adapted from 10mm release and 10 000kPa)
												Interior of enclosure/ shed + 7m to open side (if enclosed)		
	Sampling cabinet.	Vapour drifting from sample points	S	1-6	Atm	Amb	C	N	O	G	2	1m above ground level	1	IP 15, adapted from figure 5.4. (for liquid pool with surface area of 9m²)
	Draining sumps/trenches from sample points.	Liquid surface in open top drains	C	1-6	Atm	Amb	C	N	O	G	0	Interior		IP 15 section 5.4.1.0.
	Draining sumps/trenches from sample points.	Top sides of open top drains	P	1-6	Atm	Amb	C	N	O	G	1	1	1	IP 15 figure 5.5.
Oil/Water separators and spillage collection basins/sumps														
	Oil/water separators.	Interior of the separator tank.	C	1-6	Atm	Amb	C	N	O/I	G/P	0	Interior up to the height of the tank/sump walls		IP 15 section 5.4.8.
	Oil/water separator (open top).	Top sides of the separator.	C	1-6	Atm	Amb	C	N	O	G	1	Up to 1m above release point and down to ground level	2	IP 15 figure 5.4, for a liquid surface of up to 5x3m.
	Oil/water separator (closed).	Top sides of the separator.	C	1-6	Atm	Amb	C	N	O	G	1	Up to 1m above release point and down to ground level	2 from any opening	IP 15 figure 5.4, for a liquid surface of up to 5x3m.

Equipment		SOR	Grade of release (C/P/S)	Flammable Material				Ventilation			Hazardous Area			Reference
ID	Item			Material No.	P (kPa)	T (°C)	State (S/A/B/C/G (i)/G(ii))	Type (N/A)	Degree (Open-air/Adq/Inadq)	Availability (G/F/P)	Zone	Horiz (m)	Vert (m)	
	Open top basins.											Refer to open top Oil/water separators.		
	Open top sumps with no primary release points in them but located in a hazardous area (typically rain water drains).	Liquid contaminant surface and vapour drift.	C	1-6	Atm	Amb	C	N	I	G	1	Interior		IP 15 section 5.4.10.
Motorised Block Valve Chambers (buried below ground)														
	Pipes and instrumentation.	Valve stems, flanged and threaded joints.	S	1-6	<10 000 (Assumed maximum as from NMPP)	Amb	C	N	I	P	1	2.5	2.5	IP 15 Section 5.4.5. (can be zone 2 if well ventilate, >12air changes per hour over the volume of the chamber)
												Extent to interior of pit/chamber.		
Loading Gantries														
	Road tanker loading bay (covered, see sketch below).	Loading island	S	1-6	344	Atm	C	N	O	G	1	1	1	IP 15 Fig. 3.8.
											2	Under the roofing		
	Road tanker loading bay (covered).	Spillage bund	S	1-6	Atm	Atm	C	N	O	G	2	1 above ground		IP 15 Fig. 3.8.
	IP 15 Fig. 3.8.													
	Side elevation Plan - with overhead roofing Notes: 1. The bay overhead loading island is not to be located in a hazardous area, with the loading area over the island. 2. The bay overhead loading island is not to be located in a hazardous area, with the loading area over the island. 3. The bay overhead loading island is not to be located in a hazardous area, with the loading area over the island.													

Equipment		SOR	Grade of release (C/P/S)	Flammable Material				Ventilation			Hazardous Area			Reference
ID	Item			Material No.	P (kPa)	T (°C)	State (S/A/B/C/G (i)/G(ii))	Type (N/A)	Degree (Open-air/Adq/Inadq)	Availa= bility (G/F/P)	Zone	Horiz (m)	Vert (m)	
	Road tanker loading bay (open).	Flexible hose connection point	P	1-6	Atm	Atm	C	N	O	G	1	1	1	IP 15 Section 3.3.4.1.
	Road tanker loading bay (open).	Flexible hose connection point	P	1-6	Atm	Atm	C	N	O	G	1	1 and up to 1m above the flexible hose connection point's storage height.	1	IP 15 Section 3.3.
Road tanker offloading														
	Road tanker (top loading).	Tanker fill covers	P	1-6	Atm	Atm	C	N	O	G	1	1	1	IP 15 Section 3.3.
	Road tanker.	Liquid surfaces in tank	C	1-6	Atm	Atm	C	N	I	P	0	Interior		IP 15 section 1.
	Road tanker (bottom loading).	Manhole covers or vents	S	1-6	Atm	Atm	C	N	O	G	2	1	1	IP 15 Section 3.3.
	Road tanker (bottom loading).	Connection points on side of road tanker	P	1-6	Atm	Atm	C	N	O	G	1	1	1	IP 15 Section 3.3.
	Road tanker (bottom loading).	spillages	S	1-6	Atm	Atm	C	N	O	G	2	1	4	IP 15 Section 3.3.
Test and product sample rooms (As extracted from the NMPP TM2)														
	Product sample room.	Liquid surfaces in containers	C	1-6	Atm	Amb	C	A	I	P	0	Interior of containers		IP 15 Section 1.
	Product sample room	Spillages	S	1-6	Atm	Amb	C	A	A	G	1	Interior of the spillage containment system up to a height of 1m above the floor.		IP 15, section 5.4.7.

Equipment		SOR	Grade of release (C/P/S)	Flammable Material				Ventilation			Hazardous Area			Reference
ID	Item			Material No.	P (kPa)	T (°C)	State (S/A/B/C/G (i)/G(ii))	Type (N/A)	Degree (Open-air/Adq/Inadq)	Availa= bility (G/F/P)	Zone	Horiz (m)	Vert (m)	
	Product sample room.	Spillages	S	1-6	Atm	Amb	C	A	A	G	2	Interior of the room.		IP 15, section 5.4.7.
	Test room fume hood/cupboard.	Liquid in containers	C	1-6	Atm	Amb	C	A	I	P	0	Interior of containers.		IP 15, Annex E and section 1.
	Test room fume hood/cupboard	Liquid in during decanting	S	1-6	Atm	Amb	C	A	A	G	2	Volume under fume hood.		IP 15, conservative zoning, can be fire hazard only, if <25liter flammable material is used.
	Test room.	Liquid surfaces in waste sinks and waste collection sump.	P	1-6	Atm	Amb	C	A/N	A	G	1	Volume of the sink and the interior of the waste sump up to the height of the bund walls.		IP 15, adapted from section 5.4.7.
	Test room.	Liquid surfaces in waste drain pipes.	P	1-6	Atm	Amb	C	N	I	P	0	Interior of drain pipes.		IP 15 Section 1.6.8.
The extraction ventilation system in the Sample Store Room was assumed to always be operational as well as the extraction ventilation on the fume cupboards located in the sample test room. Spillages must be cleaned promptly. Self-closing mechanisms to be placed on doors leading to the Test room and the Sample room.														
Tarlton Additives Dosing Gantry														
	Road tanker for offloading.	Refer to Figure 3.12 below for zoning around the Additives carrying road tanker during offloading.												IP 15 Fig. 3.12. (conservatively adapted since the flashpoint was >55°C)

Equipment		SOR	Grade of release (C/P/S)	Flammable Material			Ventilation			Hazardous Area			Reference	
ID	Item			Material No.	P (kPa)	T (°C)	State (S/A/B/C/G (i)/G(ii))	Type (N/A)	Degree (Open-air/Adq/Inadq)	Availability (G/F/P)	Zone	Horiz (m)		Vert (m)
	IP 15 Fig. 3.12.													
	Additives Tanks.	Liquid surfaces.	C	7	Amb	Amb	C	N	I	P	0	Interior of the tanks.		IP 15, Section 1.
	Additives Tanks.	Breather vents (gooseneck type vents assumed).	S	7	Amb	Amb	C	N	A	G	2	2	2	IP 15, Section 5.4.4.2. and Section 6.2 (conservatively adapted since the flashpoint was >55°C).
	Additives Tanks.	Spillages in bund.	S	7	Amb	Amb	C	N	A	G	1	Extend to cover area below roof and down to ground level (in order to simplify). Interior of the bund and drain pipes and up to height of the bund wall.		
	Additives Tank transfer pumps.	Shaft seals (Centrifugal pumps).	S	7	<500 (obtained from similar plants)	Amb	C	N	A	G	2	4	4	IP 15 adapted from Table C9(a) (conservatively adapted since the flashpoint was >55°C).

Equipment		SOR	Grade of release (C/P/S)	Flammable Material				Ventilation			Hazardous Area			Reference
ID	Item			Material No.	P (kPa)	T (°C)	State (S/A/B/C/G(i)/G(ii))	Type (N/A)	Degree (Open-air/Adq/Inadq)	Availa=bility (G/F/P)	Zone	Horiz (m)	Vert (m)	
	Additives Tank transfer pumps.	Shaft seals (Peristaltic pumps).	S	7	<500 (obtained from similar plants)	Amb	C	N	A	G	2	2.5	2.5	IP 15, adapted from Section 5.4.1.1. (conservative Zone, fine mist or spray forming not regularly expected and FP >55°C).
	Oil/Water separator.	Refer to entry higher in table.												

Zoning in the Additives Storage Area can be read as conservative since the flash point is relatively high with regards to the handling temperatures.

NOTE 1 – Abbreviations used:

SOR source of release

Grade of release: C Continuous
P Primary
S Secondary

P: Pressure

T: Temperature

State: S solid
A fluid category A
B fluid category B
C fluid category C
G(i) fluid category G(i)
G(ii) fluid category G(ii)

Ventilation type: N Natural
F Forced/artificial

Ventilation availability: G Good
F Fair
P Poor

NOTE 2 - This table must be read in conjunction with Annex A.

NOTE 3 - A release frequency of Level I was considered appropriate.

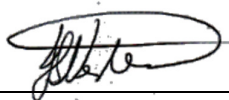
NOTE 4- A release hole size of 2mm was specified in IP15 if data on the release of these seals were not available.

6 GENERAL

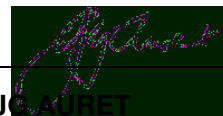
- 6.1 Where a condition or conditions (shown in *italics*) are specified in conjunction with the classification such conditions must be met to validate the classification. Non-compliance with the condition will normally require a more severe zone to be declared.

It is normally required that such conditions be displayed in affected areas and listed on area classification drawings, and that operators are trained on their necessity and application.

- 6.2 An area classification drawing (refer to ANNEX B for guidance) must be prepared referring to classification report and must be approved as a true reflection of this report. This drawing must include the explosive properties of the flammable materials as well as a reference to this report.
- 6.3 Suitable signage must be displayed to identify hazardous locations (refer to SANS 10086-1 and ANNEX D for guidance), including signage to prohibit smoking and open flames and to control the usage of standard equipment.
- 6.4 **Fixed** electrical equipment and instrumentation installed in hazardous areas must be suitably explosion protected. Any **mobile** electrical or electronic equipment that may be used in these hazardous areas (e.g. radios, electronic testers, etc.) must be explosion protected, unless used under suitable hot work permit conditions (refer to ANNEX C for guidance).
- 6.5 This document should be used as a guide only. If there are additional sources of release on the plant they should be additionally evaluated. A site specific area classification report should also be prepared, especially to capture spillage containment and to consider obstructions like walls and buildings in hazardous areas.



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Explosion Prevention Physicist



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Explosion Prevention Specialist

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ANNEX A: DISCUSSION OF ZONING TABLES

A.1 REFERENCES

SANS 60079-10 Ed 4.0: 2002 IP Part 15	Suggested format Role of RD
--	--------------------------------

A.2 APPLICATION

State: When finely divided, i.e. in dust form (typically with particle size less than 500 micron), a flammable **solid** material can form an explosive atmosphere when suspended in air.

The rate of vaporization (volatility) of a **fluid** depends on vapour pressure, or alternatively flash point and boiling point compared to ambient temperature. Therefore, IP Part 15 allocates the hazard radius in terms of the following fluid categories:

Fluid category A:	that, on release, would vapourize rapidly and substantially. This category includes: a) Any liquefied petroleum gas or lighter flammable liquid. b) Any flammable liquid at a temperature sufficient to produce, on release, more than about 40% by volume vaporization with no heat input other than from the surroundings.
Fluid Category B:	A flammable liquid, not in category A, but at a temperature sufficient for boiling to occur on release.
Fluid Category C:	A flammable liquid, not in categories A or B but that can, upon release, be at a temperature above its flash point, or form a flammable mist or spray.
Fluid Category G(i):	A typical methane-rich natural gas.
Fluid Category G(ii):	Refinery hydrogen.

These can be compared with the flammable material State (Gas, Liquid, and Liquefied Gas) referred to in IEC/SANS 60079-10.

When the fluid consists of more than one phase i.e. liquid and vapour the major phase will be stated.

Degree of ventilation: According to SANS 60079-10, the degree of ventilation for mainly indoors situations can be determined by calculating a hypothetical volume V_z in comparison to the ventilated area V_0 ; if V_z is not larger than V_0 then the degree of ventilation is sufficient to prevent stagnation and facilitate dispersion and dilution (medium or high ventilation) and the zone is directly related to the grade of release:

Continuous release	Zone 0
Primary release	Zone 1
Secondary release	Zone 2.

Low ventilation will cause a more severe zone in the case of a primary or secondary grade release.

In outdoor (open-air) locations the natural ventilation rate is accepted to be a minimum of 0,5m/s and frequently >2m/s. Turbulent flow requires 2m/s but due to turbulence induced by

obstacles even at low ventilation rates, open-air ventilation can be assumed to be fair (medium ventilation).

In practice, high ventilation can generally be applied only to a local artificial ventilation system around a source, to small enclosed areas or to very low release rates.

Low ventilation will not generally occur in open-air situations except where there are restrictions to air flow, for example, in pits.

IP Part 15 uses slightly different terminology (open-air, adequate or inadequate ventilation) but applies the same principles.

Ventilation availability: Good: ventilation is present virtually continuously;
Fair: ventilation is expected to be present during normal operation. Discontinuities are permitted provided they occur infrequently and for short periods;
Poor: ventilation, which does not meet the standard of fair or good, but discontinuities are not expected to occur for long periods.

The availability of natural ventilation is rated as good. Artificial ventilation should not be worse than poor (discontinuities is not expected to occur for long periods) if such ventilation is to be taken into account. This requires backup fans or power or shutting down of flammable material release in case of ventilation failure.

ANNEX B: AC DRAWINGS

Examples of area classification drawing as described in SANS 60079-10-2: 2009 and SANS 10089-3: 2007.

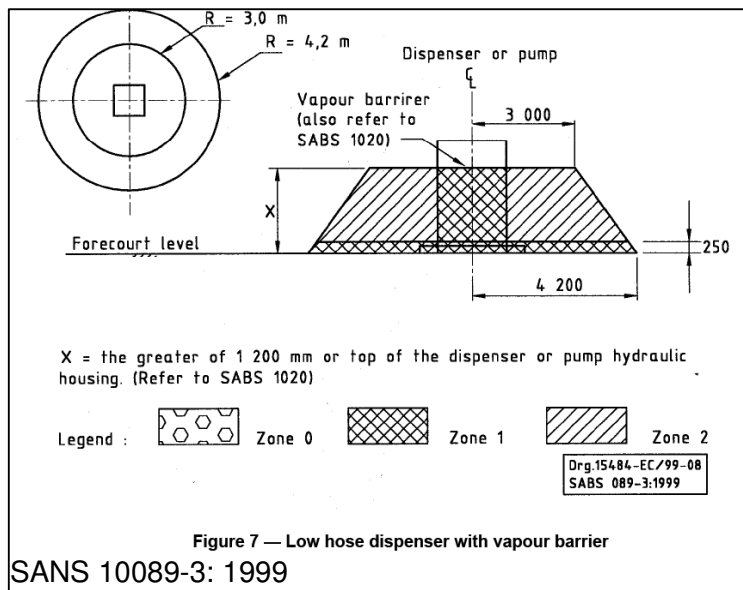
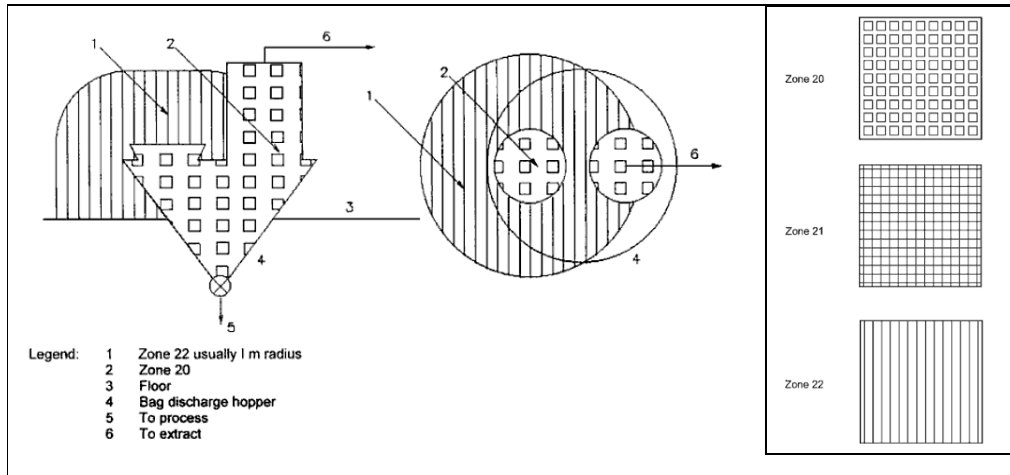


Figure 7 — Low hose dispenser with vapour barrier

SANS 10089-3: 1999

ANNEX C: EQUIPMENT SELECTION

Selection of equipment according to EPL

In the past, a statistical approach to equipment selection was followed, whereby the probability of an explosion was limited.

The equipment selection standard now also allows for a risk-based approach. In a risk-based approach, the **consequence** of an explosion is also taken into account, **together with the probability** of an explosion.

To facilitate the risk-based approach, the concept of Equipment Protection Level (EPL) was introduced. The EPL for each explosion protection technique has been determined and ranges from “Very High” to “High” to “Normal”. The table below shows the relationship between type of protection and EPLs.

Protection afforded	EPL			Type of protection	Code	According to standard	Conditions of operation
	Group I	Group II	Group III				
Very High	'Ma'			Same as 'Ga'			Equipment remains functioning when explosive atmosphere present
Very High		'Ga'		Intrinsically safe	'ia'	SANS 60079-11	Equipment remains functioning in Zones 0, 1 and 2
				Encapsulation	'ma'	SANS 60079-18	
				Two independent type of protection each meeting EPL 'Gb'		SANS 60079-26	
				Protection of equipment and transmission systems using optical radiation		SANS 60079-28	
Very High			'Da'	Intrinsically safe	'iD'	SANS 60079-11	Equipment remains functioning in Zones 20, 21 and 22
				Encapsulation	'mD'	SANS 60079-18	
				Protection by enclosure	'tD'	SANS 60079-31 (IP65 enclosure)	
High	'Mb"			Same as 'Gb'			Equipment de-energized when explosive atmosphere present
High		'Gb'		Flameproof enclosures	'd'	SANS 60079-1	Equipment remains functioning in Zones 1 and 2
				Increased safety	'e'	SANS 60079-7	
				Intrinsically safe	'ib'	SANS 60079-11	
				Encapsulation	'm' 'mb'	SANS 60079-18	
				Oil immersion	'o'	SANS 60079-6	
				Pressurized enclosures	'p', 'px' 'or 'py'	SANS 60079-2	
				Powder filling	'q'	SANS 60079-5	
				Fieldbus intrinsically safe concept (FISCO)		SANS 60079-27	
Protection of equipment and transmission systems using optical radiation		SANS 60079-28					
High			'Db'	Intrinsically safe	'iD'	SANS 60079-11	Equipment remains functioning in Zones 21 and 22
				Encapsulation	'mD'	SANS 60079-18	
				Protection by enclosure	'tD'	SANS 60079-31 (IP65 enclosure)	
				Pressurized enclosures	'pD'	SANS 61241-4	

Protection afforded	EPL			Type of protection	Code	According to standard	Conditions of operation
	Group I	Group II	Group III				
Normal		'Gc'		Intrinsically safe	'ic'	SANS 60079-11	Equipment remains functioning in Zone 2
				Encapsulation	'mc'	SANS 60079-18	
				Non-sparking	'n' or 'nA'	SANS 60079-15	
				Restricted breathing	'nR'	SANS 60079-15	
				Energy limitation	'nL'	SANS 60079-15	
				Sparking equipment	'nC'	SANS 60079-15	
				Pressurized enclosures	'pz'	SANS 60079-2	
				Fieldbus non-incendive concept (FNICO)		SANS 60079-27	
				Protection of equipment and transmission system using optical radiation		SANS 60079-28	
Normal			'Dc'	Intrinsically safe	'iD'	SANS 60079-11	Equipment remains functioning in Zone 22
				Encapsulation	'mD'	SANS 60079-18	
				Protection by enclosures	'tD'	SANS 60079-31 (IP65 enclosure)	
				Pressurized enclosures	'pD'	SANS 61241-4	

If risk is normal, which is mostly the case, the probability of an explosion is the only controlling factor and a direct relationship between EPL and Zone exists that is used to select equipment:

Zone	Minimum Equipment Protection Level (EPL)
0	Ga
1	Gb
2	Gc
20	Da
21	Db
22	Dc

ANNEX D: DEMARCATION

Demarcation of hazardous areas:

SANS 10108:2006
Edition 5

Annex D (Informative)

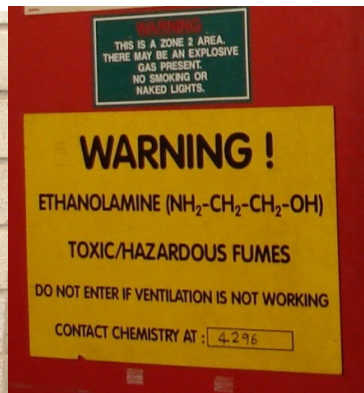
Demarcation of hazardous locations

D.1 An international convention for demarcation does not at present exist. The information provided through demarcation should identify the location as hazardous and should define the hazard level (zone or zones). The flammable materials present and the corresponding gas groups and temperature classes or dust layer and dust cloud ignition temperatures could additionally be provided.

D.2 The following are practical methods of demarcation:

- a) In a surface plant, elect a central (dominant) point that regulates access to the area, for example a control room. Display the area classification drawing(s) identifying zoned areas and the relevant flammable materials.
- b) At entry points to (or borders of) the plant, display a triangle marked "Ex" (recommended side length 150 mm, black border and letters, yellow background).

Examples of marking on plants (these examples might be out of date and it should be considered not to include too much info on the marking that may change regularly):





GEOTECHNICAL REPORT

NEW FIRE WATER INSTALLATION TRANSNET PIPELINES HOWICK DEPOT KWAZULU-NATAL

***Requested by
GreyJones (Pty) Ltd***

***Project GA1063/2025
September 2025***

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Appendix A – Locality Map and Trial Hole Positions

Appendix B – Individual Soil Profiles

Appendix C – Dynamic Cone Penetrometer Test Results

Project GA1063/2025

13th October 2025

GEOTECHNICAL REPORT
NEW FIRE WATER INSTALLATION – TRANSNET PIPELINES
HOWICK DEPOT - KWAZULU-NATAL

1 INTRODUCTION

The following report describes the findings of a geotechnical investigation undertaken on the 2nd and 3rd October 2025 for the proposed construction of new fire water infrastructure at the Transnet Pipelines Howick Depot in the town of Howick, KwaZulu-Natal. The geotechnical investigation was undertaken by Ground Africa Consulting Geotechnical Engineers at the request of Mr Blake Jones of GreyJones (Pty) Ltd.

The proposed development comprises the provision of new firefighting infrastructure. This infrastructure will comprise a pumphouse, new water tanks and new valve banks. The new tanks and pump house will be positioned in the south eastern corner of the site. The positions of the new valve banks had not been finalised at the time of the investigation. Water from the fire tanks will be conveyed by a new pipe network. The pipes will be elevated above ground along pipe racking supported on bridges.

The geotechnical investigation was undertaken to ascertain the general ground conditions underlying the earmarked site and to recommend a suitable founding regime for the new infrastructure. Commentary with respect to anticipated earthworks, ground improvement, in-situ material quality and groundwater characteristics has also been discussed herein.

A survey of the existing depot which included the general position of the new tanks and pump house was provided for the purposes of the investigation. The drawing was created by Dave Mountain Surveys and is entitled “*Howick Transnet Detail Survey*,” with document reference “*Transnet Howick Wg31.dr5*” and dated July 2025. Trial holes were excavated within the proposed position for the new tanks and pump house, as well as in representative locations across the site where the new pipe racking and valve banks may be located.

2 SITE DESCRIPTION

The existing Howick TPL Depot has GPS co-ordinates $S29^{\circ}28'38.7''$; $E30^{\circ}11'40.6''$, and is situated within the town of Howick, KwaZulu-Natal. The depot's boundary is roughly trapezoidal in shape, and encompasses an area of around 2.4ha. The site is a *National Keypoint* and access is strictly controlled. The site has an overall gentle fall to the south east. The site is accessed via a security checkpoint alongside Main Road to the south.

The site is enclosed by a steel palisade fence, with three smaller fenced-off sections located within the site's boundary. These areas comprise the security checkpoint and two substations, all located along the southern edge of the site. The majority of the site comprises an open, grassed area with a number of single storey structures. A double storey structure is located near the centre of the site. A number of asphalt and brick paved roadways pass through the site between the various structures. An existing fire tank is located in the north western corner of the site.

A relatively shallow cut platform has been created in the northern portion of the site, where the control room and main operational infrastructure are located. This platform is surrounded to the north and west by short cut slopes. Additionally, a small embankment runs along the north eastern edge of the site, which accommodates the difference in level between the site and the dirt road. The remainder of the slope generally falls gently to the south east, however excavation of trial holes shows that some fill material is present across much of the site's surface indicating a likely change to the natural fall.

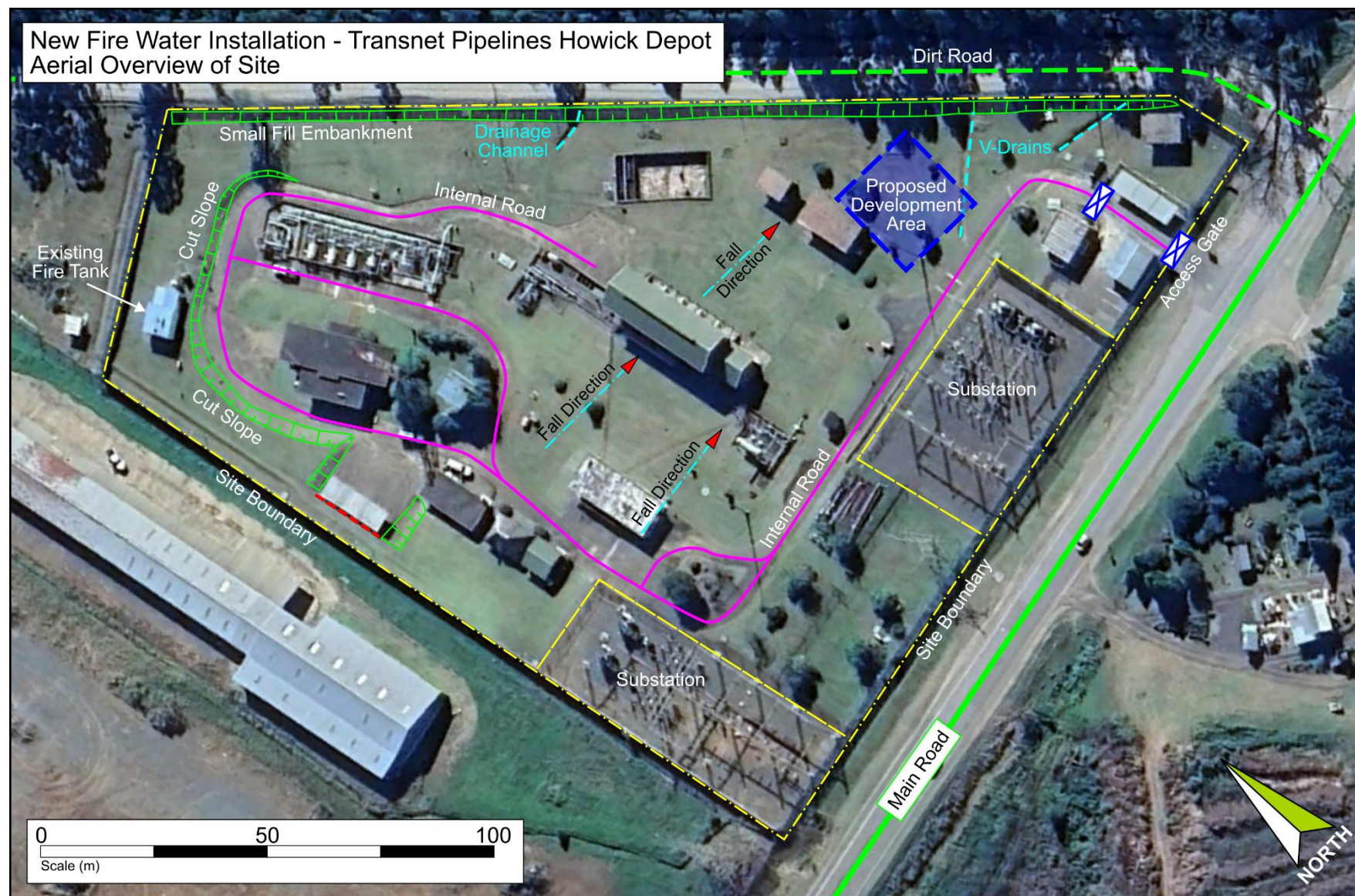
The earmarked area for the new fire pump room and water storage tank will be at the eastern extremity of the existing depot grounds, near the main entrance. The general area is grassed and has a slight downward slope towards the east. The depot is enclosed by a boundary fence to the east and has a number of existing single storey masonry structures to the west. These structures house storerooms and an electrical substation. A large concrete v-drain is aligned through the southern part of the site. A plethora of buried pipes and electrical cables are present within the footprint area where the tanks and pumproom will be situated.

Photography of the site area is prohibited due to the abundance of sensitive infrastructure across most of the depot.

3 GEOLOGY

Geological mapping of the area indicates the site to be underlain wholly by sedimentary rocks of the Volksrust Formation, Eccca Group, Karoo Supergroup. The Volksrust Formation in the identified area comprises mostly fine grained, dark grey-blue shale and subordinate lenses of fine to medium grained sandstone and siltstones. The in-situ decomposition of the shale rock material has resulted in the formation of clay and silt rich residual soils in the area.

Karoo aged dolerite dykes are present in the area, with a dyke shown as intersecting the south western corner of the site. Dolerite rock typically forms a reliable base on which to found structures, however, is often associated with the development of deep, clay rich residual soil layers. Rock, or soil derived from this underlying geology, was not encountered in any of the trial holes excavated on site, indicating the majority of the site is underlain by the Volksrust Formation.



4 FIELDWORK

4.1 Fieldwork Methods

Geotechnical fieldwork conducted on the 2nd and 3rd October 2025 comprised the following:

- Manual excavation of six (6x) trial holes to depths of between 0.5m and 1.0m below present ground level (PGL).
- Manual auger drilling at the base of selected trial holes to increase the depth of information to between 1.7m and 2.5m below PGL.
- Soil profiling of the ground layers exposed in the sidewalls of the trial holes and the material removed during auger drilling.
- Six (6x) Dynamic Cone Penetrometer tests to assess the variation in consistency of the underlying soils to depths ranging from 0.2m to 3.1m below PGL.

The locations of the trial holes are shown in **Appendix A**. Trial hole depths were determined by tape measurement from present ground level. All the trial holes were profiled according to the method of Jennings, Brink and Williams as per the paper “Revised guide to soil profiling for civil engineering purposes in Southern Africa” as published in the Transactions of the South African Institution of Civil Engineers. Individual soil profiles are included in **Appendix B**.

In the Dynamic Cone Penetrometer test (DCP), a specific angle ended cone fixed to the end of a steel rod is driven into the ground using a standard weighted hammer that drops by a constant height. The distance measured from each blow as the rod moves into the ground is recorded, and these values are correlated to known values for soils. This information is then used to assess the density/consistency of the soils and obtain an indication of likely bearing capacities with the aid of numerical calculation.

DCP field results have been included in **Appendix C**.

4.2 Fieldwork Results

4.2.1 Soil Profiles

Excavation of trial holes on site shows the ground profile consists of fine-grained residual soils which are underlain by shale rock at varying depths. A pedogenic layer has developed within the residual soils. The surface of the site is covered with some fill material of varying thicknesses. The various soil layers below the site have been named according to their origin and position within the profile for ease of reference in this report. A generalised soil profile for the identified site is given below for reference:

Fill	Slightly moist, reddish brown with khaki blotches, firm with soft zones, intact; CLAYEY SANDY SILT – Fill with some roots and gravel.
Colluvium	Slightly moist to moist, dark brown, firm, intact to slightly shattered, SANDY CLAYEY SILT – Colluvium .
Upper Residual	Slightly moist, light orange brown, firm, intact to slightly shattered; Slightly SANDY CLAYEY SILT to SANDY CLAYEY SILT – Residual .
Pedogenic	Moist to wet, mottled orange and red, firm with very stiff zones, uncemented, CLAYEY SILTY GRAVEL – Pedogenic with some zones of strongly cemented ferricrete. Note: Gravel component comprises angular ferricrete nodules.
Lower Residual	Moist to wet, light grey with khaki orange blotches, firm, intact; CLAYEY SILT to CLAY SILT – Residual . Note: Some zones of weathered rock within residual soil above rock head contact.
Soft Rock - Shale	Khaki with grey streaks, completely weathered, laminated, very soft rock – SHALE with some zones of residual clay silt.

Fill material was encountered at surface in all trial holes excavated on site. This fill typically comprised clayey sandy silt with some roots and gravel. This layer is reddish brown with khaki blotches. In places, some rubble was observed within the fill. In TH2, the fill at surface comprised slightly silty sandy gravel, indicating that some variability must be expected in the fill at surface in different areas across the site.

In TH4, a 1.0m thick layer of fill was encountered below the typical surface fill described above. This fill comprises clayey gravelly silt, and is inferred to be reworked residual material. Some completely weathered shale cobbles were encountered within this material. This fill was likely placed to slightly raise the level of this edge of the site. This fill was only encountered in this area.

The uppermost natural layer encountered below the fill was typically a colluvial layer between 0.2m and 0.4m thick. The colluvium comprises a dark brown sandy clayey silt. This material has a slightly shattered structure in-situ, indicating that slight changes in volume may be expected to accompany changes in moisture content.

The *Upper Residual* horizon was encountered in isolated areas across the site, both above and below the Pedogenic layer. This layer ranges in composition from slightly sandy clayey silt to sandy clayey silt. A slightly shattered structure was noted within this material. The colour of this material ranges from light orange brown to khaki.

A *Pedogenic* layer has developed within the residual soil profile, between the colluvial layer and the *Lower Residual* horizons. This layer was found to typically comprise clayey silty gravel, with the gravel comprising angular ferricrete nodules. This layer is mottled orange red in colour. Some zones of strongly cemented ferricrete were observed within this layer, but the overall soil fabric is uncemented. In places, some variation was noted in the degree of development of this layer, with some areas having a lower abundance of ferricrete nodules within the layer. In TH6, excavated near the south western corner of the site, the pedogenic layer was found to comprise interlocking, strongly cemented ferricrete fragments, which could not be manually excavated.

Several slightly minor, and thin, layers have been grouped together as the *Lower Residual* horizons due to their relative similarity, for ease of reference. Hand augers carried out at the base of trial holes resulted in the intersection of the *Lower Residual* horizons at depths of between 1.0m and 2.1m below PGL. These layers persist to depths of between 1.7m and 2.5m below PGL.

These layers are typically light grey in colour with khaki orange blotches. They generally comprise clayey silt, but in places become clay silt with depth. In the lower part of the residual profile, above the rock head contact, some zones of completely weathered rock were retrieved from within the residual soil layers.

Refusal of the hand augers used in the investigation occurred upon intersection of the shale rock below the site, at depths of between 1.7m and 2.5m. In one case (TH2), the auger was able to pass some way into the completely weathered rock. The rock was found to be khaki in colour, with grey streaks. A laminated structure was noted within the retrieved fragments from the auger. The fragments retrieved were of a very soft rock classification, and some zones of residual clay silt were observed between the rock fragments.

Groundwater was intersected at depths of between 0.8m and 1.3m below PGL. The groundwater level in the area appears to be perched within the *Upper Residual* soils or *Pedogenic* layer indicating the *Lower Residual* soil likely has a very low permeability. In places, the residual material directly above the rock head contact was also noted to be wet, indicating multiple, small perched water tables may exist within the same profile.

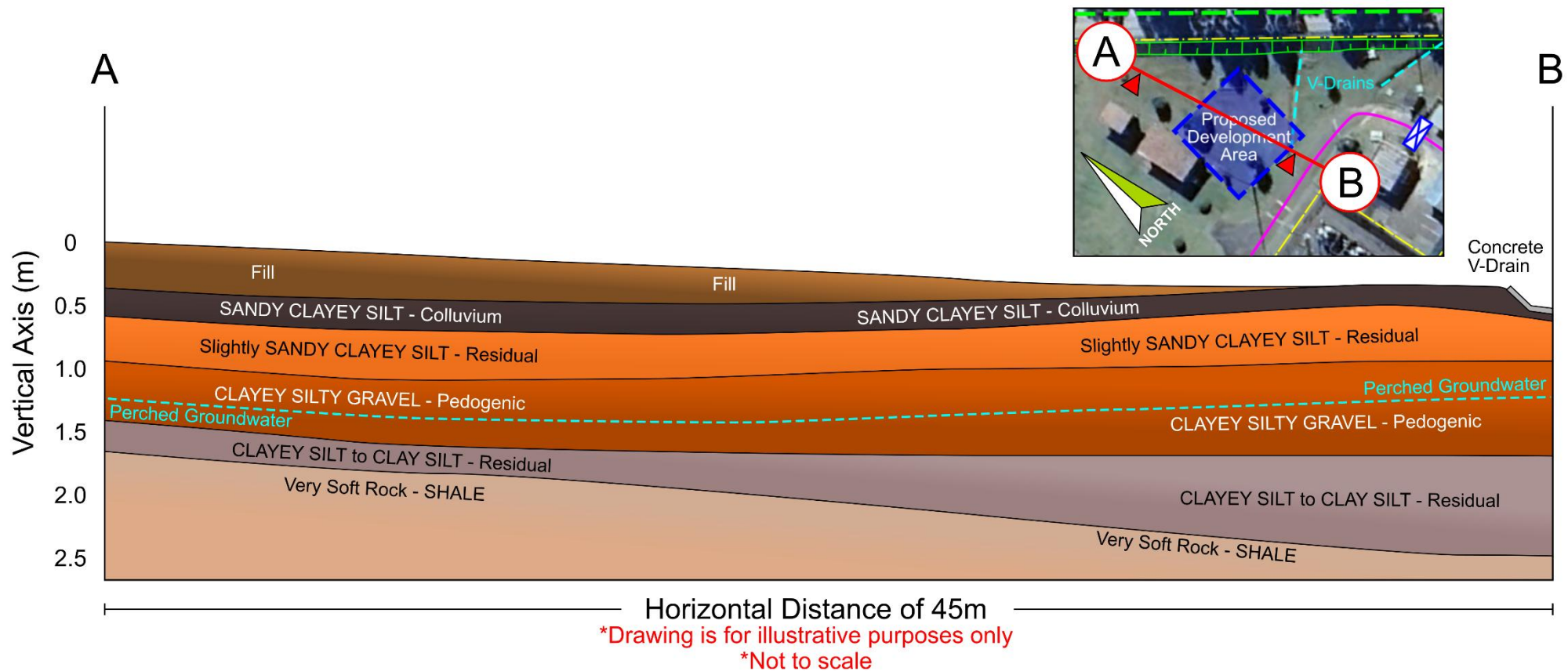
A table listing the depths to identified horizons, as well as groundwater is given below for reference:

TH	Fill Thickness	Depth to Upper Residual	Depth to Pedogenic	Depth to Lower Residual	Depth to Rock	Groundwater Depth	Total Depth
TH1	0.2m	Not present	0.6m	1.0m	2.0m	0.8m	2.0m
TH2	0.4m	0.8m (below Pedogenic)	0.4m	1.1m	1.7m	Not encountered	1.9m
TH3	0.4m	0.6m	1.0m	1.5m	1.7m	1.2m	1.7m
TH4	1.3m	1.6m	1.9m	2.1m	2.3m	1.3m	2.3m
TH5	0.3m	Not present	0.7m	1.3m	2.5m	Not encountered	2.5m
TH6	0.4m	Not present	0.4m	Not encountered	Not encountered	Not encountered	0.5m

Individual soil profiles are included in **Appendix B** of the geotechnical report.

A geological cross-section, depicting the generalised ground profile beneath the proposed development area for the new tanks and pump house is shown over-page for explanatory purposes.

Generalised Geological Cross-Section (A-B) New Fire Water Installation - Transnet Pipelines Howick Depot



4.2.2 Dynamic Cone Penetrometer Tests

Six (6x) Dynamic Cone Penetrometer (DCP) tests were undertaken from surface to depths of between 2.0m and 2.7m below PGL alongside respectively numbered trial holes. This testing was undertaken to assess the variation in consistency of the underlying soils and weathered rock with increasing depth.

Testing in the layers of fill material across the surface of the site shows that these materials are generally firm/medium dense, with some soft/loose zones near surface. Penetration rates of between 9mm/blow and 25mm/blow were typically recorded in these surface materials, with some zones with penetration rates of 50mm/blow.

The colluvium and residual materials above the pedogenic layer were typically firm, with penetration rates of 20mm/blow or less recorded. The exception to this was DCP1, where the colluvium was found to be soft.

Intersection of the pedogenic layer typically resulted in a decrease in penetration rates, indicating this layer is firm/medium dense. Some very dense/very stiff zones were observed in this material in trial holes, as this layer is unevenly cemented, although this was not recorded in the DCP tests.

Testing within the residual soil layers below the pedogenic layer shows that these transition from firm to stiff with increasing depth, with penetration rates decreasing from around 17mm/blow directly below the pedogenic layer to around 3mm/blow at the end of each test.

Intersection of the weathered shale resulted in refusal of the apparatus, except in the case of DCP6, which refused on rubble in TH6. A table listing the test number and respective depth to refusal is given below for reference:

DCP Number	Test Position	Depth to Refusal
1	Alongside TH1	1.9m
2	Alongside TH2	1.8m
3	Alongside TH3	2.1m
4	Alongside TH4	2.2m
5	Alongside TH5	3.1m
6	Alongside TH6	0.2m

Individual DCP test results have been included in **Appendix C**.

5 GEOTECHNICAL ASSESSMENT

5.1 Proposed Development

The proposed development comprises the construction of a new single storey masonry fire pump room with an associated water storage tank. An associated reticulation network of pipes and pipe supports will also form part of the project. This new infrastructure will be constructed inside the existing Howick TPL Depot site.

5.2 Earthworks

Bulk earthworks on site will comprise the removal of localised fill horizons as well as the excavation of foundation trenches. Significant cut to fill earthworks are not anticipated for this site. Further to this, retaining wall construction will not be required owing to the site's near level/slightly sloping fall. Demolition and removal of the existing surface v-drain, settling tank and buried services which are positioned within the site area, will be required.

Manual excavation through the fill and natural soil horizons was found to be easy. Trial hole sidewalls were noted to be stable in an unsupported state. Perched groundwater was intersected at depths of between 0.8m and 1.3m below present ground surface. To enable excavation to depths below this, it is recommended that cut off trenches and sumps are created to prevent water flow into foundation works.

Excavation past the rock head contact of completely weathered shale is anticipated to be easy for approximately 500mm using manual means.

5.3 Re-use Potential of In-situ Soils

The clay rich silts and fine-grained sands which make up the residual soil layers are of poor quality and strength. From visual inspection, it is apparent that they will not meet the minimum G10 quality as per TRH 14 classification. Good quality granular, material for use in creation of a gravel mattress beneath the pump room footings and the tank bottom, will need to be obtained from commercial sources.

5.4 Founding Recommendations

The underlying weathered shale rock will provide a favourable founding layer on which to place the pump room and water tank foundations and ensure negligible differential settlement. Though the valve chambers and bridge piers are lightly loaded, placing them on the underlying weathered rock as well will assist in ensuring minimum differential settlement between the different structures which form part of this development.

To avoid unwanted post-construction settlement between the new infrastructure, it is recommended that foundations are not placed in the present fill layers or the clay rich, saturated, residual soils which overlie the rock.

Depth to rock is expected to range between 1.7m and 2.5m below present ground level. To lift the invert level of foundations, imported gravel can be placed and compacted over the rock head contact up to the necessary design levels. The new foundations can then be placed on this gravel mattress.

It is recommended that the new tanks and pump room are placed on steel reinforced concrete raft foundations and that the valve chambers as well as the bridge piers are founded on pad footings.

The following is recommended prior to construction of the foundations:

1. General clearance and removal of all fill from the footprint of the proposed structures.
2. Excavate down to the completely weathered shale rock. Ensure that the rock fabric is exposed across the full footprint of the base of the excavation.
3. Create cut off trenches around the excavation to prevent perched groundwater from flowing into, and inundating, the foundation works.
4. It is imperative that a geotechnical engineer or the accountable design engineer inspect the base of the completed excavation to ensure weathered rock has been intersected over the full footprint.
5. Place imported G5 quality gravel, in successive 150mm thick lifts. Each layer to be compacted to 98% MOD AASHTO within 2% of Optimal Moisture Content (OMC).

The raft foundations for the pumproom and tanks will need to take account of minor differential ground movements (less than 5mm provided the specified material quality and compactive efforts are achieved). This movement should be expected, even after densification and the placement of a granular soil raft.

5.5 Stormwater Drainage

A major v-drain presently crosses the area where the new tanks and pumproom will be positioned. It drains stormwater runoff from the adjacent asphalt surfaced access road which is situated to the west of the earmarked site. Management of stormwater runoff from road surfaces, existing roof areas and the general site area will need to be undertaken as the earmarked development area lies at the lower eastern side, where this runoff will preferentially drain to. A combination of surface drains and berms will need to be used. Subsoil drainage will have a limited effect owing to the relatively impermeable clay rich residual soils and existing groundwater table.

6 CONCLUSION

The geotechnical investigation indicates the site is underlain by a succession of clay rich silts and fine-grained residual sands which in turn overlie weathered shale rock from depths of approximately 1.7m to 2.5m below present ground level. The clay rich, silts and fine-grained sands which overlie the rock will not be suitable on which to place foundations for the planned settlement-sensitive fire installations. Groundwater was intersected at 0.8m to 1.3m below present ground level.

The underlying weathered shale rock will provide a favourable founding layer on which to place the new tanks, pumproom, bridge piers and valve chambers, simultaneously ensuring negligible post-construction differential settlement.

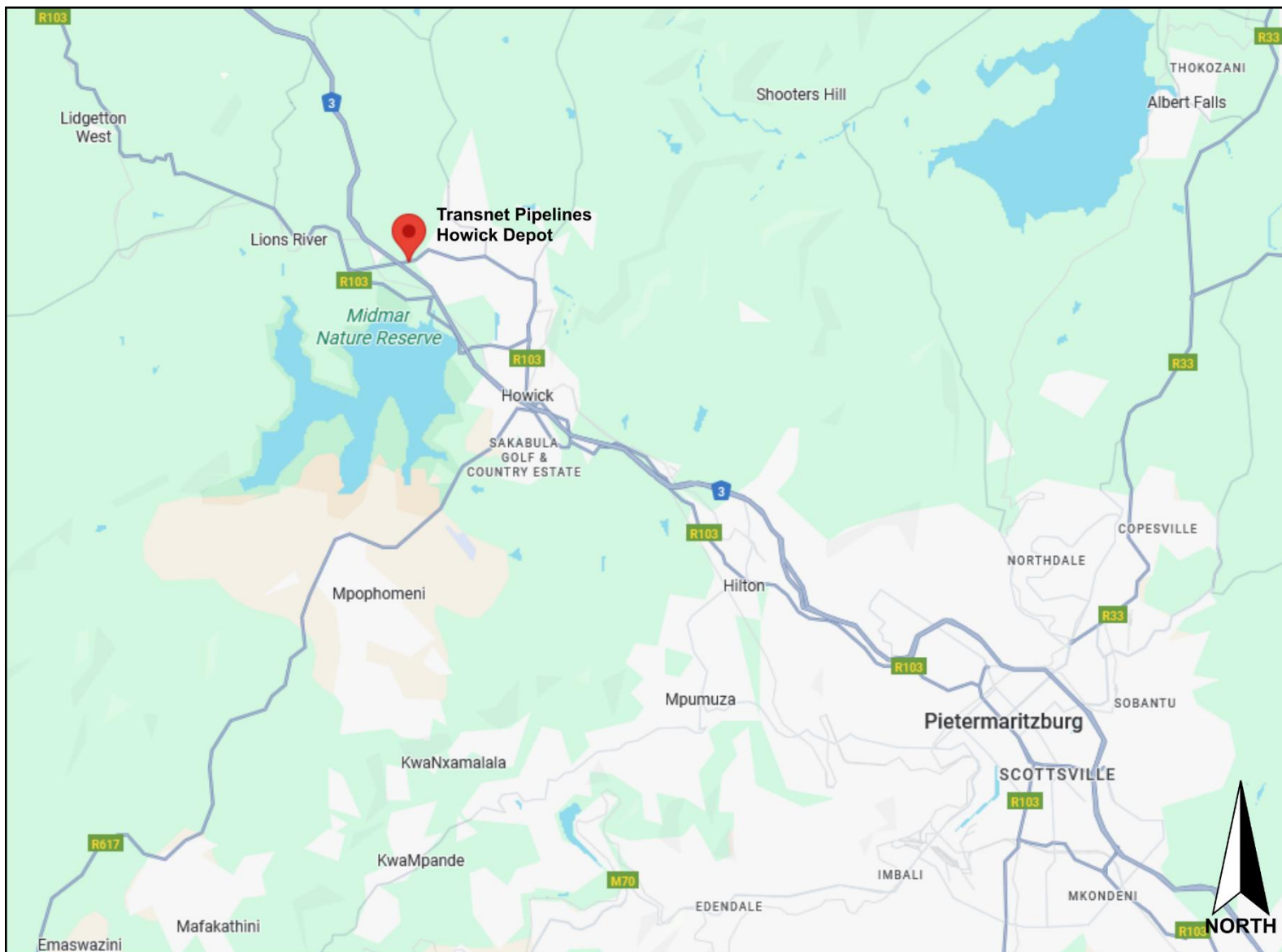
It is recommended that the infrastructure be founded on granular mattresses which in turn support raft foundations and pad footings. The granular mattress will need to be created to lift the general founding levels. This will require the removal off all fill, colluvial and residual soils to reach the underlying weathered.

The earmarked site is deemed to be geotechnically suitable for the proposed development provided the recommendations contained herein are adhered to.



Frederick Volbrecht MIEAust CPEng, PrEng
Geotechnical Engineer

APPENDIX A
Locality Map
Trial Hole and DCP Positions



New Fire Water Installation - Transnet Pipelines Howick Depot
Trail Hole and DCP Locality



APPENDIX B

Individual Soil Profiles



TRIAL HOLE PROFILE

CLIENT: GreyJones (Pty) Ltd
PROJECT: New Fire Water Installation (TPL Howick)
PROJECT NO: GA1063/2025
LOCATION: Proposed New Tanks and Pump Station

HOLE No: TH1
LATITUDE: 29°28'39.0"S
LONGITUDE: 30°11'44.1"E

Sheet 1 of 1

Depth	Description	
	<i>Present Ground Level</i>	
0.00	FILL Slightly moist to moist, reddish brown with khaki blotches, firm with soft zones, intact; CLAYEY SANDY SILT - Fill with some roots and gravel.	
0.20	SANDY CLAYEY SILT Slightly moist to moist, dark brown, firm, intact to slightly shattered; SANDY CLAYEY SILT - Colluvium.	
0.60	PEDOGENIC Wet, mottled orange and red, firm with very stiff zones, uncemented; CLAYEY SILTY GRAVEL - Pedogenic with some zones of strongly cemented ferricrete. Note: Gravel comprises angular ferricrete nodules.	
1.00	CLAYEY SILT Moist, light grey with khaki orange blotches, firm, CLAYEY SILT - Residual.	
1.30	CLAY SILT Moist, light grey with khaki orange blotches, firm, CLAY SILT - Residual.	
1.70	CLAY SILT Wet, khaki yellow, firm, CLAY SILT - Residual with some coarse sand particles.	
2.00	End of log	

- NOTES:
- 1: End of hole at 2.0m
 - 2: Hand auger commenced from 0.9m
 - 3: Auger refusal at 2.0m
 - 4: Sample HT1 obtained at 1.1m
 - 5: Perched groundwater encountered at 0.8m

EXCAVATION METHOD: Manual Excavation and Hand Auger

DATE PROFILED: 02/10/2025

PROFILED BY: OS

CHECKED BY: FCV

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TRIAL HOLE PROFILE

CLIENT: GreyJones (Pty) Ltd
PROJECT: New Fire Water Installation (TPL Howick)
PROJECT NO: GA1063/2025
LOCATION: Proposed New Tanks and Pump Station

HOLE No: TH2
LATITUDE: 29°28'38.7"S
LONGITUDE: 30°11'42.3"E

Sheet 1 of 1

Depth	Description	
	<i>Present Ground Level</i>	
0.00	FILL Slightly moist, dark grey with black speckles, medium dense, intact; Slightly SILTY SANDY GRAVEL - Fill with some roots.	
0.40	PEDOGENIC Slightly moist, mottled red and orange, firm with stiff zones, uncemented; CLAYEY SILTY GRAVEL - Pedogenic with some strongly cemented zones. Note: Gravel comprises angular ferricrete nodules.	
0.80	SANDY CLAYEY SILT Slightly moist, khaki orange, firm, intact to slightly shattered; SANDY CLAYEY SILT - Residual.	
1.10	CLAYEY SILT Moist, light grey with khaki orange blotches, firm, CLAYEY SILT - Residual.	
1.50	CLAYEY SILT Moist, light grey with khaki orange blotches, firm, CLAYEY SILT - Residual with zones of completely weathered shale.	
1.70	Very soft rock: SHALE Khaki with grey streaks, completely weathered, laminated, very soft rock; SHALE with some zones of residual clay silt.	
1.90	End of log	

- NOTES:
- 1: End of hole at 1.9m
 - 2: Hand auger commenced from 0.8m
 - 3: Auger refusal at 1.9m
 - 4: No sample obtained
 - 5: No groundwater encountered

EXCAVATION METHOD: Manual Excavation and Hand Auger

DATE PROFILED: 02/10/2025

PROFILED BY: OS

CHECKED BY: FCV

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TRIAL HOLE PROFILE

CLIENT: GreyJones (Pty) Ltd
PROJECT: New Fire Water Installation (TPL Howick)
PROJECT NO: GA1063/2025
LOCATION: Proposed New Tanks and Pump Station

HOLE No: TH3
LATITUDE: 29°28'37.7"S
LONGITUDE: 30°11'42.7"E

Sheet 1 of 1

Depth	Description	
	<i>Present Ground Level</i>	
	FILL Slightly moist to moist, reddish brown with khaki blotches, firm with soft zones, intact; CLAYEY SANDY SILT - Fill with some rubble, roots and gravel.	
0.40	SANDY CLAYEY SILT Slightly moist to moist, dark brown, firm, intact to slightly shattered; SANDY CLAYEY SILT - Colluvium.	
0.60	Slightly SANDY CLAYEY SILT Slightly moist, light orange brown, firm, intact to slightly shattered; Slightly SANDY CLAYEY SILT - Residual.	
1.00	PEDOGENIC Slightly moist, mottled orange and red, firm with very stiff zones, uncemented; CLAYEY SILTY GRAVEL - Pedogenic with some zones of strongly cemented ferricrete.	
1.20	Note: Gravel comprises angular ferricrete nodules. PEDOGENIC Moist to very moist, mottled orange and red, firm with very stiff zones, uncemented; CLAYEY SILTY GRAVEL - Pedogenic with some zones of strongly cemented ferricrete.	
1.50	Note: Gravel comprises angular ferricrete nodules. CLAYEY SILT Moist, light grey with khaki orange blotches, firm, CLAYEY SILT - Residual.	
1.70	Note: Refusal on shale rock.	
	End of log	

NOTES: 1: End of hole at 1.7m
2: Hand auger commenced from 0.9m
3: Auger refusal at 1.7m
4: No sample obtained
5: Slight groundwater seepage at 1.2m

EXCAVATION METHOD: Manual Excavation and Hand Auger

DATE PROFILED: 02/10/2025

PROFILED BY: OS

CHECKED BY: FCV

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TRIAL HOLE PROFILE

CLIENT: GreyJones (Pty) Ltd
PROJECT: New Fire Water Installation (TPL Howick)
PROJECT NO: GA1063/2025
LOCATION: Northern Corner of Depot

HOLE No: TH4
LATITUDE: 29°28'35.0"S
LONGITUDE: 30°11'40.2"E

Sheet 1 of 1

Depth	Description	
	<i>Present Ground Level</i>	
0.00	FILL Slightly moist to moist, reddish brown with khaki blotches, firm with soft zones, intact; CLAYEY SANDY SILT - Fill with some roots and gravel.	
0.30	FILL Slightly moist, mottled khaki yellow and brown, firm, intact; CLAYEY GRAVELLY SILT - Fill (Reworked Residual) with some completely weathered shale cobbles. Note: Gravel comprises completely weathered shale.	
0.5		
1.0		
1.30	SANDY CLAYEY SILT Wet, dark brown, firm, intact to slightly shattered; SANDY CLAYEY SILT - Colluvium.	
1.60	Slightly SANDY CLAYEY SILT Wet, khaki, firm, Slightly SANDY CLAYEY SILT - Residual.	
1.90	PEDOGENIC Moist, mottled grey and orange, firm, uncemented; CLAYEY GRAVELLY SILT - Pedogenic.	
2.10	Note: Gravel comprises sub-angular ferricrete nodules.	
2.30	CLAYEY SILT Moist, light grey with khaki orange blotches, firm, CLAYEY SILT - Residual.	
	End of log	

- NOTES:
- 1: End of hole at 2.3m
 - 2: Hand auger commenced from 0.9m
 - 3: Auger refusal at 2.3m
 - 4: No sample obtained
 - 5: Perched groundwater encountered at 1.3m

EXCAVATION METHOD: Manual Excavation and Hand Auger

DATE PROFILED: 02/10/2025

PROFILED BY: OS

CHECKED BY: FCV

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TRIAL HOLE PROFILE

CLIENT: GreyJones (Pty) Ltd
PROJECT: New Fire Water Installation (TPL Howick)
PROJECT NO: GA1063/2025
LOCATION: North Western Corner of Depot

HOLE No: TH5
LATITUDE: 29°28'35.6"S
LONGITUDE: 30°11'37.8"E

Sheet 1 of 1

Depth	Description	
	<i>Present Ground Level</i>	
0.00	FILL Slightly moist to moist, reddish brown with khaki blotches, firm with soft zones, intact; CLAYEY SANDY SILT - Fill with some roots and gravel.	
0.30	SANDY CLAYEY SILT Slightly moist to moist, dark brown, firm, intact to slightly shattered; SANDY CLAYEY SILT - Colluvium.	
0.70	PEDOGENIC Slightly moist, mottled orange and red, firm with very stiff zones, uncemented; CLAYEY SILTY GRAVEL - Pedogenic with some zones of strongly cemented ferricrete. Note: Gravel comprises angular ferricrete nodules.	
1.30	CLAYEY SILT Slightly moist, light grey with khaki orange blotches, firm, CLAYEY SILT - Residual.	
1.90	CLAYEY SILT Moist, light grey with khaki orange blotches, firm, CLAYEY SILT - Residual with zones of completely weathered shale.	
2.20	CLAYEY SILT Slightly moist, light grey with khaki orange blotches, firm, CLAYEY SILT - Residual.	
2.50	Note: Refusal on shale rock.	
2.5	End of log	

- NOTES:
- 1: End of hole at 2.5m
 - 2: Hand auger commenced from 1.0m
 - 3: Auger refusal at 2.5m
 - 4: Sample HT2 obtained at 0.8m
 - 5: No groundwater encountered

EXCAVATION METHOD: Manual Excavation and Hand Auger

DATE PROFILED: 03/10/2025

PROFILED BY: OS

CHECKED BY: FCV

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TRIAL HOLE PROFILE

CLIENT: GreyJones (Pty) Ltd
PROJECT: New Fire Water Installation (TPL Howick)
PROJECT NO: GA1063/2025
LOCATION: South Eastern Corner of Depot

HOLE No: TH6
LATITUDE: 29°28'39.2"S
LONGITUDE: 30°11'39.6"E

Sheet 1 of 1

Depth	Description	
	<i>Present Ground Level</i>	
0.00	FILL Slightly moist, brown with orange speckles, soft, intact; CLAYEY SANDY SILT - Fill with roots.	
0.20	FILL Slightly moist to moist, reddish brown with khaki blotches, firm with soft zones, intact; CLAYEY SANDY SILT - Fill with some roots and gravel.	
0.40	PEDOGENIC Slightly moist, mottled orange and khaki, dense to very dense, uncemented; interlocking, strongly cemented Ferricrete fragments - Pedogenic.	
0.5	0.50	End of log

NOTES: 1: End of hole at 0.5m
2: Refusal at 0.5m
3: No sample obtained
4: No groundwater encountered

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EXCAVATION METHOD: Manual Excavation

DATE PROFILED: 03/10/2025

PROFILED BY: OS

CHECKED BY: FCV

APPENDIX C

Dynamic Cone Penetrometer Test Results

