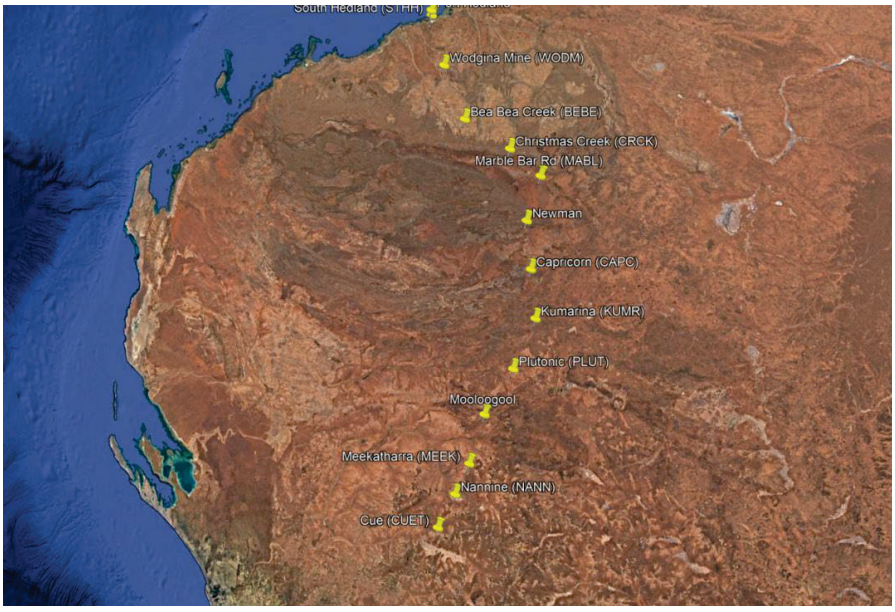
STATS Australia
Specialist Testing and Technical Services

PROPOSED TELCO PROJECTS IN THE PILBARA – GROUP 1



Geotechnical Investigation Work

Prepared for:

VERTIV

Perth Add
Unit 1/16 Production Road, Canning Vale, WA 6155
T: 08 9455 3654
F: 08 9455 3709

Karratha Add
1938 Pyramid Rd Karratha, WA 6714
T: 08 9144 4637
F: 08 9144 2665

www.statsaustralia.com.au

STATS Australia

Perth
Unit 1/16 Production Road, Canning Vale, WA 6155
Karratha
1938 Pyramid Road, Karratha, WA 6714
Singapore
71 Toh Guan Rd East, #02-01/02/06 Techcentre, SG 602598
www.statsaustralia.com.au ABN 43 155 668 269

Document History and Status

Title:	Proposed Telco Projects in the Pilbara – Phase 1
Job Number:	102667
Issue Date:	28 Apr 2023
Internal File ID:	Stats WA\Company - Documents\1. Clients – Projects\Vertiv\102667 (Quo6179)_GI@Proposed Telco Projects in the Pilbara\7. Report
Revision:	0
Status:	Final
Issued to:	VERTIV
Author:	KL
Reviewer:	AS
Approval:	AS

Distribution List for this Report	Hard Copy	Soft Copy
VERTIV	Nil	1 pdf, Email
STATS	Nil	1 pdf, Server

IMPORTANT NOTE

Please refer to STATS "Notes about Your Report"

Table of Contents

EXECUTIVE SUMMARY 1

1.0 INTRODUCTION 9
2.0 SCOPE OF INVESTIGATION 9
3.0 SITE CHARACTERISTICS 10
4.0 SITE DESCRIPTION 11
5.0 FIELD PROGRAMME 11
6.0 LABORATORY TESTS 18
7.0 GEOTECH SITE CLASSIFICATION 24
8.0 SOIL BEARING AND SETTLEMENT ASSESSMENTS 25
9.0 CONSTRUCTION STAGE SUPERVISION AND CERTIFICATION 26
10.0 GENERAL EARTHWORKS 26
11.0 CONCLUSIONS AND RECOMMENDATIONS 28
12.0 REFERENCES 29

Figures

Figure 1-7: Proposed Test Locations.

Appendices

Appendix 1: Notes Relating to this Report, Soils and Rocks Descriptions.
Appendix 2A to 2F: Test Pit Logs.
Appendix 3A to 3F: Dynamic Cone Penetrometer (DCP) Results.
Appendix 4A to 4F: Correlation of DCP Blow Counts to CBR Values.
Appendix 5A to 5F: Soil Electrical Resistivity Test Certificates.
Appendix 6: Laboratory Test Results.
Appendix 7: Soil Bearing and Settlement Assessments.
Appendix 8: Cable Detection Report (Port Hedland Site).

Photographic Survey

Photos 1-26: Site Photographs.

EXECUTIVE SUMMARY

Specialist Testing and Technical Services (STATS) was engaged by Mr. Nick Oresti on behalf of VERTIV (the Client), to conduct a Geotechnical Investigation Work for fourteen (x14) Proposed Telco Project sites from Port Hedland to Newman, Western Australia. This report covers Group 1, for a total of six (x6) sites. The site location and tests carried out are presented in Figures 1 to 7.

The table below presents a summary of the fieldwork and tests completed.

Table 1: Summary of Field Works/Tests

	Locations	Abbreviation	Completion Date	Number of Test Pit	Number of Dynamic Cone Penetrometer Test	Number of Electrical Resistivity Test
1	Cue	CUE	29/3/2023	5	5	1 Array
2	Nannine	NAN	29/3/2023	5	5	1 Array
3	Meekatharra	MEE	30/3/2023	5	5	1 Array
4	Plutonic	PLU	30/3/2023	5	5	1 Array
5	Kumarina	KUM	31/3/2023	5	5	1 Array
6	Port Hedland	PTH	4/4/2023	4	4	1 Array
			Total	**29**	**29**	**6 Arrays**

For each site (except Port Hedland site), a total of five (x5) test pits to the depth of 2.5m or refusal, five (x5) DCP tests to the depth of 1.05m and one (x1) array of electrical resistivity test (x-x and y-y direction) were completed.

At Port Hedland site, there were four (x4) test pits to the depth of 2.5m or refusal, four (x4) DCP tests to the depth of 1.05m and one (x1) array of electrical resistivity test (x-x and y-y direction) completed.

The site investigation work was carried out from 28th March 2023 to 1st April 2023 and 4th April 2023.

As there are existing structures at the Port Hedland site, cable detection work was completed on 3rd Mar 2023 by Advanced Scanning Services prior to the Geotech probing work. For the other areas, STATS carry out a desktop review for the presence of any underground services before proceeding based on Dial Before U Dig information.

The test locations are presented in Figures 1 to 7.

Findings

A summary of the sites corresponding to the type of tests annotation is presented below:

Table 2: Summary of various sites annotation

Locations	Cue	Nannine	Meekatharra	Plutonic	Kumarina	Port Hedland
Figure	2	3	4	5	6	7
Test Pit Log	2A	2B	2C	2D	2E	2F
Dynamic Cone Penetrometer Tests	3A	3B	3C	3D	3E	3F
Estimation of In-situ CBR	4A	4B	4C	4D	4E	4F
Soil Electrical Resistivity Tests	5A	5B	5C	5D	5E	5F

Location 1: CUE

Test Pit Logs

The site soil profiles encountered across all test pits are similar, which comprises of a Sand - Silt Mixture (Silty SAND): fine to medium grained, brown, moist, very dense, trace of gravels up to 60mm in size, trace of cobbles up to 130mm in size and encountered a 100 mm thick of igneous rock layer at the depth of 0.5m for TP1, TP3 and TP5, a 250 mm thick of igneous rock layer at the depth of 0.7m for TP2 and TP4; overlying Sand – Clay (Clayey SAND): fine to medium grained, pale brown/grey, dry to moist, very dense, with gravels up to 7mm in size, trace of cobbles up to 130mm in size.

All the test pits terminated at the targeted depth except for the TP1 terminated at 2.0m due to an unstable test pit wall.

Dynamic Cone Penetrometer

Based on the Soils Testing Handbook of Australian Standard, Table 6.4.6.1 (B), the density of the soils for the fine to medium grained materials (Silty SAND) over the proposed development area was generally "**very dense**" with an average of 19 blows per 100mm of penetration.

Soil Electrical Resistivity Tests

Two measurement lines with a diagonal array pattern were conducted. It consists of the x-x direction, Northeast to southwest and the y-y direction, Northwest to southeast.

For the x-x direction, Northeast to southwest:

- The soil electrical resistivities of the subsurface soil/rock have a range of 16.18 Ωm to 26.14 Ωm which surged when the probe spacing increased from 0.5m to 4.0m gradually.

For the y-y direction, Northwest to southeast:

- The soil electrical resistivities of the subsurface soil/rock have a range of 19.57 Ωm to 31.42 Ωm which surged when the probe spacing increased from 0.5m to 4.0m gradually and reduced to 28.65 Ωm when the probe spacing increased from 4.0m to 8.0m.

Location 2: NANNINE

Test Pit Logs

The site soil profiles encountered at TP1 comprised of a Sand - Clay Mixture (Clayey SAND); fine to medium grained, brown, moist, very dense, with gravels up to 60mm in size, trace of rootlets up to 0.3m in depth, terminated at the depth of 0.8m due to encountered hard rock layer.

At TP2 to TP5, they comprised of Sand - Silt Mixtures (Silty SAND); fine to medium grained, brown, moist, very dense, trace of gravels up to 60mm in size, trace of rootlets up to 0.3m in depth; overlying extremely weathered rock up to the depth of 0.7m to 1.0m.

All the test pits terminated at the depth range from 0.4m to 1.0m due to encountered hard rock layer.

Dynamic Cone Penetrometer

Based on the Soils Testing Handbook of Australian Standard, Table 6.4.6.1 (B), the density of the soils for the fine to medium grained materials (Clayey SAND and Silty SAND) over the proposed development area was generally "**very dense**" with an average of 9 blows per 100mm of penetration.

Soil Electrical Resistivity Tests

Two measurement lines with a diagonal array pattern were conducted here. It consists of the x-x direction, East to West and the y-y direction, North to South.

For the x-x direction, East to West:

- The soil electrical resistivities of the subsurface soil/rock reduced from 320.44 Ωm to 70.87 Ωm when the probe spacing increased from 0.5m to 8.0m gradually.

For the y-y direction, North to South:

- The soil electrical resistivities of the subsurface soil/rock fluctuate from 235.62 Ωm to 100.53 Ωm but showed a downward trend when the probe spacing increased from 0.5m to 8.0m gradually.

Location 3: MEEKATHARRA

Test Pit Logs

The site soil profiles encountered at TP1 and TP5 comprises of a Sand - Clay - Gravel Mixture (Gravelly Clayey SAND); fine to medium grained, brown, dry, very dense, angular to subangular gravels up to 60mm in size, trace of cobbles up to 100mm in size, trace of rootlets up to 0.3m in depth, overlying extremely weathered rock from to the depth of 0.7m to 1.0m.

In terms of TP2 to TP4, it comprised of Sand - Clay Mixtures (Clayey SAND); fine to medium grained, brown, dry, dense to very dense, with angular to subangular gravels up to 60mm in size, trace of cobbles up to 100mm in size, trace of rootlets up to 0.4m in depth.

All the test pits are terminated at the depth ranges from 0.6m to 1.0m due to encountered hard rock layer.

Dynamic Cone Penetrometer

Based on the Soils Testing Handbook of Australian Standard, Table 6.4.6.1 (B), the density of the soils for the fine to medium grained materials (Clayey SAND and Gravelly Clayey SAND) over the proposed development area was generally "**very dense**" with an average of 12 blows per 100mm of penetration.

Soil Electrical Resistivity Tests

Two measurement lines with a diagonal array pattern were conducted here. It consists of the x-x direction, Northwest to Southeast and the y-y direction, Northeast to Southwest.

For the x-x direction, Northwest to Southeast:

- The soil electrical resistivities of the subsurface soil/rock reduced from 521.50 Ωm to 175.93 Ωm when the probe spacing increased from 0.5m to 2.0m gradually.

For the y-y direction, Northeast to Southwest:

- The soil electrical resistivities of the subsurface soil/rock fluctuate from 420.97 Ωm to 163.36 Ωm but showed a downward trend when the probe spacing increased from 0.5m to 2.0m gradually.

Location 4: PLUTONIC

Test Pit Logs

The site soil profiles encountered for all test pits are similar, which comprises of a Sand - Clay Mixture (Clayey SAND); fine to medium grained, brown/red, wet to moist, dense to very dense, trace of angular to subangular gravels up to 20mm in size.

All the test pits are terminated at the depth ranges from 0.45m to 0.85m due to encountered hard rock layer.

Dynamic Cone Penetrometer

Based on the Soils Testing Handbook of Australian Standard, Table 6.4.6.1 (B), the density of the soils for the fine to medium grained materials (Clayey SAND) over the proposed development area was generally "**very dense**" with an average of 17 blows per 100mm of penetration.

Soil Electrical Resistivity Tests

Two measurement lines with a diagonal array pattern were proposed to be conducted on this site. It consists of the x-x direction, East to West and the y-y direction, North to South.

For the x-x direction, East to West:

- The soil electrical resistivities of the subsurface soil/rock reduced from 408.41 Ωm to 50.01 Ωm when the probe spacing increased from 0.5m to 4.0m gradually.

For the y-y direction, North to South:

- The soil electrical resistivities of the subsurface soil/rock reduced from 917.35 Ωm to 50.27 Ωm when the probe spacing increased from 0.5m to 4.0m gradually.

Location 5: KUMARINA

Test Pit Logs

The site soil profiles encountered at TP1, TP2, TP4 and TP5 comprises of a Sand - Gravel Mixture (Gravelly SAND); fine to medium grained, brown/grey, dry, medium dense to very dense, trace of cobbles up to 100mm in size, with low plasticity of silt/clay, overlaying Gravel - Clay - Sand Mixtures (Clayey Sandy GRAVEL); fine to coarse grained, grey/white, dry, very dense, angular to subangular, trace of cobbles up to 190mm in size.

In terms of TP3, it comprised of a Sand - Gravel Mixture (Gravelly SAND); fine to medium grained, brown/grey, dry, medium dense, trace of cobbles up to 100mm in size, with low plasticity of silt/clay, trace of rootlets up to 0.3m in depth; overlaying Clay - Gravel Mixtures (Gravelly CLAY); fine grained, grey/white, dry, very stiff to hard, with fine to medium grained sand, trace of cobbles up to 170mm in size.

All the test pits are terminated at the depth ranges from 1.2m to 2.2m due to encountered hard layer.

Dynamic Cone Penetrometer

Based on the Soils Testing Handbook of Australian Standard, Table 6.4.6.1 (B), the density of the soils for the fine to coarse grained materials (Gravelly SAND and Clayey Sandy GRAVEL) over the proposed development area was generally "**dense**" with an average of 7 blows per 100mm of penetration.

Based on the Soils Testing Handbook of Australian Standard, Table 6.4.6.1 (A), the consistency of the soils for the fine-grained materials (Gravelly CLAY) over the proposed development area was generally "**very stiff**" with an average of 10 blows per 100mm of penetration.

Soil Electrical Resistivity Tests

Two measurement lines with a diagonal array pattern were proposed to be conducted on this site. It consists of the x-x direction, East to West and the y-y direction, North to South.

For the x-x direction, East to West:

- The soil electrical resistivities of the subsurface soil/rock fluctuated from 16.59 Ωm to 37.70 Ωm when the probe spacing increased from 0.5m to 8.0m gradually.

For the y-y direction, North to South:

- The soil electrical resistivities of the subsurface soil/rock fluctuated from 54.66 Ωm to 123.15 Ωm when the probe spacing increased from 0.5m to 8.0m gradually.

Location 6: PORT HEDLAND

Test Pit Logs

The site soil profiles encountered for all test pits are similar, which comprising of a Gravel Mixture (Poorly Graded GRAVEL); fine to medium grained, grey, dry, angular to subangular; overlying Sand – Silt Mixtures (Silty SAND); fine to medium grained, brown, dry, dense to very dense, trace of fine grained gravels up to the target depth of 2.5m.

Dynamic Cone Penetrometer

Based on the Soils Testing Handbook of Australian Standard, Table 6.4.6.1 (B), the density of the soils for the fine to medium grained materials (Silty SAND) over the proposed development area was generally "**very dense**" with an average of 9 blows per 100mm of penetration.

Soil Electrical Resistivity Tests

Two measurement lines with a diagonal array pattern were proposed to be conducted on this site. It consists of the x-x direction, East to West and the y-y direction, North to South.

For the x-x direction, East to West:

- The soil electrical resistivities of the subsurface soil/rock fluctuated from 150.80 Ωm to 358.14 Ωm when the probe spacing increased from 0.5m to 4.0m gradually.

For the y-y direction, North to South:

- The soil electrical resistivities of the subsurface soil/rock fluctuated from 241.90 Ωm to 270.18 Ωm when the probe spacing increased from 0.5m to 2.0m gradually.

Laboratory Tests

Representative soil samples were taken from the test pit to determine the soil properties. Laboratory tests based on Australian Standards 1289 were conducted on the samples, at STATSWA Laboratory, Canning Vale, Perth.

The laboratory test program for this Group 1 sites consists of the following:

Table 3: Summary of Laboratory Tests

Locations	Number of Laboratory Tests					
	Particle Size Distribution AS1289 3.6.1	Atterberg Limits - One point Casagrande Method AS1289 3.1.2, 3.2.1, 3.3.1, 3.4.1	Modified Maximum Dry Density AS1289 5.2.1	California Bearing Ratio (Remoulded Specimens) AS1289 6.1.1	Point Load Strength Index AS4133.4.1	Multi Stage Direct Shear Tests (Cohesion and Frictional Angle)
Cue	4	4	1	1	1	NA
Nannine	4	4	1	1	1	1
Meekatharra	4	4	1	1	1	NA
Plutonic	4	4	1	1	1	NA
Kumarina	4	4	1	1	1	1
Port Hedland	4	4	1	1	NA	1
Total	**24**	**24**	**6**	**6**	**5**	**3**

The laboratory test results are presented in Appendix 6.

Geotechnical Site Classification

Based on the type of materials encountered, there are three (x3) Geotechnical Site Classifications provided for all the six (x6) site locations:

- ***Kumarina:***
  The site is generally assigned a Geotechnical **Site Classification of *"M"*** in accordance with the definitions provided in the Australian Standard AS2870 -2011, on the assumption that the build pad shall be prepared and compacted to the specified requirements. For the soil profile encountered the characteristic surface movement (Y_s Value) for the site was assessed as 20mm to 40mm due to seasonal moisture change would occur. To reclassify the site as Class **"S"** will requires the removal of 600mm of existing soils and replaced with a non plastic imported Select Fill material.

- ***Cue, Nannine, Meekatharra Plutonic and Port Hedland:***
  The sites are generally assigned a Geotechnical **Site Classification of *"S"*** in accordance with the definitions provided in the Australian Standard AS2870 -2011, on the assumption that the build pad shall be prepared and compacted to the specified requirements. For the soil profile encountered the characteristic surface movement (Y_s Value) for the site was assessed as 0mm to 20mm due to seasonal moisture change would occur.

Any further earthworks for site preparation shall be carried out in accordance with AS 3798-2007.

Soils Bearing and Settlement Assessments

Findings revealed pad footings of size 3m by 4m and 3m by 3m are adequate against an allowable soil bearing capacity of up to 250kPa, assuming an embedment depth of up to 1m.

Short and long term settlement estimations are computed up to 33mm at the centre of flexible footing for 4m by 3m and up to 29 mm at the centre of flexible footing for 3m by 3m pad footings, assuming the soils has been compacted to 95% MDR. A Factor of Safety of 2.5 is allowed in the assessment.

The computed soil bearing capacity and settlement estimations are presented in Appendix 7.

1.0 INTRODUCTION

1.1 The following is a Geotechnical Investigation Report for fourteen (x14) Proposed Telco Project sites from Port Hedland to Newman, Western Australia. This report covers Group 1, for a total of six (x6) sites. The site location and tests carried out are presented in Figures 1 to 7.

1.2 The objective was to obtain information on the subsurface conditions to classify the site in accordance with the definitions provided in Australian Standard AS2870 – 2011, and AS 1726 for the proposed construction work at each site, which shall comprise of substation structures and solar panel arrays.

1.4 Each site except the Port Hedland site consists of five (x5) test pits to the depth of 2.5m or refusal, five (x5) DCP tests to the depth of 1.05m and one (x1) array of electrical resistivity test (x-x and y-y direction).

1.5 The Port Hedland site consists of four (x4) test pits to the depth of 2.5m or refusal, four (x4) DCP tests to the depth of 1.05m and one (x1) array of electrical resistivity test (x-x and y-y direction).

1.6 The site investigation work was conducted from 28th March 2023 to 1st April 2023 and 4th April 2023.

2.0 SCOPE OF INVESTIGATION

2.1 The scope of investigation was as follows:

- Carried out Dial Before U Dig information, including review of existing underground services.
- Mobilised and demobilised STATS Engineering Crew (x2) and Equipment.
- Mobilised and demobilised an 8T excavator with a 300mm auger and tooth bucket options and an operator.
- STATS provided the GPS coordinate for four corners of each site based on handheld GPS unit or mobile phone app.
- Carried out up to six (x6) test pits, to depth of 2.5m to 3.0m or refusal, in accordance with the proposed six (x6) different site layouts, as shown in Figure 2 to 7.
- Carried out one (x1) set of Field Electrical Resistivity measurements along x-x and y-y direction, at spacings of 0.5m, 1m, 2m, 4m, 8m, 16m and 20m for each site.
- USC of soil profiles, sampling including DCP up to depth of 1m or refusal, to determine soil consistency versus depth as well as estimation of insitu CBR.
- Observed and logged the presence of any ground water.
- Areas of reinstated should be carried out using excavated spoils and compacted with plate compactor.
- STATS should be guided by Dial Before U Dig information on the presence of underground services and shall not be held responsible if our investigation hit or damage any services.
- Carried out the following laboratory tests on representative soil samples:
    - Particle Size Distribution Tests,
    - Plasticity Index Tests,

- Modified Maximum Dry Density Test,
- 4 days soaked CBR Test,
- Point Load Index Tests for rock samples,
- Multi Stage Direct Shear Tests (Cohesion and Frictional angle) for nominated soils.

- The laboratory tests are required as part of AS 1726 requirements to be able to carry out a Unified Soil Classification of the materials encountered, and to advice the suitability of the insitu materials for use as structural fill, or the need to import filling materials.
- Based on the laboratory and field findings, provide a Geotech report on site preparation, excavation conditions (depths to bedrocks), footing pads, material suitability, earthwork preparation, subsoil drainage requirements and compaction requirements and Geotech Site Classification for the footing at the shed area.
- Provided soils bearing capacity estimations and settlement estimations for each site.
- Provided recommendations on Suitable and Unsuitable soils encountered.

3.0 SITE CHARACTERISTICS

3.1 Geology

3.1.1 Cue

3.1.1.1 A review of the 1:250,000 Geological Survey map of Cue indicates that the site is situated on ***Agf***: Foliated fine-grained granitic rock and ***Qc:*** Colluvium – includes outwash fans, talus and scree deposits.

3.1.2 Nannine

3.1.2.1 A review of the 1:250,000 Geological Survey map of Belele indicates that the site is situated on ***Qc:*** Colluvium – quartz and rock fragments in loam, unconsolidated, forming scree and talus slopes.

3.1.3 Meekatharra

3.1.3.1 A review of the 1:250,000 Geological Survey map of Glengarry indicates that the site is situated on ***Qc:*** Colluvium, quartz and rock fragments in loam, unconsolidated.

3.1.4 Plutonic

3.1.4.1 A review of the 1:250,000 Geological Survey map of Peak Hill indicates that the site is situated on ***Qa:*** Alluvium,sand and silt in drainages.

3.1.5 Kumarina

3.1.5.1 A review of the 1:250,000 Geological Survey map of Collier indicates that the site is situated on ***Qc:*** Colluvium – unconsolidated silt, sand, gravel and rubble; minor alluvium.

3.1.6 Port Hedland

3.1.6.1 A review of the 1:250,000 Geological Survey map of Port Hedland – Bedout Island indicates that the site is situated on ***Qbo-kla:*** Bossut Formation: calcarenite; minor calcirudite and calcilutite.

3.2 Groundwater

3.2.1 No groundwater was encountered at all the test pit locations during the test pitting program.

4.0 SITE DESCRIPTION

4.1 A review of the Landgate information and aerial photography of the various sites revealed the following:

- Cue: Within an industrial area, next to a warehouse at 28 Heydon Place, Cue;
- Nannine: Western side of the Great Northern Highway, H006 - SLK 690.50;
- Meekatharra: Eastern side of the Great Northern Highway, H006 - SLK 748.48;
- Plutonic: Western side of the Great Northern Highway, H006 - SLK 919.38;
- Kumarina: Western side of the Great Northern Highway, H006 - SLK 1003.78;
- Port Hedland: Within a residential area, next to a tennis court at McGregor Street, Port Hedland.

5.0 FIELD PROGRAMME

5.1 Cue

5.1.1 Test Pit Logs

5.1.1.1 The test pit logs were positioned over the proposed area of development.

5.1.1.2 The site soil profiles encountered for all test pits are similar, which comprises of a Sand - Silt Mixture (Silty SAND): fine to medium grained, brown, moist, very dense, trace of gravels up to 60mm in size, trace of cobbles up to 130mm in size and encountered a 10 mm thick of igneous rock layer up to 0.6m in depth for TP1, TP3 and TP5, a 25 mm thick of igneous rock layer up to 0.95m in depth for TP2 and TP4; overlying Sand – Clay (Clayey SAND): fine to medium grained, pale brown/grey, dry to moist, very dense, with gravels up to 7mm in size, trace of cobbles up to 130mm in size.

5.1.1.3 All the test pits terminated at the target depth except for the TP1, which terminated at 2.0m due to unstable test pit wall which collapses before reaching the depth.

5.1.1.4 The test pit logs are presented in Appendix 2A.

5.1.1.5 The test pit locations are presented in Figure 2.

5.1.2 Dynamic Cone Penetrometer

5.1.2.1 Dynamic Cone Penetrometer (DCP) testing was carried out alongside each test pit location to determine the soil density/consistency versus depth.

5.1.2.2 Based on the Soils Testing Handbook of Australian Standard, Table 6.4.6.1 (B), the density of the soils for the fine to medium grained materials (Silty SAND) over the proposed development area was generally "**very dense**" with an average of 19 blows per 100mm of penetration.

5.1.2.3 The DCP results are presented in Appendix 3A of this report and the Correlation of DCP Blow Counts to CBR Values is presented in Appendix 4A.

5.1.3 Soil Electrical Resistivity Tests

5.1.3.1 Two measurement lines with a diagonal array pattern were conducted for this site, along the x-x direction, East to West and the y-y direction, North to South.

5.1.3.2 For the x-x direction, Northeast to southwest:

- The soil electrical resistivities of the subsurface soil/rock have a range of 16.18 Ωm to 26.14 Ωm which surged when the probe spacing increased from 0.5m to 4.0m gradually.

5.1.3.3 For the y-y direction, Northwest to southeast:

- The soil electrical resistivities of the subsurface soil/rock have a range of 19.57 Ωm to 31.42 Ωm which surged when the probe spacing increased from 0.5m to 4.0m gradually and reduced to 28.65 Ωm when the probe spacing increased from 4.0m to 8.0m.

5.1.3.4 The Soil Electrical Resistivity Test Certificates are presented in Appendix 5A.

5.2 Nannine

5.2.1 Test Pit Logs

5.2.1.1 The test pit logs were positioned over the proposed area of development.

5.2.1.2 The site soil profiles encountered at TP1 comprises of a Sand - Clay Mixture (Clayey SAND); fine to medium grained, brown, moist, very dense, with gravels up to 60mm in size, trace of rootlets up to 0.3m in depth, terminated at the depth of 0.8m due to encountered hard rock layer.

5.2.1.3 At TP2 to TP5, the soil profile encountered comprised of a Sand - Silt Mixture (Silty SAND); fine to medium grained, brown, moist, very dense, trace of gravels up to 60mm in size, trace of rootlets up to 0.3m in depth; overlying extremely weathered rock up to the depth of 0.7m to 1.0m.

5.2.1.4 All the test pits terminated at the depth range from 0.4m to 1.0m due to a hard rock layer encountered.

5.2.1.5 The test pit logs are presented in Appendix 2B.

5.2.1.6 The test pit locations are presented in Figure 3.

5.2.2 Dynamic Cone Penetrometer

5.2.2.1 Dynamic Cone Penetrometer (DCP) testing was carried out alongside each test pit location to determine the soil density/consistency versus depth.

5.2.2.2 Based on the Soils Testing Handbook of Australian Standard, Table 6.4.6.1 (B), the density of the soils for the fine to medium grained materials (Clayey SAND and Silty SAND) over the proposed development area was generally "**very dense**" with an average of 9 blows per 100mm of penetration.

5.2.2.3 The DCP results are presented in Appendix 3B of this report and the Correlation of DCP Blow Counts to CBR Values is presented in Appendix 4B.

5.2.3 Soil Electrical Resistivity Tests

5.2.3.1 Two measurement lines with a diagonal array pattern were conducted for this site, along the x-x direction, East to West and the y-y direction, North to South.

5.2.3.2 For the x-x direction, East to West:

- The soil electrical resistivities of the subsurface soil/rock reduced from 320.44 Ωm to 70.87 Ωm when the probe spacing increased from 0.5m to 8.0m gradually.

5.2.3.3 For the y-y direction, North to South:

- The soil electrical resistivities of the subsurface soil/rock fluctuate from 235.62 Ωm to 100.53 Ωm but showed a downward trend when the probe spacing increased from 0.5m to 8.0m gradually.

5.2.3.4 The Soil Electrical Resistivity Test Certificates are presented in Appendix 5B.

5.3 Meekatharra

5.3.1 Test Pit Logs

5.3.1.1 The test pit logs were positioned over the proposed area of development.

5.3.1.2 The site soil profiles encountered for TP1 and TP5 comprised of a Sand - Clay - Gravel Mixtures (Gravelly Clayey SAND); fine to medium grained, brown, dry, very dense, angular to subangular gravels up to 60mm in size, trace of cobbles up to 100mm in size, trace of rootlets up to 0.3m in depth, overlying extremely weathered rock from to the depth of 0.7m to 1.0m.

5.3.1.3 In terms of TP2 to TP4, it comprised of Sand - Clay Mixtures (Clayey SAND); fine to medium grained, brown, dry, dense to very dense, with angular to subangular gravels up to 60mm in size, trace of cobbles up to 100mm in size, trace of rootlets up to 0.4m in depth.

5.3.1.4 All the test pits terminated at the depth varying from 0.6m to 1.0m due to a hard rock layer encountered.

5.3.1.5 The test pit logs are presented in Appendix 2C.

5.3.1.6 The test pit locations are presented in Figure 4.

5.3.2 Dynamic Cone Penetrometer

5.3.2.1 Dynamic Cone Penetrometer (DCP) testing was carried out alongside each test pit location to determine the soil density/consistency versus depth.

5.3.2.2 Based on the Soils Testing Handbook of Australian Standard, Table 6.4.6.1 (B), the density of the soils for the fine to medium grained materials (Clayey SAND and Gravelly Clayey SAND) over the proposed development area was generally "**very dense**" with an average of 12 blows per 100mm of penetration.

5.3.2.3 The DCP results are presented in Appendix 3C of this report and the Correlation of DCP Blow Counts to CBR Values is presented in Appendix 4C.

5.3.3 Soil Electrical Resistivity Tests

5.3.3.1 Two measurement lines with a diagonal array pattern were conducted for this site, along the x-x direction, East to West and the y-y direction, North to South.

5.3.3.2 For the x-x direction, Northwest to Southeast:

- The soil electrical resistivities of the subsurface soil/rock reduced from 521.50 Ωm to 175.93 Ωm when the probe spacing increased from 0.5m to 2.0m gradually.

5.3.3.3 For the y-y direction, Northeast to Southwest:

- The soil electrical resistivities of the subsurface soil/rock fluctuate from 420.97 Ωm to 163.36 Ωm but showed a downward trend when the probe spacing increased from 0.5m to 2.0m gradually.

5.3.3.4 The Soil Electrical Resistivity Test Certificates are presented in Appendix 5C.

5.4 Plutonic

5.4.1 Test Pit Logs

5.4.1.1 The test pit logs were positioned over the proposed areas of development.

5.4.1.2 The site soil profiles encountered for all test pits are similar, which comprises of a Sand - Clay Mixture (Clayey SAND); fine to medium grained, brown/red, wet to moist, dense to very dense, trace of angular to subangular gravels up to 20mm in size.

5.4.1.3 All the test pits terminated at the depth varying from 0.45m to 0.85m due to a hard rock layer encountered.

5.4.1.4 The test pit logs are presented in Appendix 2D.

5.4.1.5 The test pit locations are presented in Figure 5.

5.4.2 Dynamic Cone Penetrometer

5.4.2.1 Dynamic Cone Penetrometer (DCP) testing was carried out alongside each test pit location to determine the soil density/consistency versus depth.

5.4.2.2 Based on the Soils Testing Handbook of Australian Standard, Table 6.4.6.1 (B), the density of the soils for the fine to medium grained materials (Clayey SAND) over the proposed development area was generally “very dense” with an average of 17 blows per 100mm of penetration.

5.4.2.3 The DCP results are presented in Appendix 3D of this report and the Correlation of DCP Blow Counts to CBR Values is presented in Appendix 4D.

5.4.3 Soil Electrical Resistivity Tests

5.4.3.1 Two measurement lines with a diagonal array pattern were conducted for this site, along the x-x direction, East to West and the y-y direction, North to South.

5.4.3.2 For the x-x direction, East to West:

- The soil electrical resistivities of the subsurface soil/rock reduced from 408.41 Ωm to 50.01 Ωm when the probe spacing increased from 0.5m to 4.0m gradually.

5.4.3.3 For the y-y direction, North to South:

- The soil electrical resistivities of the subsurface soil/rock reduced from 917.35 Ωm to 50.27 Ωm when the probe spacing increased from 0.5m to 4.0m gradually.

5.4.3.4 The Soil Electrical Resistivity Test Certificates are presented in Appendix 5D.

5.5 Kumarina

5.5.1 Test Pit Logs

5.5.1.1 The test pit logs were positioned over the proposed areas of development.

5.5.1.2 The site soil profiles encountered for TP1, TP2, TP4 and TP5 comprised of a Sand - Gravel Mixtures (Gravelly SAND); fine to medium grained, brown/grey, dry, medium dense to very dense, trace of cobbles up to 100mm in size, with low plasticity of silt/clay, overlaying a Gravel - Clay - Sand Mixture (Clayey Sandy GRAVEL); fine to coarse grained, grey/white, dry, very dense, angular to subangular, trace of cobbles up to 190mm in size.

5.5.1.3 TP3 comprised of a Sand - Gravel Mixtures (Gravelly SAND); fine to medium grained, brown/grey, dry, medium dense, trace of cobbles up to 100mm in size, with low plasticity of silt/clay, trace of rootlets up to 0.3m in depth; overlaying Clay - Gravel Mixtures (Gravelly CLAY); fine grained, grey/white, dry, very stiff to hard, with fine to medium grained sand, trace of cobbles up to 170mm in size.

5.5.1.4 All the test pits are terminated at the depth varying from 1.2m to 2.2m due to a hard layer encountered.

5.5.1.5 The test pit logs are presented in Appendix 2E.

5.5.1.6 The test pit locations are presented in Figure 6.

5.5.2 Dynamic Cone Penetrometer

5.5.2.1 Dynamic Cone Penetrometer (DCP) testing was carried out alongside each test pit location to determine the soil density/consistency versus depth.

5.5.2.2 Based on the Soils Testing Handbook of Australian Standard, Table 6.4.6.1 (B), the density of the soils for the fine to coarse grained materials (Gravelly SAND and Clayey Sandy GRAVEL) over the proposed development area was generally "**dense**" with an average of 7 blows per 100mm of penetration.

5.5.2.3 Based on the Soils Testing Handbook of Australian Standard, Table 6.4.6.1 (A), the consistency of the soils for the fine grained materials (Gravelly CLAY) over the proposed development area was generally "**very stiff**" with an average of 10 blows per 100mm of penetration.

5.5.2.4 The DCP results are presented in Appendix 3E of this report and the Correlation of DCP Blow Counts to CBR Values is presented in Appendix 4E.

5.5.3 Soil Electrical Resistivity Tests

5.5.3.1 Two measurement lines with a diagonal array pattern were conducted for this site, along the x-x direction, East to West and the y-y direction, North to South.

5.5.3.2 For the x-x direction, East to West:

- The soil electrical resistivities of the subsurface soil/rock fluctuated from 16.59 Ωm to 37.70 Ωm when the probe spacing increased from 0.5m to 8.0m gradually.

5.5.3.3 For the y-y direction, North to South:

- The soil electrical resistivities of the subsurface soil/rock fluctuated from 54.66 Ωm to 123.15 Ωm when the probe spacing increased from 0.5m to 8.0m gradually.

5.5.3.4 The Soil Electrical Resistivity Test Certificates are presented in Appendix 5E.

5.6 Port Hedland

5.6.1 Test Pit Logs

5.6.1.1 The test pit logs were positioned over the proposed areas of development.

5.6.1.2 The site soil profiles encountered for all test pits are similar, which comprises of a Gravel Mixture (Poorly Graded GRAVEL); fine to medium grained, grey, dry, angular to subangular; overlying Sand – Silt Mixtures (Silty SAND); fine to medium grained, brown, dry, dense to very dense, trace of fine grained gravels up to the target depth of 2.5m.

5.6.1.3 The test pit logs are presented in Appendix 2F.

5.6.1.4 The test pit locations are presented in Figure 7.

5.6.2 Dynamic Cone Penetrometer

5.6.2.1 Dynamic Cone Penetrometer (DCP) testing was carried out alongside each test pit location to determine the soil density/consistency versus depth.

5.6.2.2 Based on the Soils Testing Handbook of Australian Standard, Table 6.4.6.1 (B), the density of the soils for the fine to medium grained materials (Silty SAND) over the proposed development area was generally “very dense” with an average of 9 blows per 100mm of penetration.

5.6.2.3 The DCP results are presented in Appendix 3F of this report and the Correlation of DCP Blow Counts to CBR Values is presented in Appendix 4F.

5.6.3 Soil Electrical Resistivity Tests

5.6.3.1 Two measurement lines with a diagonal array pattern were conducted for this site, along the x-x direction, East to West and the y-y direction, North to South.

5.6.3.2 For the x-x direction, East to West:

- The soil electrical resistivities of the subsurface soil/rock fluctuated from 150.80 Ωm to 358.14 Ωm when the probe spacing increased from 0.5m to 4.0m gradually.

5.6.3.3 For the y-y direction, North to South:

- The soil electrical resistivities of the subsurface soil/rock fluctuated from 241.90 Ωm to 270.18 Ωm when the probe spacing increased from 0.5m to 2.0m gradually.

5.6.3.4 The Soil Electrical Resistivity Test Certificates are presented in Appendix 5F.

6.0 LABORATORY TESTS

6.1 Laboratory Tests

6.1.1 Representative soil samples were taken from the test pit to determine the soil properties. Laboratory tests based on Australian Standards 1289 were conducted on the samples, at STATSWA Laboratory, Canning Vale, Perth.

6.1.2 The laboratory test program consists of the following:

- Particle Size Distribution Tests (x24),
- Plasticity Index Tests (x24),
- Modified Maximum Dry Density Tests (x6),
- 4 days soaked CBR Tests (x6),
- Point Load Index Tests for rock samples (x5),
- Multi Stage Direct Shear Tests - Cohesion and Frictional angle (x3).

6.1.3 The laboratory test results are presented in Appendix 6. A summary of the laboratory test findings is presented in the Tables below.

Table 4: Summary of Laboratory Tests - Cue

Test Pit ID	TP1	TP2	TP3	TP5
Depth (m)	0.8-1.5m	2.0-2.6m	1.8-2.3m	2.2-2.6m
USC	SC	SC	SC	SC-SM
Passing 2.36mm (%)	82	76	70	65
Passing 75µm (%)	29	23	23	18
Liquid Limit (%)	35	29	33	23
Plastic Limit (%)	24	20	24	17
Plasticity Index (%)	11	9	9	6
Linear Shrinkage (%)	2.5	4.0	3.5	2.0
Opt. Moisture Content (%)	15.5	-	-	-
Modified Maximum Dry Density (t/m^3)	1.73	-	-	-
4 days soaked CBR (%)	20@2.5mm	-	-	-
Point Load Test Results				
Number of tests	-	-	-	2
Average Point Load Strength I_s (MPa)	-	-	-	4.05 (3.4-4.7)
Average Point Load Strength Index $I_{s(50)}$ (MPa)	-	-	-	4.55 (3.4-5.7)

Table 5: Summary of Laboratory Tests - Nannine

Test Pit ID	TP1	TP2	TP3	TP5
Depth (m)	0.1-0.8m	0.1-0.3m	0.1-0.4m	0.1-0.7m
USC	SC-SM	SM	SM	SM
Passing 2.36mm (%)	83	86	76	87
Passing 75µm (%)	20	18	22	20
Liquid Limit (%)	17	16	18	16
Plastic Limit (%)	11	13	14	13
Plasticity Index (%)	6	3	4	3
Linear Shrinkage (%)	3.0	2.0	2.0	1.0
Opt. Moisture Content (%)	7.0	-	-	-
Modified Maximum Dry Density (t/m^3)	2.18	-	-	-
4 days soaked CBR (%)	20@2.5mm	-	-	-
Point Load Test Results				
Number of tests	-	-	-	7
Average Point Load Strength I_s (MPa)	-	-	-	1.07 (0.7-1.3)
Average Point Load Strength Index $I_{s(50)}$ (MPa)	-	-	-	1.17 (0.8-1.5)

Table 6: Summary of Laboratory Tests - Meekatharra

Test Pit ID	TP1	TP3	TP4	TP5
Depth (m)	0.1-0.7m	0.1-0.6m	0.1-0.6m	0.1-0.7m
USC	SC-SM	SC	SC	SC
Passing 2.36mm (%)	63	75	72	69
Passing 75µm (%)	16	22	20	27
Liquid Limit (%)	17	20	19	18
Plastic Limit (%)	11	12	11	11
Plasticity Index (%)	6	8	8	7
Linear Shrinkage (%)	3.0	3.5	2.5	4.0
Opt. Moisture Content (%)	-	-	8.5	-
Modified Maximum Dry Density (t/m^3)	-	-	2.22	-
4 days soaked CBR (%)	-	-	7@5.0mm	-
Point Load Test Results				
Number of tests	-	3	-	-
Average Point Load Strength I_s (MPa)	-	3.87 (3.5-4.1)	-	-
Average Point Load Strength Index $I_{s(50)}$ (MPa)	-	3.37 (3.2-3.6)	-	-

Table 7: Summary of Laboratory Tests - Plutonic

Test Pit ID	TP1	TP2	TP4	TP5
Depth (m)	0.1-0.45m	0.1-0.6m	0.1-0.5m	0.1-0.5m
USC	SC	SC-SP	SC	SC
Passing 2.36mm (%)	97	95	97	80
Passing 75µm (%)	32	8	35	16
Liquid Limit (%)	18	21	20	23
Plastic Limit (%)	9	9	9	14
Plasticity Index (%)	9	12	11	9
Linear Shrinkage (%)	4.5	4.5	4.5	4.5
Opt. Moisture Content (%)	-	-	-	10.5
Modified Maximum Dry Density (t/m^3)	-	-	-	2.00
4 days soaked CBR (%)	-	-	-	20@2.5mm
Point Load Test Results				
Number of tests	-	-	-	3
Average Point Load Strength I_s (MPa)	-	-	-	0.1 (0.0-0.1)
Average Point Load Strength Index $I_{s(50)}$ (MPa)	-	-	-	0.1 (0.0-0.1)

Table 8: Summary of Laboratory Tests - Kumarina

Test Pit ID	TP1	TP2	TP3	TP5
Depth (m)	1.5-2.0m	0.3-1.5m	0.3-1.0m	0.1-0.3m
USC	GC	GC	CL	SC
Passing 2.36mm (%)	52	60	65	68
Passing 75µm (%)	16	35	38	24
Liquid Limit (%)	42	39	36	22
Plastic Limit (%)	22	21	17	11
Plasticity Index (%)	20	18	19	11
Linear Shrinkage (%)	7.5	7.0	10.0	4.0
Opt. Moisture Content (%)	-	2.04	-	-
Modified Maximum Dry Density (t/m^3)	-	10.0	-	-
4 days soaked CBR (%)	-	19@5.0mm	-	-
Point Load Test Results				
Number of tests	3	-	-	-
Average Point Load Strength I_s (MPa)	3.27 (2.6-4.5)	-	-	-
Average Point Load Strength Index $I_{s(50)}$ (MPa)	3.1 (2.5-4.3)	-	-	-

Table 9: Summary of Laboratory Tests – Port Hedland

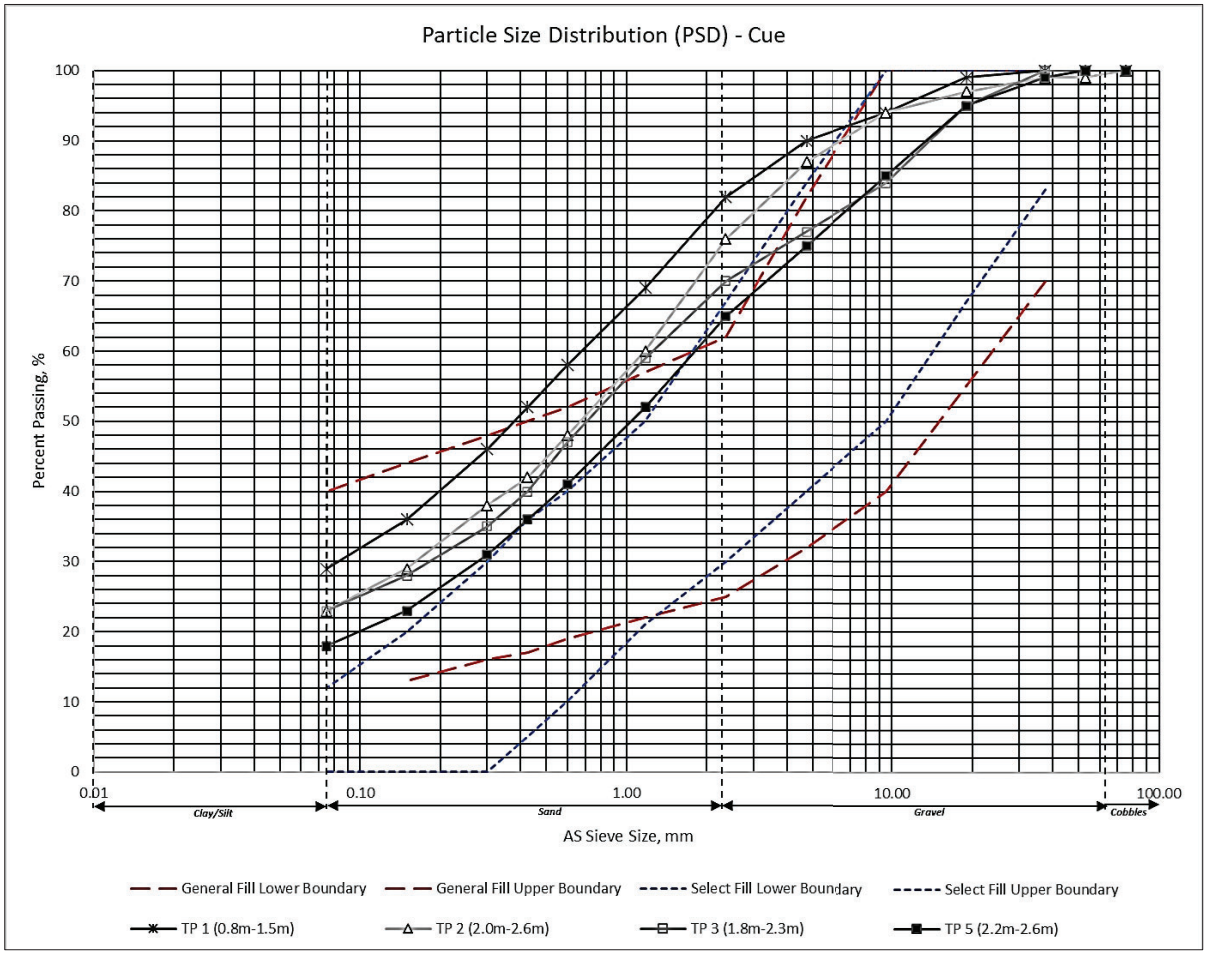
Test Pit ID	TP1	TP2	TP3	TP4
Depth (m)	1.8-2.2m	2.0-2.5m	1.2-1.8m	0.8-1.3m
USC	SM	SM	SP-SM	SP-SM
Passing 2.36mm (%)	91	86	85	86
Passing 75µm (%)	28	19	10	7
Liquid Limit (%)	NO	NO	NO	NO
Plastic Limit (%)	NO	NO	NO	NO
Plasticity Index (%)	NP	NP	NP	NP
Linear Shrinkage (%)	N/A	N/A	N/A	N/A
Opt. Moisture Content (%)	-	10.5	-	-
Modified Maximum Dry Density (t/m^3)	-	1.99	-	-
4 days soaked CBR (%)	-	9@5.0mm	-	-

Table 10: Summary of Laboratory Tests – Multistage Drained Direct Shear Test

Location	Nannine		Kumarina		Port Hedland	
Test Pit ID	TP1		TP2		TP2	
Depth (m)	0.10 – 0.80		0.30 – 1.50		2.00 – 2.50	
	Peak	Ultimate/Residual	Peak	Ultimate/Residual	Peak	Ultimate/Residual
Cohesion, C′ (kPa)	33.53	7.88	56.22	23.66	34.16	13.18
Angle of Shear Resistance, ϕ′ (°)	45.57	38.66	40.03	37.23	43.83	40.70

6.1.4 A summary of the Particle Size Distribution (PSD) for all the materials encountered at ***Cue*** was plotted against General and Select Fill criteria and presented in Graph 1 below.

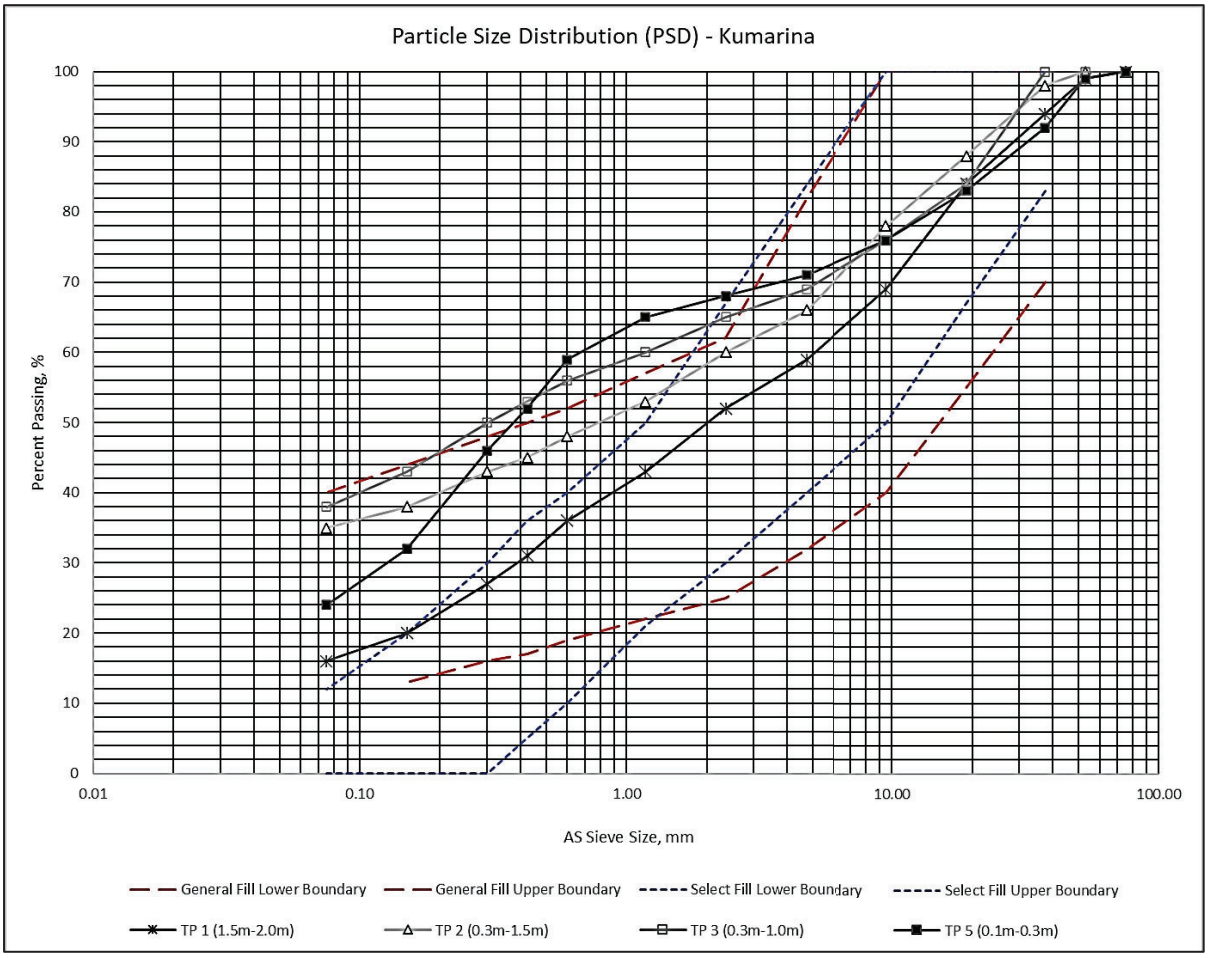
Graph 1: Particle Size Distribution (PSD) for materials encountered at Cue against General and Select Fill requirements



6.1.4.1 The findings revealed that the materials encountered on site from TP1 (0.8m to 1.5m) is suitable for use as a General FILL material.

6.1.5 A summary of the Particle Size Distribution (PSD) for all the materials encountered at ***Kumarina*** was plotted against General and Select Fill criteria and presented in Graph 5 below.

Graph 2: Particle Size Distribution (PSD) for materials encountered at Kumarina against General and Select Fill requirements.



6.1.5.1 The findings revealed that the materials encountered on site from TP1 (1.5m to 2.0m) and TP2 (0.3m – 1.5m) are suitable as a General FILL material.

7.0 GEOTECH SITE CLASSIFICATION

7.1 Based on the type of materials encountered, a summary of the Geotechnical Site Classifications is provided in the table below:

Table 11: Summary of the Site Classification

	Site Location	Site Classification	Soil Description Based on Reactivity
1	Cue	S	moderate ground movements from moisture changes
2	Nannine	S	slight ground movements from moisture changes
3	Meekatharra	S	slight ground movements from moisture changes
4	Plutonic	S	slight ground movements from moisture changes
5	Kumarina	M	moderate ground movements from moisture changes
6	Port Hedland	S	slight ground movements from moisture changes

7.1.1 The site at ***Kumarina*** is issued a Geotechnical **Site Classification of *"M"*** in accordance with the definitions provided in the Australian Standard AS2870 -2011, on the assumption that the build pad shall be prepared and compacted to the specified requirements. For the soil profile encountered the characteristic surface movement (Y_s Value) for the site was assessed as 20mm to 40mm due to seasonal moisture change would occur. To reclassify the site as Class **"S"** will requires the removal of 600mm of existing soils and replaced with a non plastic imported Select Fill material.

7.1.2 The sites at ***Cue, Nannine, Meekatharra, Plutonic and Port Hedland***, a Geotechnical **Site Classification of *"S"*** in accordance with the definitions provided in the Australian Standard AS2870 -2011 is issued, on the assumption that the build pad shall be prepared and compacted to the specified requirements. For the soil profile encountered the characteristic surface movement (Y_s Value) for the site was assessed as 0mm to 20mm due to seasonal moisture change would occur.

7.2 The explanation of the site classification is outlined in the Table below (source: tables 2.1 & 2.3 AS2870 2011).

Table 12: Classification by Characteristic Surface Movement Ys

Site Class	Soil Description Based on Reactivity	Characteristic Surface movement *Ys (mm)*
A	Most Sand & Rock Sites with little or no ground movement from moisture changes	0
S	Slightly reactive clay sites which may experience slight ground movements from moisture changes	$0 < Ys \leq 20$
M	Moderately reactive clay or silt sites which may experience moderate ground movements from moisture changes	$20 < Ys \leq 40$
H1	Highly reactive clay sites which may experience high ground movements from moisture changes	$40 < Ys \leq 60$
H2	Highly reactive clay sites which may experience very high ground movements from moisture changes	$60 < Ys \leq 75$
E	Extremely reactive sites which may experience extreme ground movements from moisture changes	$Ys > 75$
P	Sites with inadequate bearing capacity or is affected by factors other than Reactivity of the soil eg. soft soils, landslip, mine subsidence, uncontrolled fill, coastal erosion and the site cannot be classified based on soil reactivity	-

8.0 SOIL BEARING AND SETTLEMENT ASSESSMENTS

8.1 A Soil Bearing Capacity and Settlement estimations for different sizes of pad footings were carried out based on the soil properties at the uppermost depth.

8.2 Findings revealed pad footings of size 3m by 4m and 3m by 3m are adequate against an allowable soil bearing capacity of up to 250kPa, assuming an embedment depth of up to 1m.

8.3 Short and long term settlement estimations are computed up to 33mm at the centre of flexible footing for 4m by 3m and up to 29 mm at the centre of flexible footing for 3m by 3m pad footings, assuming the soils has been compacted to 95% MDR and a Factor of Safety of 2.5, for both short term and long term conditions.

8.4 A summary of the settlement assessment is presented in the table below. The computed soil bearing capacity and settlement estimations are presented in Appendix 7.

Table 13: Summary of the Settlement Assessments

Type	Weight (ton)	Size	Loading (kPa)	Max. Long-term Settlement (mm)		Max. Short-term Settlement (mm)	
				Flexible Footing	Rigid Footing	Flexible Footing	Rigid Footing
I	30	4m x 3m	250	32.23 at centre	24.49	25.78 at centre	19.59
II	22.5	3m x 3m	250	28.88 at centre	21.14	23.10 at centre	16.91

9.0 CONSTRUCTION STAGE SUPERVISION AND CERTIFICATION

9.1 The site investigation and subsequent classification has been carried out using a limited amount of test pits, visual inspection, sampling, and testing programme.

9.2 To achieve a full coverage of the site to ensure all variations are investigated and coverage is not practical and is seldom done due to cost and time constraints.

9.3 Due to the inherent nature of “natural ground” it is very possible that subsurface conditions may vary over short distances within the site. STATS is to be informed if the findings differ from that reported here during the excavation works.

9.4 It is essential that during the earthworks, a qualified Engineer/Technician be further engaged to inspect the foundation material and excavation work, including providing certification that the compaction works are completed satisfactory. This enables verification of the information contained in this report, and to advise on any changes to the design that may be needed, based on any variations encountered. Thus, the foundation material can then be certified as complying with the requirements of this report and the proposed design.

10.0 GENERAL EARTHWORKS

10.1 Any loose or areas of weakness should be removed and backfilled with approved granular fill. If boulders, rocks, or building rubble (>300mm) is encountered, they should be removed from the works.

10.2 Where there is the presence of minor organics and tree roots the material should be raked and removed using a rake with a 50mm grid spacing.

10.3 The base of the building pads shall be compacted using a 700kg vibrating plate compactor prior to importing of fill.

10.4 For this development, excavate to 0.5m below existing level, stockpile the excavated materials, compact at this base level until satisfactory, then backfill in two layers (max. 250mm lift each) and compact.

10.5 Backfill Materials

10.5.1 Any imported structural fill material to support footings should be clean sand with maximum 10% passing 0.075mm sieve.

10.5.2 All fill import is to be compacted in maximum layers of 250mm (loose) and compacted to achieve the specified minimum density ratio by an approved method.

10.5.3 Compaction required to achieve the density requirements is set out in the following tables and shall be conducted in accordance with AS 1289.5.1.1.

Table 14: Compaction Requirements for Fill

Item	Application	Compaction Criteria	
		Min Density Ratio (Cohesive Soils)	Min Density Index (Cohesion less Soils)
1	Commercial: To support minor loadings, including floor loadings up to 120kPa and isolated pad or strip footings to 100kPa	98%	75%

10.5.4 The plasticity index shall be < 5%.

10.6 Drainage and Stormwater Disposal

10.6.1 If construction works were to take place during the rainy seasons, the perimeter around the site and areas of proposed earthworks should be constructed with a shallow gradient to allow drainage to a sump and to allow water to be discharged from the site. It is important that the conditions under the footings remain relatively dry. Where required, drains should be constructed to divert water from the site and to ensure no erosion or premature saturation occurs around the footings.

10.6.2 Storm water should be collected and stored as the surface runoff controlled to prevent scour and loss of soil during periods of high intensity rainfall.

10.6.3 Based on the topography on sites, discharge of stormwater on site is not recommended. Stormwater discharge shall be channeled to detention basins or swales.

10.6.4 It is recommended that the sitework along the Great Northern Highway shall not to be carried out during wet weather e.g. seasonal cyclone events, whereby the site and road may be impacted by heavy rainfall, localized flash flooding and ponding.

11.0 CONCLUSIONS AND RECOMMENDATIONS

11.1 Based on the soils we encountered on different site locations, three Geotechnical Site Classification are provided below:

- ***Kumarina:***
  The site is generally assigned a Geotechnical **Site Classification of *"M"*** in accordance with the definitions provided in the Australian Standard AS2870 -2011, on the assumption that the build pad shall be prepared and compacted to the specified requirements. For the soil profile encountered the characteristic surface movement (Y_s Value) for the site was assessed as 20mm to 40mm due to seasonal moisture change would occur. To reclassify the site as Class **"S"** will requires the removal of 600mm of existing soils and replaced with a non plastic imported Select Fill material.

- ***Cue, Nannine, Meekatharra, Plutonic and Port Hedland:***
  The sites are generally assigned a Geotechnical **Site Classification of *"S"*** in accordance with the definitions provided in the Australian Standard AS2870 -2011, on the assumption that the build pad shall be prepared and compacted to the specified requirements. For the soil profile encountered the characteristic surface movement (Y_s Value) for the site was assessed as 0mm to 20mm due to seasonal moisture change would occur.

11.2 It is recommended that the site is prepared in accordance with the recommendations given in Australian Standard AS 3798-2011, "Guidelines on Earthworks for Commercial and Residential Developments".

11.3 Storm water should be collected and stored as the surface runoff controlled to prevent scour and loss of soil during periods of high intensity rainfall.

11.4 Based on the type of soils encountered, stormwater shall be channelled and discharged offsite into Swale Drains.

11.5 It is highly recommended that ongoing geotechnical supervision, sampling and testing be carried out throughout the different stages during the course of construction to verify the level of compaction prior to pouring concrete.

11.6 Pad footings of size 3m by 4m and 3m by 3m are adequate against an allowable soil bearing capacity of up to 250kPa, assuming an embedment depth of up to 1m.

11.7 Short and long term settlement estimations are computed up to 33mm at the centre of flexible footing for 4m by 3m and up to 29 mm at the centre of flexible footing for 3m by 3m pad footings, assuming the soils has been compacted to 95% MDR and a Factor of Safety of 2.5.

12.0 REFERENCES

- AS 1289 -2000, “Methods of Testing Soils for Engineering Purposes”.
- AS 1726 - 2017, “Geotechnical Site Investigations”.
- AS 2870 - 2011, “Residential Slabs and Footings”.
- AS 3798 - 2007, “Guidelines on earthworks for commercial and residential developments”.

STATS AUSTRALIA

Kevin Loh
MEng(Civil), BSc(Eng), MIE(Aust)
Civil Engineer

Aidan Seck
BEng (Civil), MIE(Aust), CPeng, NPER
Principal Engineer/Manager

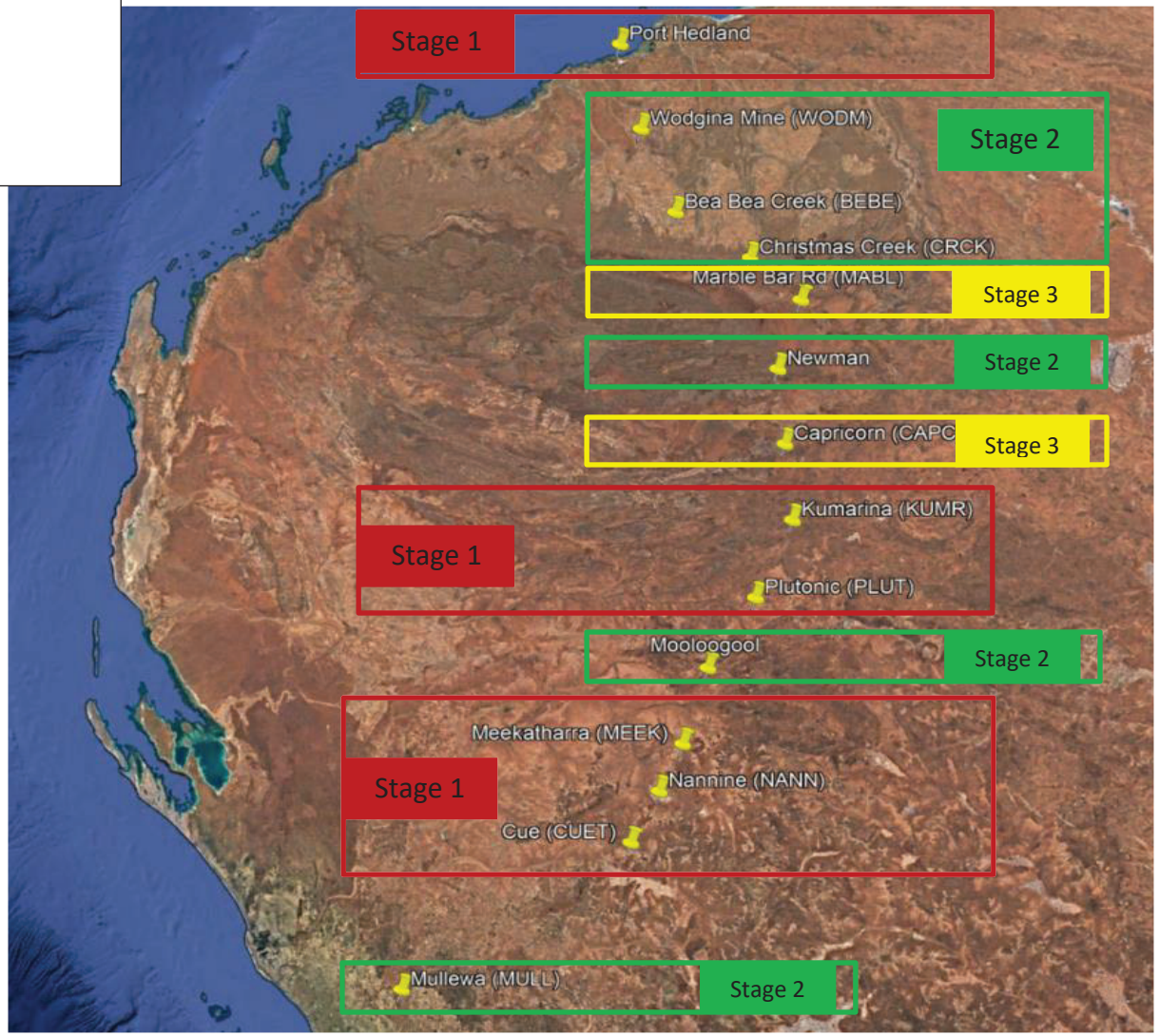
Figures

Figure 1 to 7: Proposed Overall Site Layout and Test Locations

(No of pages including this page: 08)

Legend

- Proposed Stage 1 Location
- Proposed Stage 2 Location
- Proposed Stage 3 Location



Project Title: **Proposed Telco Projects (Port Hedland to Mullewa)** - **Geotechnical Investigation Work**	**Title: Overall Site Layout and Telco Locations**	
	Figure: 1	**Scale: NTS**
	Date: 17 Apr 2023	**Drawn: KL**
	Checked: AS	**Approved: AS**
	Drawing No: 102667	**Rev: 1**

STATS AUSTRALIA
Unit 1/16 Production Road,
CANNING VALE WA 6155

Tel: 08 9455 3654
Fax: 08 9455 3709
www.statsaustralia.com.au

Legend

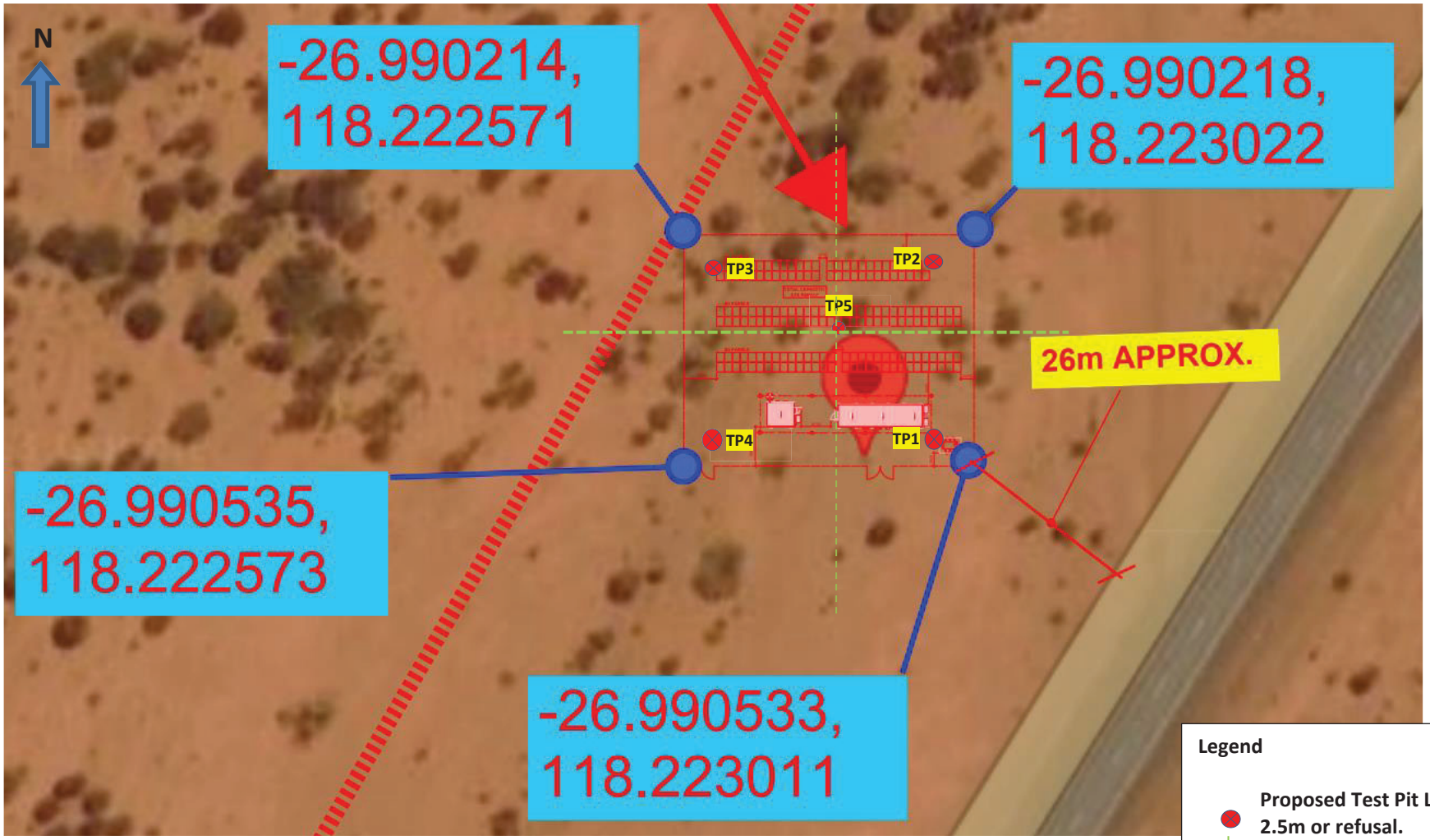
- Proposed Test Pit Locations (x5) to depth 2.5m or refusal.
  Field Electrical Resistivity (x2) @0.5m, 1m, 2m, 4m, 8m, 16m and 20m spacing.

Project Title:
Proposed Telco Projects (Port Hedland to Mullewa)
- **Geotechnical Investigation Work**

Title: Proposed test locations Layout (Cue)	
Figure: 2	**Scale: NTS**
Date: 17 Apr 2023	**Drawn: KL**
Checked: AS	**Approved: AS**
Drawing No: 102667	**Rev: 1**

STATS AUSTRALIA
Unit 1/16 Production Road,
CANNING VALE WA 6155

Tel: 08 9455 3654
Fax: 08 9455 3709
www.statsaustralia.com.au



Legend

- Proposed Test Pit Locations (x5) to depth 2.5m or refusal.
- Field Electrical Resistivity (x2) @0.5m, 1m, 2m, 4m, 8m, 16m and 20m spacing.

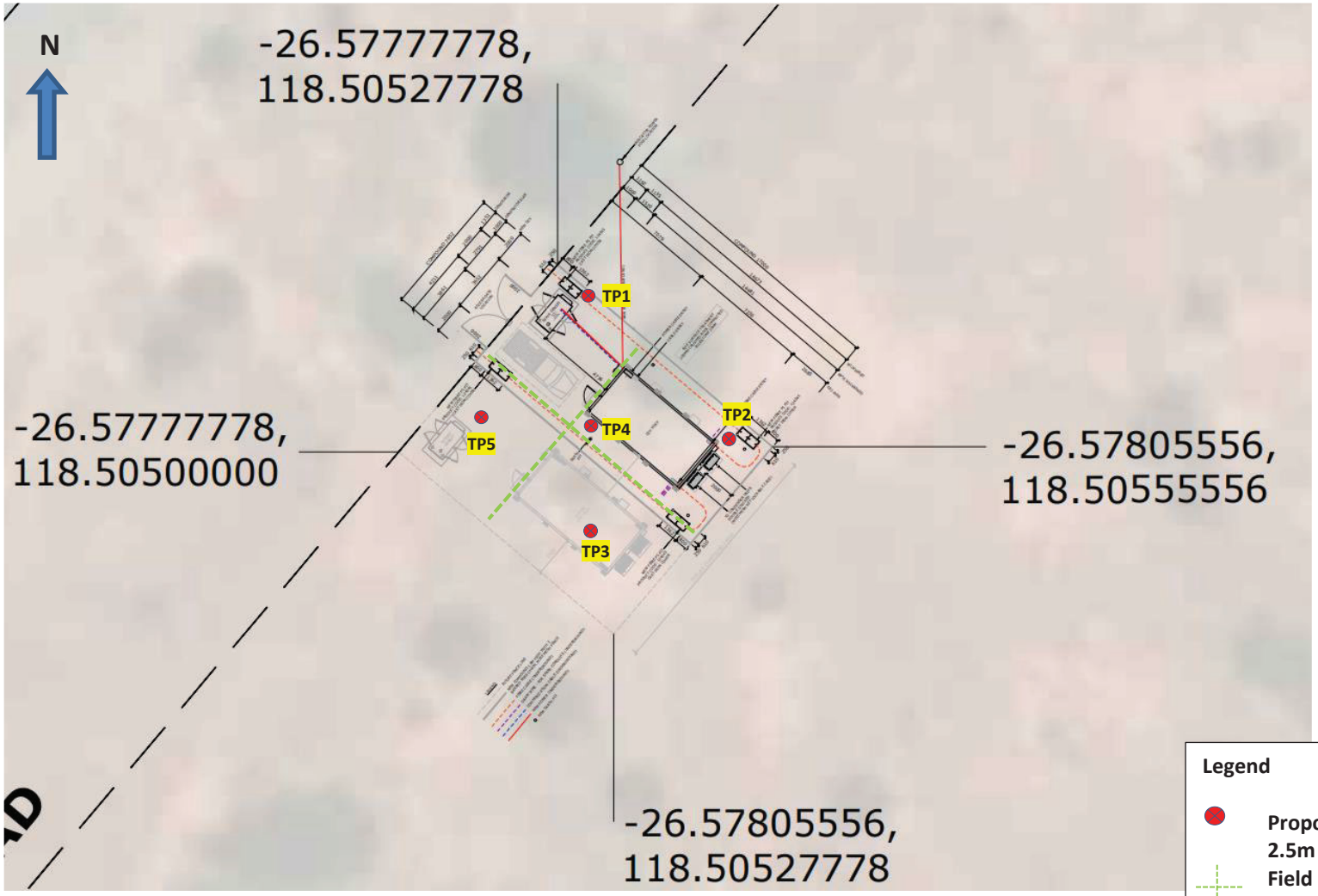
Project Title:
Proposed Telco Projects (Port Hedland to Mullewa)
- **Geotechnical Investigation Work**

Title: Proposed test locations Layout (Nannie)	
Figure: 3	**Scale: NTS**
Date: 17 Apr 2023	**Drawn: KL**
Checked: AS	**Approved: AS**
Drawing No: 102667	**Rev: 1**

STATS AUSTRALIA
Unit 1/16 Production Road,
CANNING VALE WA 6155

Tel: 08 9455 3654
Fax: 08 9455 3709
www.statsaustralia.com.au

CELEBRATING STATS 10 YEARS IN BUSINESS



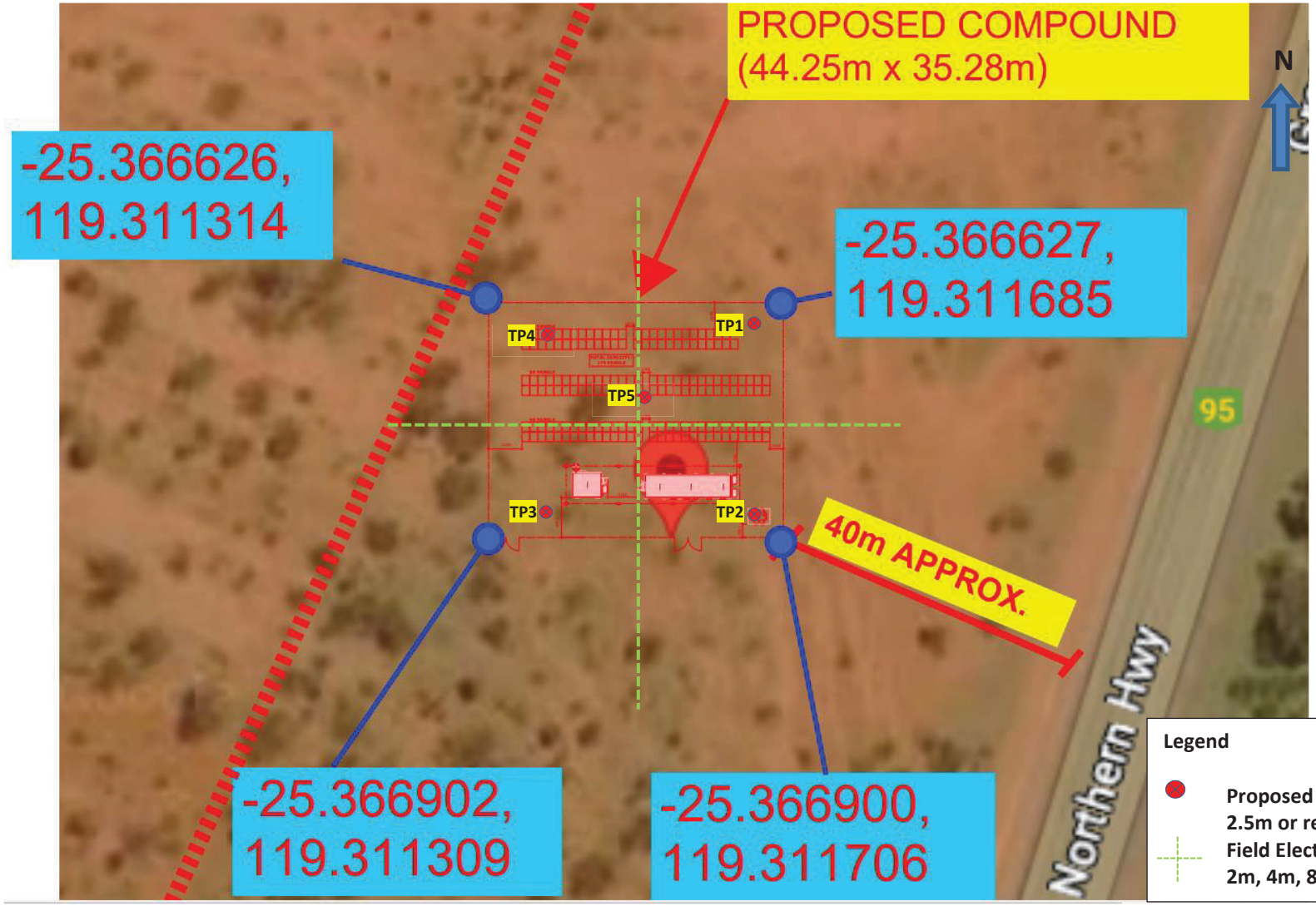
Legend

- Proposed Test Pit Locations (x5) to depth 2.5m or refusal.
- Field Electrical Resistivity (x2) @0.5m, 1m, 2m, 4m, 8m, 16m and 20m spacing.

Project Title: **Proposed Telco Projects (Port Hedland to Mullewa)** - **Geotechnical Investigation Work**	**Title: Proposed test locations Layout (Meekatharra)**	
	Figure: 4	**Scale: NTS**
	Date: 17 Apr 2023	**Drawn: KL**
	Checked: AS	**Approved: AS**
	Drawing No: 102667	**Rev: 1**

STATS AUSTRALIA
Unit 1/16 Production Road,
CANNING VALE WA 6155

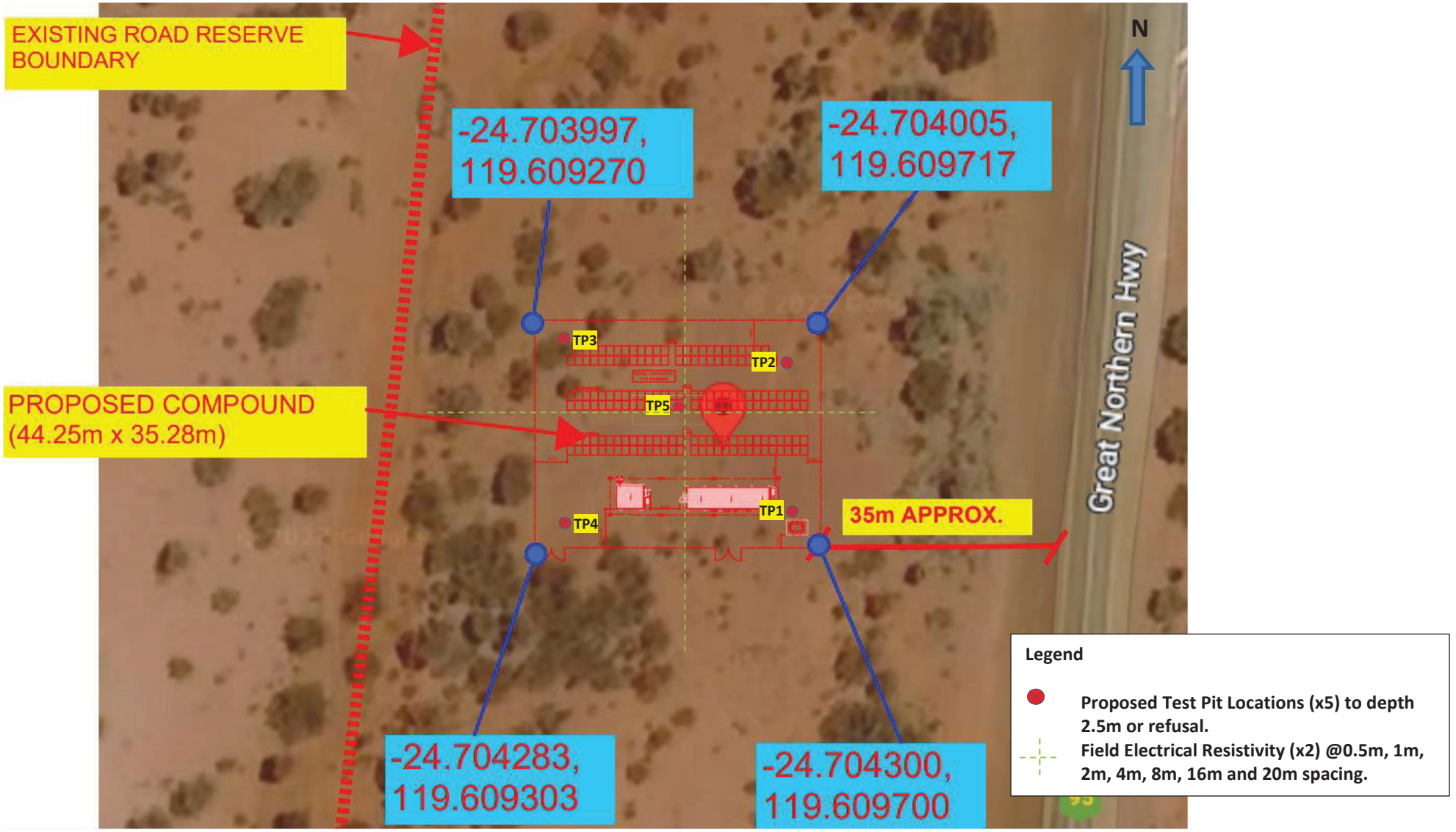
Tel: 08 9455 3654
Fax: 08 9455 3709
www.statsaustralia.com.au



Project Title: **Proposed Telco Projects (Port Hedland to Mullewa)** - **Geotechnical Investigation Work**	**Title: Proposed test locations Layout (Plutonic)**	
	Figure: 5	**Scale: NTS**
	Date: 17 Apr 2023	**Drawn: KL**
	Checked: AS	**Approved: AS**
	Drawing No: 102667	**Rev: 1**

STATS AUSTRALIA
Unit 1/16 Production Road,
CANNING VALE WA 6155

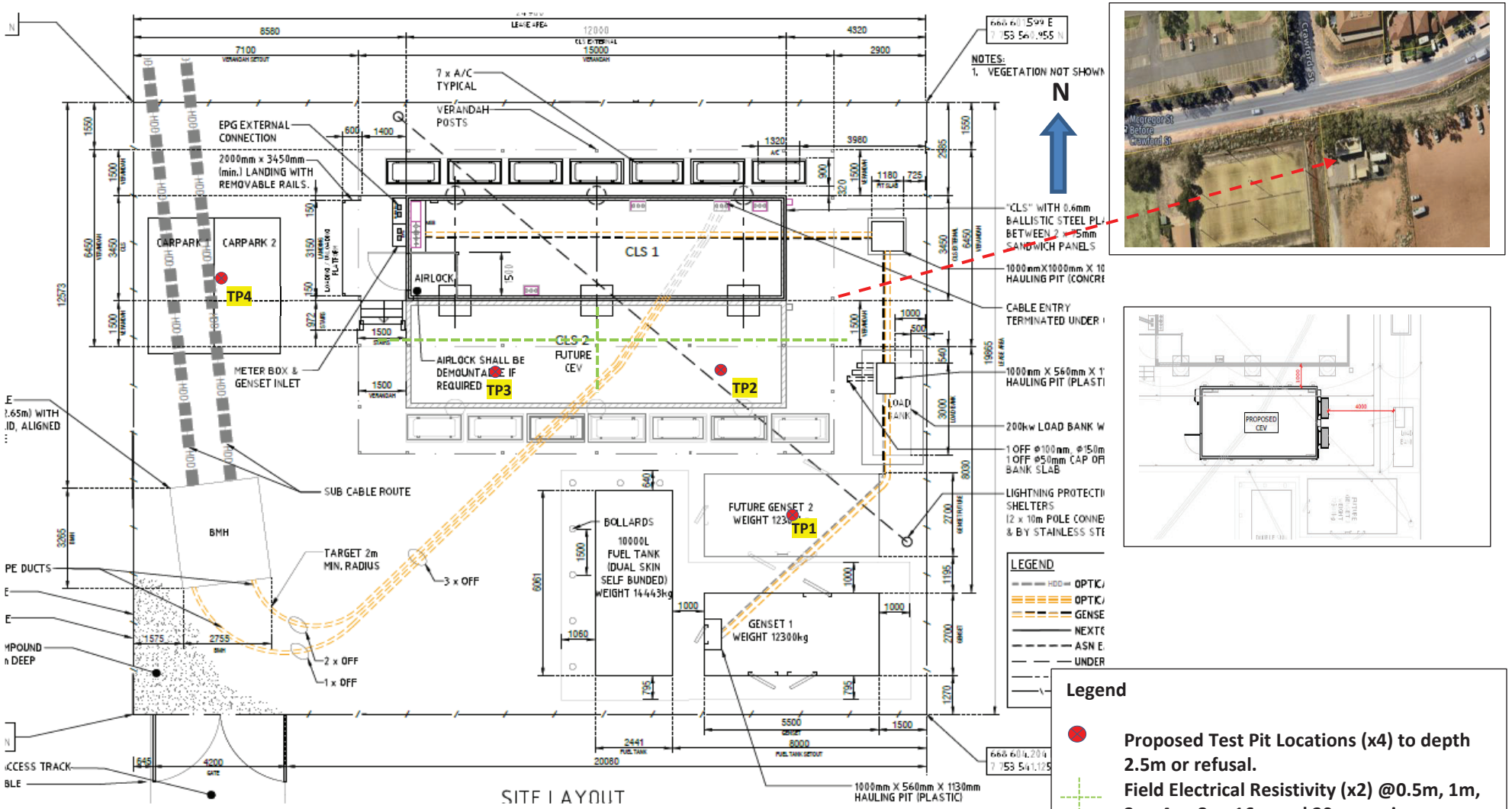
Tel: 08 9455 3654
Fax: 08 9455 3709
www.statsaustralia.com.au



Project Title: **Proposed Telco Projects (Port Hedland to Mullewa)** - **Geotechnical Investigation Work**	**Title: Proposed test locations Layout (Kumarina)**	
	Figure: 6	**Scale: NTS**
	Date: 17 Apr 2023	**Drawn: KL**
	Checked: AS	**Approved: AS**
	Drawing No: 102667	**Rev: 1**

STATS AUSTRALIA
Unit 1/16 Production Road, CANNING VALE WA 6155

Tel: 08 9455 3654
Fax: 08 9455 3709
www.statsaustralia.com.au



Project Title: **Proposed Telco Projects (Port Hedland to Mullewa)** - **Geotechnical Investigation Work**	**Title: Proposed test locations Layout (Port Hedland)**
Figure: 7	**Scale: NTS**
Date: 17 Apr 2023	**Drawn: KL**
Checked: AS	**Approved: AS**
Drawing No: 102667	**Rev: 1**

STATS AUSTRALIA
Unit 1/16 Production Road,
CANNING VALE WA 6155

Tel: 08 9455 3654
Fax: 08 9455 3709
www.statsaustralia.com.au