# APPENDIX D2 FURTHER ANALYSIS BY DM MCMAHON PTY LTD

# SOIL SURVEY REPORT

# WELLINGTON SOLAR FARM

## March 2018

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## Project brief

At the request of Jane Blomfield of NGH Environmental Pty Ltd a review and summary of soil sampling, analysis and reporting was carried out on work done by Douglas and Partners on the site on 9 and 10 January 2018. The document provides information about the site and soil conditions from field observations and laboratory analysis.

## Site identification

**Address**: Goolma Road, Wellington NSW 2820
**Real property description:** Lots 89, 90, 91, 92, 99, 102, 103, 104 DP2987
Lot 2 DP 807187
Lot 1 DP 520396
Lot 1 DP 34690
**Centre co-ordinate:** 684095 6401015 MGA GDA z55
**Property size**: approx. 492ha
**Owner**: c/o NGH Environmental Pty Ltd
**Local Council Area**: Dubbo Regional
**Present use**: Agriculture
**Development Application Reference:** not known
**Report identification:** 5120-Wellington South

**Certification**

| Name | Signed | Date | Revision Number |
|---|---|---|---|
| **David McMahon**<br>**BAppSc**<br>**GradDip WRM** |  | 29/03/18 | 2 |

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## 1.0 Introduction

The report presents the results of a soil survey carried out by Douglas Partners Pty Ltd (DP) and reviewed and summarised by DM McMahon Pty Ltd (McMahon) for the proposed Wellington Solar Farm near Wellington, NSW. The relevant extracts from the DP report can be seen attached and the document number is 91256.00.R.001.Rev0 dated 22 February 2018.

The work was commissioned by Jane Blomfield of NGH Environmental Pty Ltd and was undertaken in general accordance with an email dated 20 March 2018. The email outlines that more information is required from NSW Department of Primary Industries in relation to the Douglas Partners report submitted as part of the Environmental Impact Statement, as follows:

*Provide clearer information on the quality and fertility of the soil and potential impacts of the project on future land use, particularly considering the site has been mapped as Biophysical Strategic Agricultural Land.*

## 2.0 Site Characteristics

A brief desktop review and investigation of the topography, hydrology, soil, lithology, geology and hydrogeology of the site has been undertaken and are as follows:

### *2.1 Topography*

The site is situated over two different topographic map sheets: The Wellington 1:50,000 Topographic map sheet (8632-N) and the Geurie 1:50,000 Topographic map sheet (8633-S). The site is located at an elevation range of approximately 300m to 400m AHD. The site slope is classed as level to very gently inclined in the west and gently to moderately inclined to the east. The landform is a generally a simple slope with a crest formation to the east and drainage plain associated with the Wuuluman Creek which traverses the south of the site and the associated tributary of such to the north.

### *2.2 Vegetation*

The site is used for agricultural production, predominantly livestock. The pastures consist of lucerne and grass with some sorghum planted. Cathead and Paddy Melon weeds are prevalent. A more detailed assessment of vegetation present can be seen in NGH Environmental scoping report.

### *2.3 Weather*

The mean rainfall for Wellington is approximately 617.1mm per annum. The wettest months are November, December and January, however the rainfall is spread relatively evenly throughout the year. Annual mean pan evaporation range is 1679mm. Mean maximum temperatures range from 15.2 ºC in July to 33.0 ºC in January and mean minimum temperatures range from 2.2 ºC in July to 15.2 ºC in January. Historical records obtained from Wellington (D&J Rural) AWS 065034 (www.bom.gov.au).

## *2.4 Hydrology*

The site is located in the Macquarie River catchment area. Natural watercourses have been extensively modified since European settlement to improve channel efficiency. Run-off of surface waters from precipitation will flow into the drainage system of Wuuluman Creek and ultimately into the Macquarie River.

## *2.5 Soil & Landform*

The site is located entirely in the soil landscapes coded **bz** from the Soil Landscapes of the Dubbo 1:250 000 Sheet (Murphy and Lawrie, 1998). A brief description of the soil landscapes are as follows, **Table 1**.

**Table 1**: Soil landscape

| **bz – Bodangora** | |
|---|---|
| Topography | Low undulating hills ranging in elevation from 300 – 500 m. Local relief from 40 – 100m. Slopes are gently inclined (3 – 10%) with slopes from 1000 – 3000 m long. Drainage lines are 500 – 1000 m apart. |
| Soils: | **Euchrozems**<br>*Topsoil*<br>Dark reddish-brown clay loams to light clays, moderately well structured with sub-angular or angular blocky peds. Field pH increases from 5.5 to 7.0 in the A horizon; to 35cm depth. Gradual boundary to-<br>*Subsoils*<br>Moderate to strongly structured reddish-brown light to medium clays with smooth-faced, sub-angular or polyhedral peds. Gravel increases with depth and soft nodules of calcium carbonate begin to appear at about 90cm depth. Field pH 8.0 to 8.5.<br>**Non-calcic Brown Soils**<br>*Top Soils*<br>Hardsetting, gravelly (50-90%) dark reddish-brown fine sandy loams to sandy clay loams with weak crumb or sub-angular blocky peds; pH 6 – 7; to 30cm depth. Clear boundary to –<br>*Subsoils*<br>Gravelly, dark reddish-brown, light medium clays with moderately structured fine sub-angular blocky peds; pH 8.0; weathered rock is encountered at about 80cm.<br>**Terra Rossa Soils**<br>*Topsoils*<br>Friable dark reddish-brown fine sandy clay loams to clay loams with moderately structured, fine angular blocky, smooth-faced peds. pH 5.5; 12cm depth. Clear boundary to-<br>*Subsoils*<br>Dark reddish-brown, clay loams to medium clays; strongly structured, fine angular blocky peds with some limestone gravel at depth; pH 7.0 to 8.0, becoming 8.0 to 8.5 at depth. |

| | |
|---|---|
| Geology and Regolith: | Geological units are Ordovician undifferentiated, Silurian undifferentiated and Gowan Green Group. Parent rocks are Andesite, tuff, keratophyric lava and tuff, shale, limestone, conglomerate, agglomerate, siltstone and chert. *In situ* and colluvial-alluvial materials are derived from parent rock. |

The site lies within the mapping unit **MO3** from the Digital Atlas of Australian Soils (CSIRO, 1991). The map unit **MO3** is described as:

"Gently undulating plains with occasional higher stony ridges: a complex array of soils is present but loamy nodular mottled yellow earths (Gn2.61), with lesser (Gn2.64) and (Gn2.74), are probably dominant. Closely associated are important areas of loamy or, less commonly, sandy red earths (Gn2.11, Gn2.14); these usually occur on well-defined stream levees. Smaller areas of friable earths (Gn3.71) and (Gn3.91) and deep loamy duplex soils (Dy3.81) also occur. The higher stony ridges have shallow gravelly duplex soils (Dy3.41) and shallow stony loams (Um2.12) and (Um4.1). Data are fairly limited. Occurs on sheet(s): 7"

## *2.6 Geology*

The site geology is distributed over undifferentiated Ordovician and Silurian units and the Gowan Green Group.

## *2.7 Hydrogeology*

From the Geoscience Australia hydrogeology dataset, the groundwaters beneath the site are crossed over two units. They are described as porous extensive highly productive aquifers and fractured or fissured closer to the Macquarie River environs and extensive aquifers of low to moderate productivity elsewhere.

## *2.8 Biophysical Strategic Agricultural Land*

The site is located within a Biophysical Strategic Agricultural Land (BSAL) area, NSW DPE 2016. The dataset comes with an important note for users, that 'mapping was done at a regional scale, not at a property boundary level' therefore, a site-specific assessment is required to gauge the development against the BSAL mapping. A further investigation of the metadata which provides criteria for the BSAL mapping demonstrates that the site is within two classes being 'grazing - modified pasture' in the east and 'dryland cropping' in the west, OEH 2018. This is in conflict with the criteria for the BSAL mapping which suggests that land capability classes I or II under the Land and Soil Capability Mapping of NSW is BSAL land. Of note the incorrect classes have been applied to the BSAL mapping with the old land classes I and II from the NSW Agriculture 2002 system being incorrectly applied to the Land and Soil Capability Classes of 1 and 2, OEH 2012. The classification systems are inverse which confuses the relevance of the BSAL dataset for use in land classification.

However, this assessment of the subject site categorises the land as Class 3 in the western lower slopes and plains and Class 4 on the eastern higher slopes and crests by reference to the Land and Soil Capability Classes, OEH 2012. Class 3 is defined as having moderate agricultural limitations with careful management required while Class 4 has moderate to high agricultural limitations with restricted management options. More on the site-specific impacts of the proposal and the recommended management can be seen in section 6.6.

## 3.0 Scope of Works

The requirement for the review of the Douglas Partners geotechnical investigation is to satisfy the specification in the NSW DPI SEARs for the project which are as follows:

- A detailed soil survey to consider the potential for erosion and impacts associated with sodic soils, and paying particular attention to the compatibility of the development with the existing land uses on the site and adjacent land (e.g. operating mines, extractive industries, mineral or petroleum resources, exploration activities, aerial spraying, dust generation, and risk of weed and pest infestation) during operation and after decommissioning, with reference to the zoning provisions applying to the land, and measures [proposed to appropriately avoid, reduce or mitigate these impacts (including protentional landuses sharing arrangements with agriculture); and
- Proposed baseline data collection and monitoring to be adopted to inform rehabilitation, including a land capability assessment of the proposed disturbance footprint.

## 4.0 Results

As follows is a map of the investigated site and approximate pit locations, **Figure 1**.


**Figure 1**: Soil survey investigation pit locations.

### *4.1 Field Survey*

A free soil survey was conducted with 34 investigation points across the 492ha property. Classification of the soils was carried out as per The Australian Soil Classification (Isbell, 1996). Density of the investigation points was at a 'Moderately High (Detailed)' intensity level by reference to the Guidelines for Surveying Soil and Land Resources (2008) which was

deemed appropriate for satisfying the objectives for detailed project planning. The soils encountered were typical of the locale, generally falling into reconnaissance survey classes. Slight variations in profiles exist due to the complex soil sequences that are associated with such. Soil moisture contents varied between soil types but were generally found to be moderately moist at depth. Free groundwater was not encountered to the investigated depths.

## *4.2 Typical Soil Profiles*

Soils have been classified into a typical soil profile across the site as per the Australian Soil Classification system (Isbell, 1996) and the Great Soil Groups (Stace *et al.,* 1968). Representative photographs from profiles examined can be seen below with a brief description of the profile characteristics. All investigation points were located on managed agricultural lands. Field soil log sheets and pit photographs can be seen attached.

### 4.2.3 Ferrosols (Equivalent to Euchrozems).

*Topsoil*

Dark reddish-brown clay loams to light clays, moderately well-structured with sub-angular or angular blocky peds. Field pH increases from 5.5 to 7.0 in the A horizon; to 35cm depth. Gradual boundary to-

*Subsoils*

Moderate to strongly structured reddish-brown light to medium clays with smooth-faced, sub-angular or polyhedral peds. Gravel increases with depth and soft nodules of calcium carbonate begin to appear at about 90cm depth. Field pH 8.0 to 8.5.

As follows are photographs of typical profiles found across the farm, pits 8 and 11 that can be seen in **Figures 2 and 3**.


**Figure 2**: Photograph of soil pit 8

**Figure 3**: Photograph of soil pit 11

### *4.4 Laboratory Analysis*

24 representative soil samples were obtained and analysed at a NATA accredited laboratory for the establishment of baseline soil data that may be referred to and used in preparation of a site decommissioning plan. Laboratory certificates of analysis can be found in the attachments and soil parameters can be seen summarised in **Table 2**. Topsoil and subsoil samples were tested for pH, Electrical Conductivity (EC), chloride, sulphate, available phosphorous, Phosphorous Buffer Index (PBI) and Emerson class number.

### *4.4.1 Topsoil Analysis*

Eight topsoil samples from representative locations were analysed for pH, EC, phosphorous and PBI.

#### 4.4.1.1 pH & Electrical Conductivity

Topsoil pH ranged from 5.5 to 7.2 and can be classed as being 'strongly to slightly acid' (Bruce & Rayment, 1982). Electrical conductivity (EC) ranged from 91 – 340µS/cm and are classed as non-saline (Richards, 1954).

#### 4.4.1.2 Cation Exchange Capacity & Exchangeable Sodium Percentage

Cation Exchange Capacity (CEC) ranges from 11 to 26cmol(+)/kg. CEC of the soils is rated by Metson, (1961) from low (6-12) to moderate (12-25). Exchangeable Sodium Percentage (ESP) were all <% which is given a sodicity rating of 'non-sodic' Hazelton & Murphy, 2007.

#### 4.4.1.3 Colwell Phosphorus and Phosphorus Buffer Index

Colwell P is generally high (>25mg/kg). Phosphorus Buffering Index (PBI) ranged from 350 to 1,600 and is classed from 'high' to 'very high' (Burkitt *et al*., 2002).

#### 4.4.1.4 Calcium:Magnesium Ratio

Ca:Mg ratio should be at least 2:1. Effects of higher calcium contents are non-discernible however higher magnesium content may result in soil dispersion. Ca:Mg determined for topsoils returned results ranging from 2.9 to 5.1, indicating that there is low potential for dispersion and swelling of topsoils upon wetting.

### *4.4.2 Subsoil Analysis*

#### 4.4.2.1 pH & Electrical Conductivity

Subsoil pH ranged from 6.7 to 9.1 and can be classed as being neutral to strongly alkaline (Bruce & Rayment, 1982). EC ranged from 15 - 500µS/cm and are rated as non-saline (Richards, 1954).

#### 4.4.2.2 Aggregate Stability

Determination of aggregate stability indicated that the majority of soils have slight to negligible dispersibility. (Hazelton & Murphy, 2007).

## 5.0 Summary of Test Results

**Table 2**: Topsoil - Results of laboratory testing.

| Pit/Sample | Horizon | pH (1:5 Water) | Electrical Conductivity | Colwell P | PBI | CEC | Calcium | Magnesium | Sodium | Potassium | Aluminium | Aluminium % of Cations | Calcium % of Cations | Magnesium % of Cations | Sodium % of Cations | Potassium % of Cations | Ca/Mg Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Units | - | - | **µS/cm** | **mg/kg** | - | **cmol(+)/kg** | **cmol(+)/kg** | **cmol(+)/kg** | **cmol(+)/kg** | **cmol(+)/kg** | **Cmol(+)/kg** | **%** | **%** | **%** | **%** | **%** | - |
| **3** | A | 7.2 | 100 | 25 | 760 | 22 | 15 | 3.7 | <0.1 | 3.1 | - | - | 68 | 17 | <1 | 14 | 4.1 |
| **8** | A | 6.8 | 100 | 31 | 570 | 19 | 13 | 3.9 | <0.1 | 2.2 | - | - | 68 | 21 | <1 | 12 | 3.3 |
| **9** | A | 7.0 | 91 | 63 | 480 | 26 | 19 | 3.7 | <0.1 | 3.3 | - | - | 73 | 14 | <1 | 13 | 5.1 |
| **12** | A | 5.5 | 300 | 97 | 560 | 11 | 6.6 | 1.7 | <0.1 | 2.5 | - | - | 60 | 15 | <1 | 23 | 3.9 |
| **13** | A | 5.9 | 160 | 30 | 600 | 16 | 10 | 3.4 | <0.1 | 2.3 | - | - | 63 | 21 | <1 | 14 | 2.9 |
| **17** | A | 6.3 | 150 | 42 | 560 | 20 | 13 | 3.2 | <0.1 | 3.9 | - | - | 65 | 16 | <1 | 20 | 4.1 |
| **18** | A | 5.5 | 340 | 58 | 350 | 12 | 7.5 | 2.1 | <0.1 | 2.4 | - | - | 63 | 18 | <1 | 20 | 3.6 |
| **22** | A | 6.1 | 110 | 58 | 1600 | 14 | 9.3 | 2.3 | <0.1 | 2.1 | - | - | 66 | 16 | <1 | 15 | 4.0 |

**Table 3**: Subsoil - Results of laboratory testing

| Pit/sample | 1 | 3 | 4 | 7 | 7 | 9 | 13 | 14 | 13 | 14 | 17 | 18 | 19 | 24 | 32 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Depth (m)** | 0.5 | 0.5 | 0.5 | 0.5 | 2.0 | 0.9 | 0.5 | 0.6 | 1.2 | 0.9 | 0.3 | 2.2 | 1.0 | 2.5 | 0.5 | 2.0 |
| **pH** | 6.9 | 6.7 | 7.1 | 6.9 | 8.3 | 8.3 | 7.9 | 7.9 | 8.7 | 8.4 | 7.6 | 8.6 | 8.1 | 9.1 | 7.5 | 8.2 |
| **EC** | 21 | 34 | 38 | 41 | 75 | 72 | 64 | 42 | 500 | 120 | 28 | 270 | 24 | 73 | 15 | 110 |
| **Emerson class number** | 3b | 5 | 5 | 5 | 3b | 5 | 7 | 3b | 4 | 3b | 5 | 1 | 3b | 4 | 5 | 4 |

## 6.0 Comments and Recommendations

The discussion and recommendations provided below are based on field observations and testing at discrete locations.

### *6.1 Potential Limitations*

Potential landscape limitations have been summarised in **Table 4** below.

**Table 4**: Potential landscape limitation assessment

| Soil Type | Erosion Hazard | Salinity Risk | Acid Soil | Waterlogging Risk | Acid Sulfate Soils | Infrastructure |
|---|---|---|---|---|---|---|
| **Ferrosol** | LOW | LOW | YES | MODERATE | NO | MODERATE |

As follows is the soil landscape map (OEH, 2018) that has been generally validated by the soil survey through laboratory and field techniques, **Figure 4**. As such, management practices can be grouped into management classes of either soil landscape units or Australian Soil Classification units. This report identifies management practices for the single ASC unit in section 6.6 below.


**Figure 4**: Bodangora soil landscape with site overlay

### *6.2 Erosion Control*

In order to mitigate the occurrence of erosion the following primary principles should be adhered to, particularly throughout the construction period of the project. Best Management Practices (BMP's) should be employed where applicable to further reduce the risk of potential erosion and sediment control.

- Integrate project design with any site constraints.
- Preserve and stabilise drainageways.
- Minimise the extent and duration of disturbance.
- Control stormwater flows onto, through and from the site in stable drainage structures.
- Install perimeter controls.
- Stabilise disturbed areas promptly.
- Protect steep slopes.
- Employ the use of sediment control measures to prevent off and on-site damage.
- Protect inlets, storm drain outlets and culverts.
- Provide access and general construction controls.
- Inspect and maintain sediment and erosion control measures regularly.

The risk of erosion on site due to construction activities is considered low due to the very low relief and generally low salinity and sodicity of topsoils and subsoils. Excavation of subsoils should be limited where possible, and excavated subsoils should be stockpiled and contained to avoid potential dispersion and sediment transfer. Ground cover around the structures should be maintained where possible. Maintenance of ground cover will also aid in the prevention of topsoil losses from wind erosion.

Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 2004) and Volume 2A & 2C (DECC, 2008) should be consulted further in the development an Erosion and Sediment Control Plan (ESCP).

### *6.3 Acid Sulfate Soils*

Acid sulphate soils is the common name given to naturally occurring soils containing iron sulphides. Exposure of the sulphides present in these soils to oxygen from drainage or excavation will lead to the generation of sulfuric acid. Field pH of these soils in their undisturbed state is generally pH4 or less.

Landscape characteristics such as; the dominance of mangroves, reeds, rushes and other marine/estuarine or swamp-tolerant vegetation, low lying areas, back swamps or scalded areas of coastal estuaries and floodplains and sulphurous smell following rain after prolonged dry periods (Stone *et al*, 1998) after soil disturbance were not observed. There was no evidence of a jarositic horizon or jarosite precipitates or coatings on any root channels or cracks in the soil.

From the soil survey conducted, it has been deduced that acid sulfate soils are not present on site.

### *6.4 Potential Impacts on Salinity, Groundwater Resources and Hydrology*

Current operational procedures include dryland farming and grazing. Associated water features drainage plains and lines and five groundwater bores. At the time of investigation, the pasture condition appeared to be poor with minimal ground cover which would increase the flux of rainwater into the subsoil through recharge. Given the soils on site are classified as 'non-sodic' and low salinity the risk of salt build up in discharge areas is thought to be low

risk. However, changing direction of surface waters and any run-on should be avoided as local changes in the water regime are likely to mobilise any salts stores, however low, in the soil. Deep rooted vegetation should be maintained where present and established where not and ground clearing should be minimised.

There are five groundwater bores found within the subject the site as can be seen in **Figure 55** below. http://allwaterdata.water.nsw.gov.au/water.stm

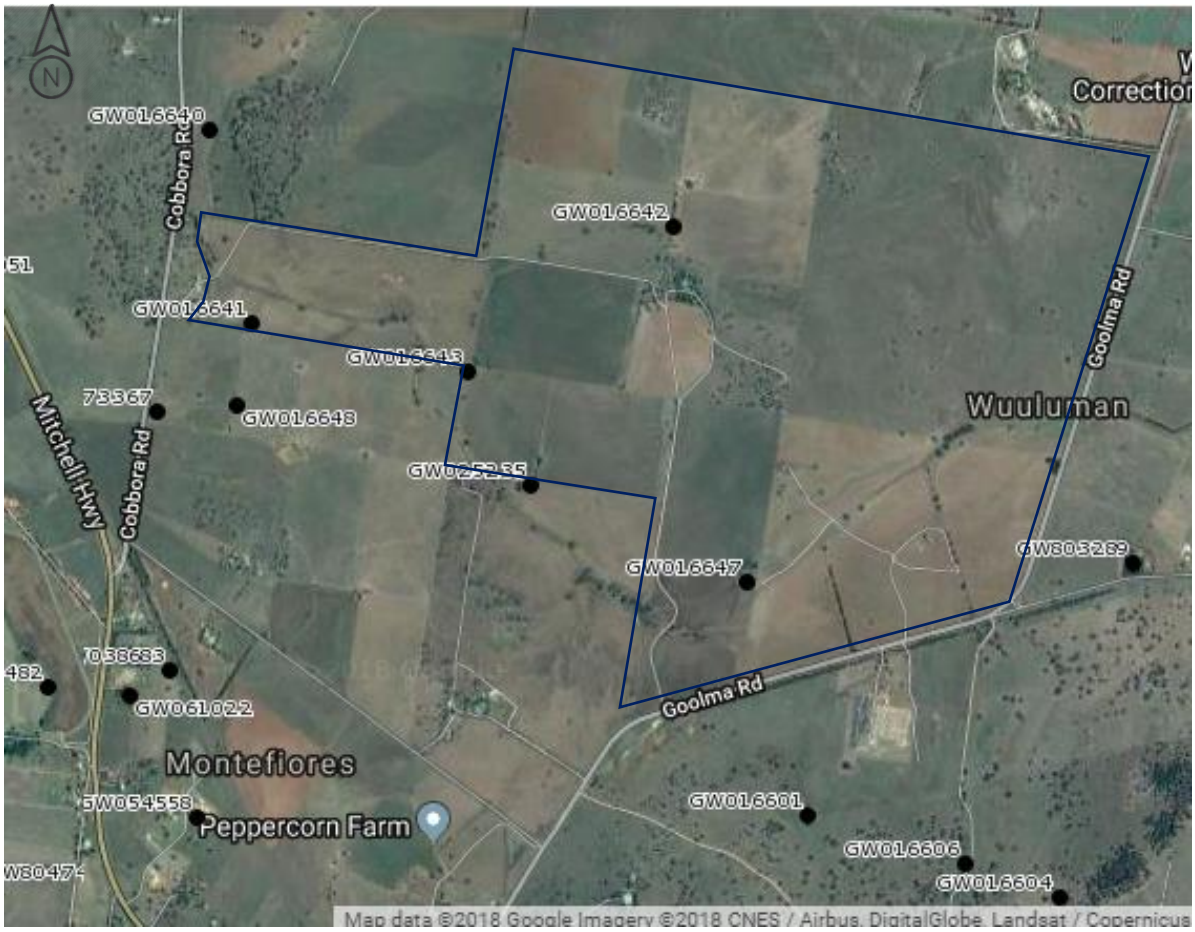


**Figure 5:** Registered groundwater bores on site

The details of the bore construction for the bores located above are shown as follows in **Table 5** (DPI, 2017).

**Table 5**: Registered groundwater bores in the locale

| Bore ID | Drilled depth (m) | Water bearing zone (m) | Standing water level (m) | AHD (m) | Purpose |
|---|---|---|---|---|---|
| **GW016641** | 8.5 | No data | No data | 300 | Stock |
| **GW016642** | 20.7 | No data | No data | 330 | Stock |
| **GW016643** | 7.3 | No data | No data | 310 | Stock |
| **GW016647** | 10.4 | No data | No data | 340 | Stock |
| **GW025235** | 61.0 | No data | No data | 320 | Stock |

As can be seen above the groudwater bores are all for stock use and are located adacent to drainage lines. The groudwater is likely to be in alluvial layers and be responisve to rainfall event in terms of standing water level and salinity. From a review of the current and propsed site operations the potential impacts on saliity, groundwater and hydrology are thtough to be low.

### *6.5 Potential Impacts on Agricultural Resources*

The proposal is to install solar panels for a short to medium term period with a view to restore the land to the original land use setting upon decommissioning. The proposal is to build limited infrastructure in the form of boundary roads and substations while the solar panels will be installed on pile driven posts or on small pad footings. Upon decommissioning of the solar farm, the pile driven posts or small pad footings will be removed causing minimal soil and landscape disturbance and the land will be fit for purpose for continued primary industry use dependent upon the soil management responses outlined as follows being implemented. During operation of the solar farm ground cover will be maintained and managed with the option for slashing, crash grazing, reseeding and amelioration with fertiliser and/or lime dependant upon the results of the monitoring and reporting carried out. Therefore, based on the findings of this report from the site-specific assessment, the proposal will have limited impact on agricultural resources, and the land upon decommissioning of the solar farm will be suitable for alternative land uses such as forestry and mining in addition to agriculture.

## *6.6 Soil Characteristics and Management Responses*

As follows are the soil characteristics and management responses to the soil type found on site.

### 6.6.1 Ferrosols

**Table 6**: Characteristics and management responses

| Soil Property | Behaviour of soil to activity or environment | Management responses/measures |
|---|---|---|
| Soil Surface | | |
| These soils generally have moderate structure in the surface and subsoil and are non-sodic. | Surface structure can deteriorate following prolonged cultivation/ handling to produce a hardsetting surface. | Excessive cultivation or handling of these soils should be avoided.<br><br>Soil structure and surface infiltration rate can be maintained through the incorporation of composted organic matter and by maintaining vegetative cover.<br><br>Limit traffic and do not disturb unless necessary to avoid destruction of the soil structure.<br><br>Construct gravel roads on the site and limit access off these roads. |
| Expansive Clays | | |
| These soils contain little to no shrink swell clays. | Some of these soils may contain layers of shrink swell clays at depth. | Reinstate soils in order they are removed (ie. topsoil above subsoil) to reduce possible effect on infrastructure. |
| Clay subsoils | | |
| These soils contain clay loam to medium clay subsoils that are mainly grouped into a red group. | Subsoils have moderate to strong structure with texture ranging from clay loam to medium clay. Where these soils are formed on weathered rock profiles may be shallow (some rocky), while those developed on alluvium are deep. The subsoil of this soil type is generally suitable for most earthwork purposes. However both the topsoil and subsoil are prone to structural decline and compaction. | Relieve compaction of subsoil material where revegetation required, amelioration may assist. Excessive handling of these soils should be avoided. |

| Soil Property | Behaviour of soil to activity or environment | Management responses/measures |
|---|---|---|
| Dispersion | | |
| These soils are usually non-dispersive. | These soils generally have low sodium content (ie. non-sodic) and as a result are likely to be nondispersive.<br>However, these soils may be susceptible to rill and sheet erosion when left exposed to heavy rainfall and/or stream bank erosion when located adjacent to watercourses. | Maintain cover to reduce sheet and rill erosion.<br><br>Final shaping of sloping land should avoid the concentration of water flows (ie. maintain sheet flow).<br><br>Stream bank erosion managed by maintaining vegetative cover and encouraging plants with fibrous root systems. |
| Salinity | | |
| Due to their free drainage characteristics, these soils generally have low salt levels (depending on parent material and landscape practices) | Soil parent material often contains minimal salt, this in combination with elevated landscape position with good runoff and/ or permeable soil characteristics are such that these soils do not generally contain high salt concentration within the soil profile | Maintain site drainage.<br>Avoid applying poor quality water (ie. salty) water to these soils to maintain low salinity status |
| Fertility | | |
| These soils are often fertile with clay textured soils generally the best. | Moderate clay content and moderate fertility. | May require limited fertiliser additions to stimulate plant growth, particularly nitrogen and phosphorus (depending on plants).<br>Topsoil conservation should be maximised through appropriate soil handling practices.<br>Addition of organic matter in the form of composted organics will maintain fertility, nutrient retention assist to and improve moisture holding capacity of these soils. |

| Soil Property | Behaviour of soil to activity or environment | Management responses/measures |
|---|---|---|
| Revegetation | | |
| These soils have strongly to slightly acid pH, they are well drained with good fertility and plant available water holding capacity (depending on profile depth). | Plant species need be selected that are adapted to these conditions. | Relieve any compaction present and ensure adequate fertility for quick establishment (testing required).<br>Shallow profiles will require frequent, low volume watering. Deep profiles can be watered for longer periods and less frequently (monitor moisture conditions).<br>Protect surface with mulch material to reduce raindrop induced crusted or hardsetting surface.<br>Stabilisation and revegetation targets and timeframes should be in accordance with IECA (2008) guidelines |
| Soil Handling | | |
| These soils have very few limitations for agronomic and engineering uses. | The objective of soil handling is to minimise off site impacts and maximise the productive capacity of the soil on site consistent with the intended use. | Topsoil stripping should maximise available reserves and should avoid mixing salty and/or sodic subsoils – testing is recommended.<br>Topsoil or subsoil stockpiles should be kept separate.<br>Reinstate soil in the order they were removed (ie. lower subsoil below upper subsoil).<br>To maintain soil structure, limit the handling of soil material and ensure traffic is concentrated on constructed road surfaces (reduce dust generation).<br>Installation of erosion and sediment control structures may be required where soil is exposed (eg. clean water diversions upslope, sediment fences around stockpiles).<br>Trafficability of these soils should be avoided when wet (structural decline), the use of gravel road surfaces may improve site access. |

## 7.0 Notes relating to results

### Groundwater

No Free groundwater was encountered during the investigation. A groundwater table or seepage may be present at other times and fluctuations in groundwater levels and seepage could occur due to rainfall, changes in temperature and other factors.

### Bore hole / test pit logging

The information supplied in the log sheets is based on data supplied by visual and tactile assessment based on field conditions at the time of testing. The log sheets can include inferred data based on the experience of the geotechnician as well as factual data from in situ testing.

### Samples

| | |
|---|---|
| D | Disturbed sample |
| B | Bulk or composite sample |
| U | Undisturbed sample |

### Moisture Condition

| | |
|---|---|
| D | Dry – runs freely through the fingers |
| M | Moist – does not run freely but is able to be formed |
| W | Wet – free water visible on the soil surface |

### Consistency (Cohesive Soils)

| Description | Unconfined Compressive Strength (UCS) |
|---|---|
| Very soft | <25kPa |
| Soft | 25-50kPa |
| Firm | 50-100kPa |
| Stiff | 100-200kPa |
| Very Stiff | 200-400kPa |
| Hard | >400kPa |

### Relative Density (Cohesionless Soils)

| Description | N Value blows per 300mm | Density Index Range% | Soil Friction Angle (degrees) |
|---|---|---|---|
| Very Loose | 0-4 | <15 | <30 |
| Loose | 4-10 | 15-35 | 30-35 |
| Medium | 10-30 | 35-65 | 35-40 |
| Dense | 30-50 | 65-85 | 40-45 |
| Very Dense | >50 | >85 | <45 |

## 8.0 Disclaimer

The information contained in this report has been extracted from field and laboratory sources believed to be reliable and accurate. DM McMahon Pty Ltd will not assume any responsibility for the misinterpretation of information supplied in this report. The accuracy and reliability of recommendations identified in this report need to be evaluated with due care according to individual circumstances. It should be noted that the recommendations and findings in this report are based solely upon the said site location and the ground level conditions at the time of testing. The results of the said investigations undertaken are an overall representation of the conditions encountered. The properties of the soil within the location may change due to variations in ground conditions outside of the tested area. The author has no control or liability over site variability that may warrant further investigation that may lead to significant design changes.

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## 10.0 Attachments

Field soil logs

Laboratory results

McMahon EARTH SCIENCE

# DOCUMENT ATTACHMENTS

## REPORT 2018

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**Attachment 01** : *Field soil logs*

# TEST PIT LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 685150
**NORTHING:** 6400915

**PIT No:** 1
**PROJECT No:** 91256.00
**DATE:** 10/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.14 | TOPSOIL - Brown gravelly silt topsoil, with trace to some fine to coarse grained sand clay and rootlets | | D | 0.05 | | | | |
| | | GRAVELLY CLAY / CLAYEY GRAVEL - (Hard / dense), red-brown gravelly clay / clayey gravel, gravel portion subrounded up to 50mm in size, trace to some silt and fine to coarse grained sand, (M<Wp / humid) | | D | 0.3 | | | | |
| | | | | B | 0.4<br>0.5 | | | | |
| | 1.2 | SILTY CLAY - Hard, red/orange/brown mottled off-white silty clay, with trace to some fine to coarse grained sand, trace subrounded gravel up to 15mm in size, M<Wp (possible tuffaceous zones) | | D | 1.3 | | | | |
| | | | | D | 2.0 | | | | |
| | 3.0 | Pit discontinued at 3.0m, limit of investigation | | D | 3.0 | | | | |

**RIG:** Hyundai 14 Tonne Excavator with 450mm wide toothed bucket **LOGGED:** Ballinger **SURVEY DATUM:** MGA94

**WATER OBSERVATIONS:** No free groundwater observed while pit remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# TEST PIT LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 684992
**NORTHING:** 6401177

**PIT No:** 2
**PROJECT No:** 91256.00
**DATE:** 10/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.25 | TOPSOIL - Brown gravelly silt topsoil, with trace to some fine to coarse grained sand and clay, abundant organics | | D | 0.05 | | | | |
| | | GRAVELLY CLAY / CLAYEY GRAVEL - (Hard), red-brown gravelly clay / clayey gravel, gravel portion subrounded up to 50mm in size, trace to some silt and fine to coarse grained sand, (M<Wp) | | B | 0.5<br>0.6 | | | | |
| | 0.75 | SILTY CLAY - Hard, red-brown mottled off-white silty clay, with trace to some fine to coarse grained sand and subrounded gravel up to 15mm in size, M<Wp (possible tuffaceous zones) | | D<br>$U_{50}$ | 0.8<br>0.85<br>1.3 | | | | |
| | 1.4 | SANDY CLAY - Hard, pale brown sandy clay, fine to coarse grained, with trace silt and subrounded gravel up to 10mm in size, M⩽Wp (completely weathered rock) | | D | 2.0 | | | | |
| | 3.0 | Pit discontinued at 3.0m, limit of investigation | | D | 3.0 | | | | |

**RIG:** Hyundai 14 Tonne Excavator with 450mm wide toothed bucket **LOGGED:** Ballinger **SURVEY DATUM:** MGA94

**WATER OBSERVATIONS:** No free groundwater observed while pit remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# TEST PIT LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 684728
**NORTHING:** 6400751

**PIT No:** 3
**PROJECT No:** 91256.00
**DATE:** 10/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 150mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.1 | TOPSOIL - Brown clayey silt topsoil, with some fine to coarse grained sand and rootlets | | D | 0.05 | | | | |
| | | SILTY CLAY - Hard, red-brown silty clay, with trace fine to coarse grained sand and subrounded gravel up to 20mm in size, M<Wp | | B | 0.3<br>0.4 | | | | |
| | | | | | 0.6 | | | | |
| | | | | $U_{50}$ | | | | | |
| | 1 | | | D | 0.94<br>1.0 | | | | 1 |
| | 1.8 | META SILTSTONE - (Very low strength, highly weathered to moderately weathered), grey and brown meta siltstone | | | | | | | |
| | 2 | | | D | 2.2 | | | | 2 |
| | | From 2.4m, (low to medium and high strength, moderately weathered to slightly weathered), slow excavation progress | | | | | | | |
| | | | | D | 2.8 | | | | |
| | 3 | | | | | | | | 3 |
| | 3.0 | Pit discontinued at 3.0m, limit of investigation | | | | | | | |
| | 4 | | | | | | | | 4 |

**RIG:** Hyundai 14 Tonne Excavator with 450mm wide toothed bucket **LOGGED:** Ballinger **SURVEY DATUM:** MGA94

**WATER OBSERVATIONS:** No free groundwater observed while pit remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# TEST PIT LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 684503
**NORTHING:** 6401314

**PIT No:** 4
**PROJECT No:** 91256.00
**DATE:** 10/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 150mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.1 | TOPSOIL - Brown slightly sandy silt, fine to coarse grained, with some organics and subrounded gravel up to 20mm in size, trace to some clay | | D | 0.05 | | | | |
| | | | | D | 0.2 | | | | |
| | 0.35 | GRAVELLY CLAY - Hard, brown gravelly clay, gravel portion subrounded up to 30mm in size, trace organics and fine to coarse grained sand, M<Wp | | | 0.4 | | | | |
| | | | | B | 0.5 | | | | |
| | | SILTY CLAY - Hard, red-brown silty clay, with some subrounded gravel up to 30mm in size, M<Wp | | D | 0.6 | | | | |
| | 0.9 | | | | | | | | |
| | 1 | META SILTSTONE - (Low to medium and high strength), moderately weathered to slightly weathered), grey and brown meta siltstone, within extremely low strength matrix (soil like properties) | | D | 1.0 | | | | |
| | | | | D | 1.8 | | | | |
| | 2 | From 2.0m, slow excavation progress (matrix less weathered) | | | | | | | |
| | 2.65 | Pit discontinued at 2.65m, refusal due to slow excavation progress | | | | | | | |
| | 3 | | | | | | | | |
| | 4 | | | | | | | | |

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

**RIG:** Hyundai 14 Tonne Excavator with 450mm wide toothed bucket **LOGGED:** Ballinger **SURVEY DATUM:** MGA94

**WATER OBSERVATIONS:** No free groundwater observed while pit remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# TEST PIT LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 684395
**NORTHING:** 6401736

**PIT No:** 5
**PROJECT No:** 91256.00
**DATE:** 10/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 150mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.1 | TOPSOIL - Brown sandy silt topsoil, fine to coarse grained, with some clay and organics | | D | 0.05 | | | | |
| | | SILTY CLAY - Hard, red-brown silty clay, with trace to some fine to coarse grained sand and subrounded gravel up to 15mm in size, M<Wp | | D | 0.4 | | | | |
| | 0.7 | META SILTSTONE - (Low to medium strength, highly weathered to moderately weathered), grey and brown meta siltstone, within extremely low strength matrix (soil like properties) | | D | 0.8 | | | | |
| | 1 | From 1.0m, (medium to high strength, moderately weathered to slightly weathered), slow excavation progress (matrix less weathered) | | D | 1.2 | | | | |
| | | | | D | 1.7 | | | | |
| | 1.75 | Pit discontinued at 1.75m, refusal | | | | | | | |
| | 2 | | | | | | | | |
| | 3 | | | | | | | | |
| | 4 | | | | | | | | |

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

**RIG:** Hyundai 14 Tonne Excavator with 450mm wide toothed bucket **LOGGED:** Ballinger **SURVEY DATUM:** MGA94

**WATER OBSERVATIONS:** No free groundwater observed while pit remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# TEST PIT LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 682782
**NORTHING:** 6401179

**PIT No:** 6
**PROJECT No:** 91256.00
**DATE:** 9/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.03 | SILTY CLAY - Hard, red-brown silty clay, with trace to some fine to coarse grained sand, trace organics, M<Wp | | D | 0.01 | | | | |
| | | SANDY SILT - Hard, brown sandy silt, fine to coarse grained, with trace to some clay, trace organics, M<Wp | | B | 0.3 | | | | |
| | | | | D | 0.4 | | | | |
| | 0.5 | SILTY CLAY - Hard, red-brown silty clay, with trace to some fine to coarse grained sand, M<Wp | | | 0.55 | | | | |
| | | | | $U_{50}$ | 0.82 | | | | |
| | 1 | | | D | 1.2 | | | | |
| | 2 | | | D | 2.0 | | | | |
| | 3 | | | D | 3.0 | | | | |
| | 3.0 | Pit discontinued at 3.0m, limit of investigation | | | | | | | |
| | 4 | | | | | | | | |

**RIG:** Hyundai 14 Tonne Excavator with 450mm wide toothed bucket **LOGGED:** Ballinger **SURVEY DATUM:** MGA94

**WATER OBSERVATIONS:** No free groundwater observed while pit remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# TEST PIT LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 638020
**NORTHING:** 6401757

**PIT No:** 7
**PROJECT No:** 91256.00
**DATE:** 9/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 150mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.12 | TOPSOIL - Red-brown clayey silt topsoil, with some fine to coarse grained sand and organics | | D | 0.05 | | | | |
| | | SILTY CLAY - Hard, red-brown silty clay, with fine to coarse grained sand, subrounded gravel (siltstone fragments) up to 20mm in size and organics, M<Wp | | D | 0.3 | | | | |
| | | | | B | 0.4<br>0.5 | | | | |
| | | From 0.6m, with trace gravel and sand | | $U_{50}$ | 0.55 | | | | |
| 1 | | | | D | 0.98<br>1.0 | | | | 1 |
| | 1.9 | | | | | | | | |
| 2 | | META SILTSTONE - (Extremely low strength, extremely weathered) grey and brown meta siltstone | | D | 2.0 | | | | 2 |
| | | From 2.4m, (low to medium strength, moderately weathered) | | D | 2.5 | | | | |
| | | From 2.6m, slow excavation progress | | | | | | | |
| 3 | 3.0 | Pit discontinued at 3.0m, limit of investigation | | D | 3.0 | | | | 3 |
| 4 | | | | | | | | | 4 |

**RIG:** Hyundai 14 Tonne Excavator with 450mm wide toothed bucket **LOGGED:** Ballinger **SURVEY DATUM:** MGA94

**WATER OBSERVATIONS:** No free groundwater observed while pit remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# TEST PIT LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 684200
**NORTHING:** 6400911

**PIT No:** 8
**PROJECT No:** 91256.00
**DATE:** 10/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.14 | TOPSOIL - Brown sandy silt topsoil, with some clay and organics, trace subrounded gravel up to 20mm in size | | D | 0.05 | | | | |
| | | SILTY CLAY - Hard, red-brown silty clay, with trace to some subrounded gravel up to 10mm in size, M<Wp | | B | 0.3<br>0.4 | | | | |
| | 1 | | | D | 0.7 | | | | 1 |
| | 1.4 | SILTY CLAY - Hard, grey and brown silty clay, with some fine to coarse grained sand and subrounded gravel (siltstone fragments) up to 50mm in size, M<Wp (completely weathered rock) | | D | 1.5 | | | | |
| | 2 | | | D | 2.0 | | | | 2 |
| | 2.3 | META SILTSTONE - (Low to medium strength, highly weathered to moderately weathered) grey and brown meta siltstone | | | | | | | |
| | 3 | | | D | 3.0 | | | | 3 |
| | 3.0 | Pit discontinued at 3.0m, limit of investigation | | | | | | | |
| | 4 | | | | | | | | 4 |

**RIG:** Hyundai 14 Tonne Excavator with 450mm wide toothed bucket **LOGGED:** Ballinger **SURVEY DATUM:** MGA94

**WATER OBSERVATIONS:** No free groundwater observed while pit remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# TEST PIT LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 684336
**NORTHING:** 6399978

**PIT No:** 9
**PROJECT No:** 91256.00
**DATE:** 10/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 150mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.18 | TOPSOIL - Brown slightly sandy silt topsoil, fine to medium grained, with some clay and rootlets | | D | 0.1 | | | | |
| | | SILTY CLAY - Hard, red-brown silty clay, with fine to medium grained sand and trace subrounded gravel up to 20mm in size, M<Wp | | D | 0.3 | | | | |
| | | | | B | 0.4–0.5 | | | | |
| | | | | D | 0.6 | | | | |
| | | | | D | 0.9 | | | | |
| | 1.0 | META SILTSTONE - (Very low to low strength, highly weathered), grey and brown meta siltstone | | | | | | | |
| | | | | D | 1.4 | | | | |
| | | From 1.8m, (medium to high strength, moderately weathered to slightly weathered and fresh, within extremely weathered matrix (soil like properties)) | | | | | | | |
| | | | | D | 2.2 | | | | |
| | 3.0 | Pit discontinued at 3.0m, limit of investigation | | | | | | | |

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; 1, 2, 3, 4

**RIG:** Hyundai 14 Tonne Excavator with 450mm wide toothed bucket **LOGGED:** Ballinger **SURVEY DATUM:** MGA94

**WATER OBSERVATIONS:** No free groundwater observed while pit remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# TEST PIT LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 683647
**NORTHING:** 6399600

**PIT No:** 10
**PROJECT No:** 91256.00
**DATE:** 9/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 150mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.02 | TOPSOIL - Red-brown sandy silt topsoil, fine to medium grained, with some organics, trace subrounded gravel up to 10mm in size | | D | 0.01 | | | | |
| | | SILTY CLAY - Hard, red-brown silty clay, with trace to some fine to coarse grained sand, trace organics and subangular gravel up to 5mm in size, M<Wp | | B | 0.2 | | | | |
| | | | | D | 0.4 | | | | |
| | | | | $U_{50}$ | 0.57 | | | | |
| | 0.6 | META SANDSTONE - (Low to medium strength, highly weathered to moderately weathered) grey stained red/orange/brown meta sandstone | | | | | | | |
| | 1 | | | D | 1.0 | | | | |
| | | From 1.7m, (medium to high strength, moderately weathered to slightly weathered) | | D | 1.8 | | | | |
| | 1.9 | Pit discontinued at 1.9m, refusal | | | | | | | |
| | 2 | | | | | | | | |
| | 3 | | | | | | | | |
| | 4 | | | | | | | | |

**RIG:** Hyundai 14 Tonne Excavator with 450mm wide toothed bucket **LOGGED:** Ballinger **SURVEY DATUM:** MGA94

**WATER OBSERVATIONS:** No free groundwater observed while pit remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# TEST PIT LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 683424
**NORTHING:** 6400433

**PIT No:** 11
**PROJECT No:** 91256.00
**DATE:** 9/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 150mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.04 | TOPSOIL - Brown sandy silt topsoil, fine to coarse grained, with some organics and clay | | D | 0.01 | | | | |
| | | | | D | 0.1 | | | | |
| | 0.2 | SANDY SILT - Hard, brown sandy silt, fine to coarse grained, with trace to some clay, trace organics, M<Wp | | D | 0.25 | | | | |
| | | SILTY CLAY - Hard, red-brown silty clay, with trace fine to coarse grained sand, trace organics, M<Wp | | D | 0.4 | | pp = 450 | | |
| | | | | $U_{50}$ | 0.45 | | | | |
| | 1 | | | | 0.9 | | | | 1 |
| | | | | D | 1.5 | | | | |
| | 2 | From 2.0m, with trace to some sand, trace subrounded gravel up to 15mm in size | | | | | | | 2 |
| | | | | D | 2.2 | | | | |
| | 3 3.0 | Pit discontinued at 3.0m, limit of investigation | | D | 3.0 | | | | 3 |
| | 4 | | | | | | | | 4 |

**RIG:** Hyundai 14 Tonne Excavator with 450mm wide toothed bucket **LOGGED:** Ballinger **SURVEY DATUM:** MGA94

**WATER OBSERVATIONS:** No free groundwater observed while pit remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# TEST PIT LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 683345
**NORTHING:** 6401062

**PIT No:** 12
**PROJECT No:** 91256.00
**DATE:** 9/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.02 | TOPSOIL - Brown slightly sandy silt topsoil, fine to coarse grained, with some clay, abundant organics | | D | 0.01 | | | | |
| | 0.25 | SANDY SILT - Hard, brown sandy silt, fine to coarse grained, with trace to some clay, trace organics, M<Wp | | D | 0.2 | | | | |
| | | SANDY SILTY CLAY - Hard, red-brown sandy silty clay, fine to coarse grained, with trace gravel, M<Wp | | D | 0.4 | | | | |
| | | | | B | 0.5 | | | | |
| | | | | | 0.6 | | | | |
| | 0.8 | META SILTSTONE - (Extremely low to very low strength, extremely weathered to highly weathered), grey and red brown meta siltstone | | | | | | | |
| 1 | | | | D | 1.2 | | | | 1 |
| 2 | | From 2.0m (low strength, highly weathered), within extremely weathered matrix (soil-like properties)) | | D | 2.0 | | | | 2 |
| | | | | D | 2.5 | | | | |
| 3 | 3.0 | From 2.8m, (low to medium and high strength, moderately weathered to slightly weathered, within extremely weathered matrix (soil like properties)) | | D | 3.0 | | | | 3 |
| | | Pit discontinued at 3.0m, limit of investigation | | | | | | | |
| 4 | | | | | | | | | 4 |

**RIG:** Hyundai 14 Tonne Excavator with 450mm wide toothed bucket **LOGGED:** Ballinger **SURVEY DATUM:** MGA94

**WATER OBSERVATIONS:** No free groundwater observed while pit remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# TEST PIT LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 683230
**NORTHING:** 6400716

**PIT No:** 13
**PROJECT No:** 91256.00
**DATE:** 9/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 150mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.03 | TOPSOIL - Brown sandy silt topsoil, fine to coarse grained, with some organics and clay | | D | 0.01 | | | | |
| | | SILTY CLAY - Hard, red-brown silty clay, with fine to coarse grained sand and trace gravel, trace organics, M<Wp | | | 0.35 | | | | |
| | | | | | 0.4 | | | | |
| | | | | B $U_{50}$ | 0.6 | | | | |
| | | | | | 0.8 | | | | |
| | 1 | | | D | 1.2 | | | | |
| | 1.7 | META SILTSTONE - (Very low to low and medium strength, highly weathered to moderately weathered within extremely low strength matrix (soil like properties), grey and brown meta siltstone (ripped fragments typically up to 100mm in size) | | D | 2.0 | | | | |
| | 2 | From 2.5m, (extremely low to very low strength, extremely weathered to highly weathered) | | D | 2.5 | | | | |
| | 3 | | | D | 3.0 | | | | |
| | 3.0 | Pit discontinued at 3.0m, limit of investigation | | | | | | | |
| | 4 | | | | | | | | |

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

**RIG:** Hyundai 14 Tonne Excavator with 450mm wide toothed bucket **LOGGED:** Ballinger **SURVEY DATUM:** MGA94

**WATER OBSERVATIONS:** No free groundwater observed while pit remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# TEST PIT LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 682402
**NORTHING:** 6401110

**PIT No:** 14
**PROJECT No:** 91256.00
**DATE:** 9/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 150mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.04 | TOPSOIL - Brown sandy silt topsoil, fine to coarse grained, with some organics and clay | | D | 0.01 | | | | |
| | | GRAVELLY SILTY CLAY - Hard, red-brown gravelly silty clay, gravel portion subrounded up to 15mm in size, trace fine to coarse grained sand, M<Wp | | D | 0.2 | | | | |
| | 0.4 | SILTY CLAY - Hard, red-brown, silty clay, with fine to coarse grained sand and trace gravel, M<Wp | | B | 0.5<br>0.6 | | | | |
| | 1 | | | D | 0.9<br>0.95 | | | | |
| | | | | $U_{50}$ | | | | | |
| | | From 1.2m, M≥Wp | | | 1.25 | | | | |
| | 2 | From 2.0m, M>Wp<br>From 2m depth, becoming clayey sand | | D | 2.5 | | | | |
| | 3 3.0 | Pit discontinued at 3.0m, limit of investigation | | D | 3.0 | | | | |
| | 4 | | | | | | | | |

**RIG:** Hyundai 14 Tonne Excavator with 450mm wide toothed bucket **LOGGED:** Ballinger **SURVEY DATUM:** MGA94

**WATER OBSERVATIONS:** Slight seepage observed in base (at 3.0m depth) while pit remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# TEST PIT LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 681973
**NORTHING:** 6401048

**PIT No:** 15
**PROJECT No:** 91256.00
**DATE:** 9/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 150mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.14 | TOPSOIL - Red-brown silty clay topsoil, with trace to some fine to coarse grained sand and subrounded gravel up to 10mm in size, abundant rootlets | | D | 0.05 | | | | |
| | | SANDY SILTY CLAY - Hard, red-brown silty clay, with trace to some fine to coarse grained sand, trace subrounded gravel up to 10mm in size, M<Wp | | D | 0.4 | | | | |
| | | | | B | 0.5 | | | | |
| | | | | | 0.6 | | | | |
| | | | | $U_{50}$ | 0.65 | | | | |
| | | | | | 0.91 | | | | |
| | 1 | | | D | 1.0 | | | | |
| | 2 | From 2.0m, M⩽Wp | | D | 2.0 | | | | |
| | 3 | | | | | | | | |
| | 3.3 | Pit discontinued at 3.3m, limit of investigation | | | | | | | |
| | 4 | | | | | | | | |

**RIG:** Hyundai 14 Tonne Excavator with 450mm wide toothed bucket **LOGGED:** Ballinger **SURVEY DATUM:** MGA94

**WATER OBSERVATIONS:** Slight seepage observed in base (at 3.0m depth) while pit remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# TEST PIT LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 684889
**NORTHING:** 6401603

**PIT No:** 16
**PROJECT No:** 91256.00
**DATE:** 10/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.1 | TOPSOIL - Brown clayey sandy silt topsoil, with some subrounded gravel up to 30mm in size | | D | 0.01 | | | | |
| | | META SILTSTONE - (Low to medium strength, highly weathered to moderately weathered), grey stained red/orange/brown meta siltstone | | D | 0.3 | | | | |
| | 1 | From 1.1m, (medium to highly strength, to slightly weathered to fresh stained) | | D | 1.2 | | | | |
| | | From 1.7m, (fresh stained to fresh) | | | | | | | |
| | 2 | | | D | 2.2 | | | | |
| | 2.4 | Pit discontinued at 2.4m, practical refusal due to slow excavation progress | | | | | | | |
| | 3 | | | | | | | | |
| | 4 | | | | | | | | |

Dynamic Penetrometer Test (blows per mm): 5, 10, 15, 20

**RIG:** Hyundai 14 Tonne Excavator with 450mm wide toothed bucket **LOGGED:** Ballinger **SURVEY DATUM:** MGA94

**WATER OBSERVATIONS:** No free groundwater observed while pit remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# TEST PIT LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 684910
**NORTHING:** 6400128

**PIT No:** 17
**PROJECT No:** 91256.00
**DATE:** 10/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 150mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.1 | TOPSOIL - Brown clayey silt topsoil, with some fine to coarse grained sand and rootlets | | D | 0.05 | | | | |
| | | SILTY CLAY - Hard, red brown silty clay, with some to slightly gravelly, gravel portion subrounded up to 50mm in size, some fine to coarse grained sand, M<Wp | | | 0.2 | | | | |
| | | | | B | 0.4 | | | | |
| | | | | D | 0.5 | | | | |
| | 0.7 | META SILTSTONE - (Low to medium strength, highly weathered to moderately weathered), grey and brown meta siltstone, within extremely weathered matrix (soil-like properties) | | D | 0.8 | | | | |
| | 1 | | | | | | | | 1 |
| | 2 | From 2.4m, (medium to high strength, slightly weathered to fresh), slow excavation progress (matrix less weathered) | | D | 2.5 | | | | 2 |
| | 3 | | | | | | | | 3 |
| | 3.0 | Pit discontinued at 3.0m, limit of investigation | | | | | | | |
| | 4 | | | | | | | | 4 |

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

**RIG:** Hyundai 14 Tonne Excavator with 450mm wide toothed bucket **LOGGED:** Ballinger **SURVEY DATUM:** MGA94

**WATER OBSERVATIONS:** No free groundwater observed while pit remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# TEST PIT LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 682978
**NORTHING:** 6400578

**PIT No:** 18
**PROJECT No:** 91256.00
**DATE:** 9/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 150mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.03 | TOPSOIL - Brown sandy silt topsoil, fine to coarse grained, with some organics and clay | | D | 0.01 | | | | |
| | 0.25 | SILTY CLAY - Hard, red-brown silty clay, with fine to coarse grained sand, trace organics, M<Wp | | D | 0.2 | | | | |
| | | SANDY SILTY CLAY - Hard, red-brown sandy silty clay, fine to coarse grained, M<Wp | | D | 0.5 | | | | |
| | 0.6 | SILTY CLAY - Hard, red-brown silty clay, with trace fine to coarse grained sand, trace organics, M<Wp | | | 0.75 | | | | |
| 1 | | | | $U_{50}$ | | | | | 1 |
| | | | | | 1.2 | | | | |
| | | | | D | 1.5 | | | | |
| 2 | | | | | | | | | 2 |
| | | | | D | 2.2 | | | | |
| 3 | 3.0 | Pit discontinued at 3.0m, limit of investigation | | D | 3.0 | | | | 3 |
| 4 | | | | | | | | | 4 |

5 10 15 20

**RIG:** Hyundai 14 Tonne Excavator with 450mm wide toothed bucket **LOGGED:** Ballinger **SURVEY DATUM:** MGA94

**WATER OBSERVATIONS:** No free groundwater observed while pit remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# TEST PIT LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 683765
**NORTHING:** 6401490

**PIT No:** 19
**PROJECT No:** 91256.00
**DATE:** 10/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 150mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.12 | TOPSOIL - Brown sandy silt topsoil, fine to coarse grained, with some clay and organics | | D | 0.05 | | | | |
| | | SILTY CLAY - Hard, red-brown silty clay with gravel, gravel portion comprising subrounded siltstone fragments up to 15mm in size, trace fine to coarse grained sand and organics, M<Wp | | D | 0.25 | | | | |
| | | | | D | 0.3 | | | | |
| | 0.45 | | | | 0.4 | | | | |
| | | SILTY CLAY - Hard, red-brown silty clay, with trace to some fine to coarse grained sand and subrounded gravel (siltstone fragments) typically up to 10mm in size, M<Wp | | | | | | | |
| | 1 | | | D | 1.0 | | | | 1 |
| | 2 | | | D | 2.0 | | | | 2 |
| | 3 | | | | | | | | 3 |
| | 3.0 | Pit discontinued at 3.0m, limit of investigation | | D | 3.0 | | | | |
| | 4 | | | | | | | | 4 |

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

**RIG:** Hyundai 14 Tonne Excavator with 450mm wide toothed bucket **LOGGED:** Ballinger **SURVEY DATUM:** MGA94

**WATER OBSERVATIONS:** No free groundwater observed while pit remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

Douglas Partners
Geotechnics / Environment / Groundwater

# TEST PIT LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 683870
**NORTHING:** 6400391

**PIT No:** 20
**PROJECT No:** 91256.00
**DATE:** 9/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 150mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.03 | TOPSOIL - Red-brown sandy silt topsoil, fine to medium grained, with some organics, trace subrounded gravel up to 10mm in size | | D | 0.01 | | | | |
| | | SILTY CLAY - Hard, red-brown silty clay, with trace to some fine to coarse grained sand and subrounded gravel (weathered rock fragments), M<Wp | | | 0.2 | | pp >400 | | |
| | | | | D | 0.45<br>0.5 | | | | |
| | | | | $U_{50}$ | | | | | |
| | | | | | 0.9 | | | | |
| 1 | | | | D | 1.0 | | | | 1 |
| | | | | D | 1.5 | | | | |
| | 1.6 | SANDY CLAY - Hard, brown sandy clay, fine to coarse grained, with trace to some silt and subrounded gravel / cobbles up to 150mm in size (completely weathered rock), M<Wp | | | | | | | |
| 2 | | | | D | 2.2 | | | | 2 |
| 3 | 3.0 | Pit discontinued at 3.0m, limit of investigation | | D | 3.0 | | | | 3 |
| 4 | | | | | | | | | 4 |

**RIG:** Hyundai 14 Tonne Excavator with 450mm wide toothed bucket **LOGGED:** Ballinger **SURVEY DATUM:** MGA94

**WATER OBSERVATIONS:** No free groundwater observed while pit remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

Douglas Partners
Geotechnics / Environment / Groundwater


Pit 1

| | | | |
|---|---|---|---|
| Douglas Partners<br>Geotechnics / Environment / Groundwater | **Geotechnical Investigation**<br>**Proposed Solar Farm**<br>**Goolma Road, Wellington, NSW** | PROJECT: | 91256.00 |
| | | PLATE No: | 1 |
| | | REV: | 0 |
| | CLIENT: First Solar (Australia) Pty Ltd | DATE: | 22-Feb-18 |


Pit 2

| | | |
|---|---|---|
| Douglas Partners Geotechnics / Environment / Groundwater | **Geotechnical Investigation**<br>**Proposed Solar Farm**<br>**Goolma Road, Wellington, NSW** | PROJECT: 91063.00<br>PLATE No: 2<br>REV: 0 |
| | CLIENT: First Solar (Australia) Pty Ltd | DATE: 22-Feb-18 |


Pit 3

| | | | |
|---|---|---|---|
| Douglas Partners<br>Geotechnics / Environment / Groundwater | **Geotechnical Investigation**<br>**Proposed Solar Farm**<br>**Goolma Road, Wellington, NSW** | PROJECT: | 91256.00 |
| | | PLATE No: | 3 |
| | | REV: | 0 |
| | CLIENT: First Solar (Australia) Pty Ltd | DATE: | 22-Feb-18 |


Pit 4

| | | |
|---|---|---|
| Douglas Partners Geotechnics / Environment / Groundwater | **Geotechnical Investigation**<br>**Proposed Solar Farm**<br>**Goolma Road, Wellington, NSW** | PROJECT: 91256.00<br>PLATE No: 4<br>REV: 0 |
| | CLIENT: First Solar (Australia) Pty Ltd | DATE: 22-Feb-18 |


Pit 5

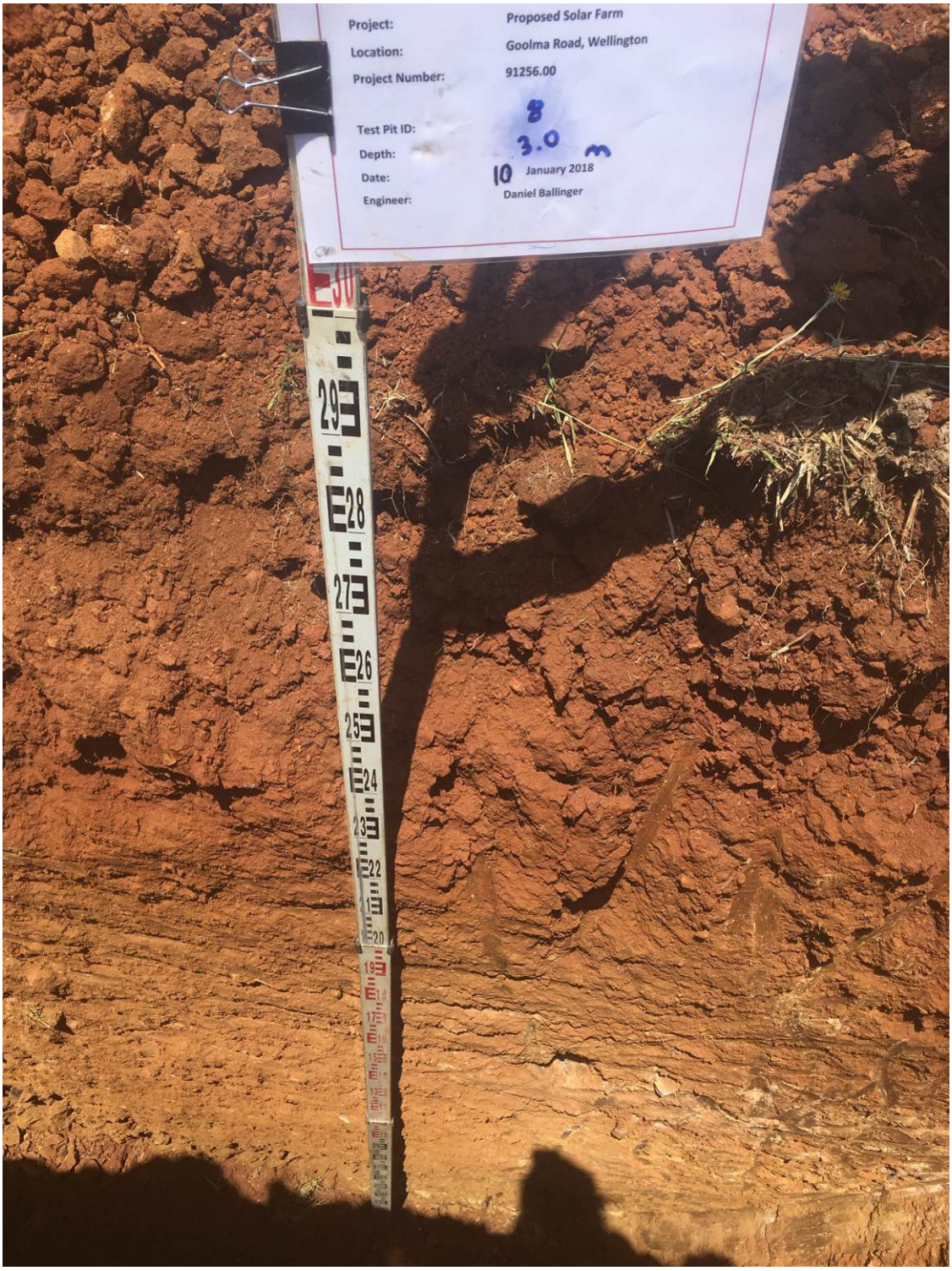
| | | | |
|---|---|---|---|
| Douglas Partners<br>Geotechnics / Environment / Groundwater | **Geotechnical Investigation**<br>**Proposed Solar Farm**<br>**Goolma Road, Wellington, NSW** | PROJECT: | 91256.00 |
| | | PLATE No: | 5 |
| | | REV: | 0 |
| | CLIENT: First Solar (Australia) Pty Ltd | DATE: | 22-Feb-18 |


Pit 6

| | | | |
|---|---|---|---|
| Douglas Partners Geotechnics / Environment / Groundwater | **Geotechnical Investigation** | PROJECT: | 91256.00 |
| | **Proposed Solar Farm** | PLATE No: | 6 |
| | **Goolma Road, Wellington, NSW** | REV: | 0 |
| | CLIENT: First Solar (Australia) Pty Ltd | DATE: | 22-Feb-18 |


Pit 7

| | | | |
|---|---|---|---|
| Douglas Partners<br>Geotechnics / Environment / Groundwater | **Geotechnical Investigation**<br>**Proposed Solar Farm**<br>**Goolma Road, Wellington, NSW** | PROJECT: | 91256.00 |
| | | PLATE No: | 7 |
| | | REV: | 0 |
| | CLIENT: First Solar (Australia) Pty Ltd | DATE: | 22-Feb-18 |




Pit 8

| | | | |
|---|---|---|---|
| Douglas Partners<br>Geotechnics / Environment / Groundwater | **Geotechnical Investigation**<br>**Proposed Solar Farm**<br>**Goolma Road, Wellington, NSW** | PROJECT: | 91256.00 |
| | | PLATE No: | 8 |
| | | REV: | 0 |
| | CLIENT: First Solar (Australia) Pty Ltd | DATE: | 22-Feb-18 |


Pit 9

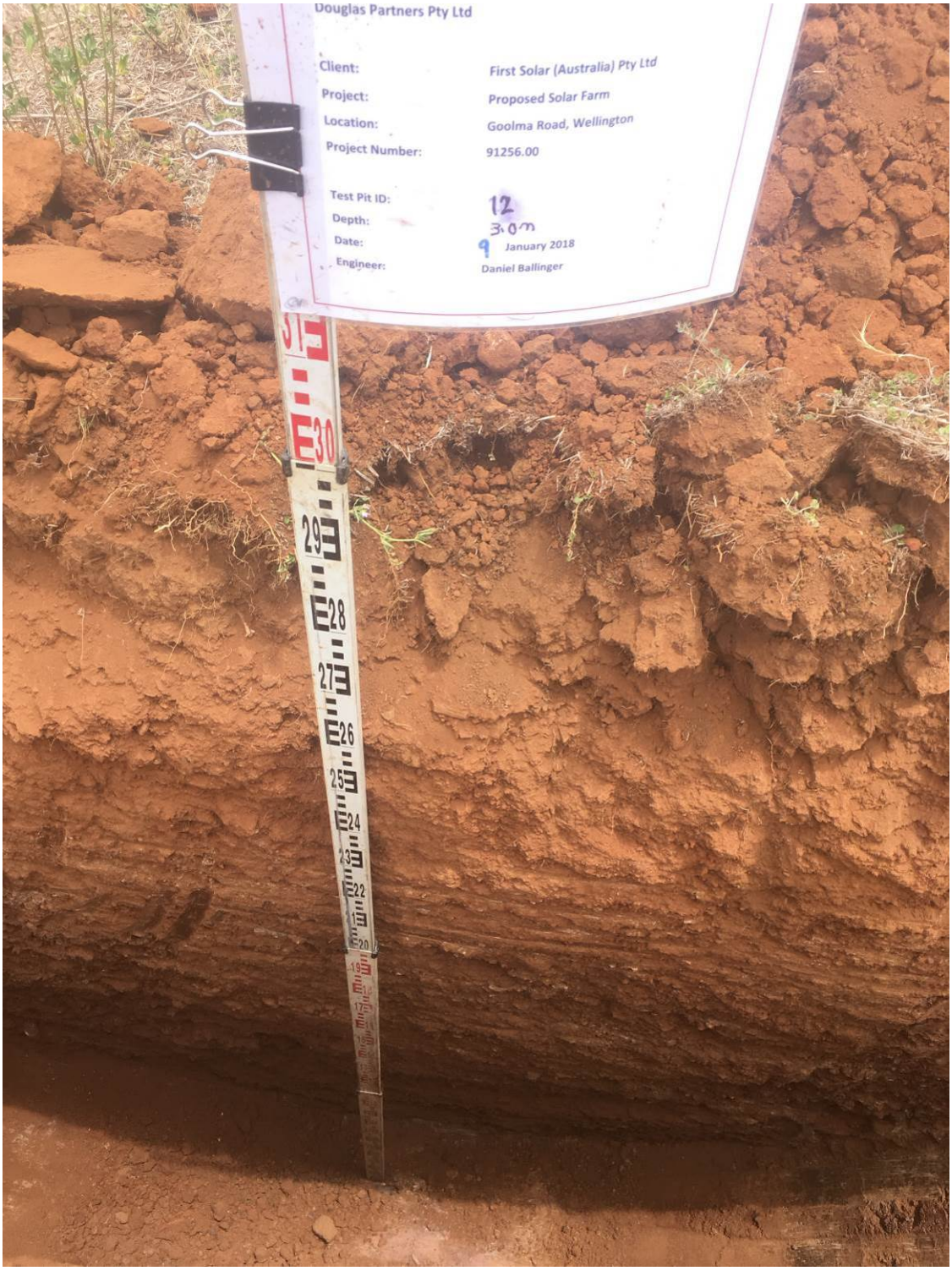
| | | | |
|---|---|---|---|
| Douglas Partners<br>Geotechnics / Environment / Groundwater | **Geotechnical Investigation**<br>**Proposed Solar Farm**<br>**Goolma Road, Wellington, NSW** | PROJECT: | 91256.00 |
| | | PLATE No: | 9 |
| | | REV: | 0 |
| | CLIENT: First Solar (Australia) Pty Ltd | DATE: | 22-Feb-18 |

Pit 10

| | | | |
|---|---|---|---|
| Douglas Partners<br>Geotechnics / Environment / Groundwater | **Geotechnical Investigation**<br>**Proposed Solar Farm**<br>**Goolma Road, Wellington, NSW** | PROJECT: | 91256.00 |
| | | PLATE No: | 10 |
| | | REV: | 0 |
| | CLIENT: First Solar (Australia) Pty Ltd | DATE: | 22-Feb-18 |


Pit 11

| | | | |
|---|---|---|---|
| Douglas Partners Geotechnics / Environment / Groundwater | **Geotechnical Investigation**<br>**Proposed Solar Farm**<br>**Goolma Road, Wellington, NSW** | PROJECT: | 91256.00 |
| | | PLATE No: | 11 |
| | | REV: | 0 |
| | CLIENT: First Solar (Australia) Pty Ltd | DATE: | 22-Feb-18 |




Pit 12

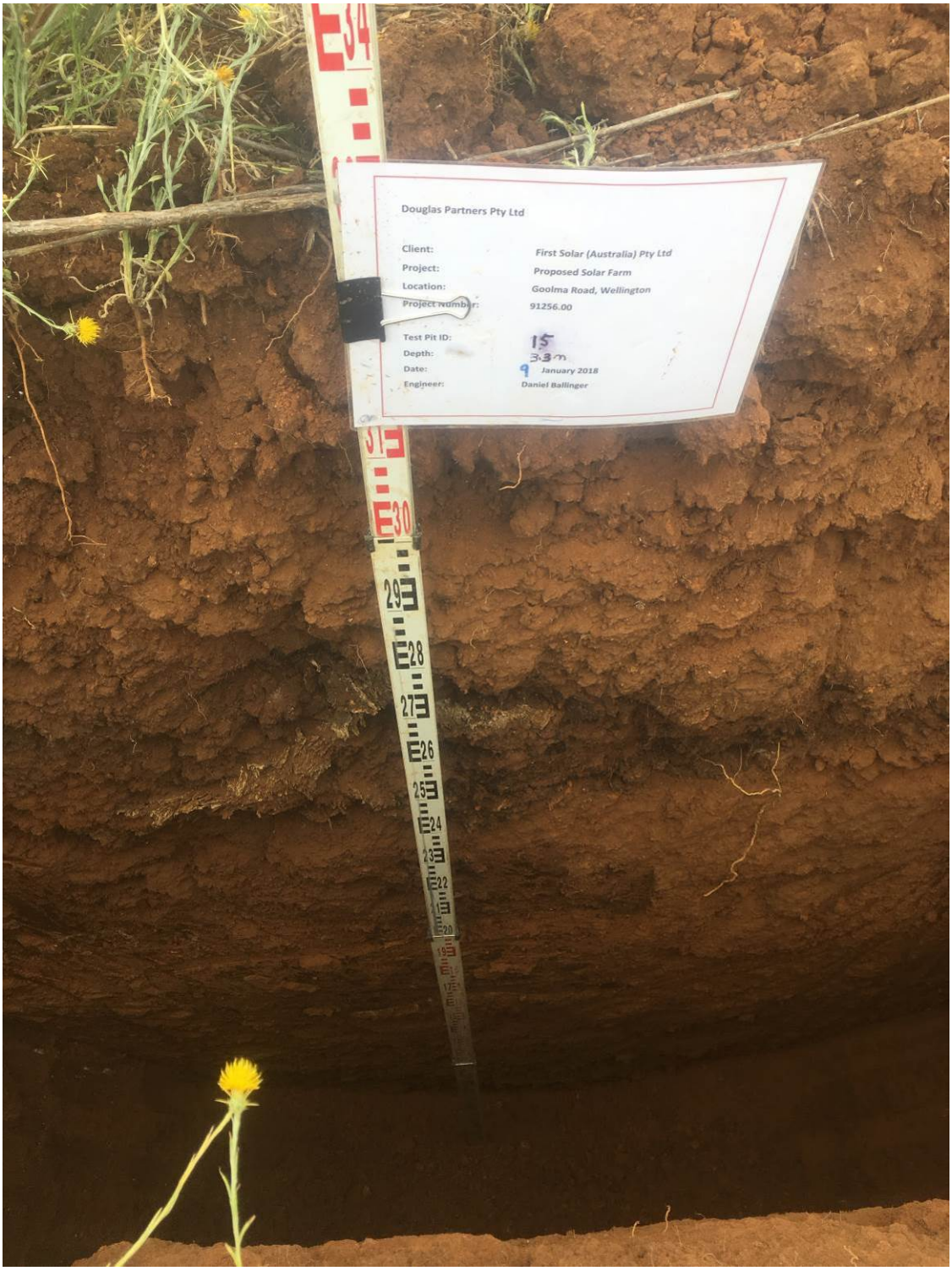
| | | |
|---|---|---|
| Douglas Partners Geotechnics / Environment / Groundwater | **Geotechnical Investigation**<br>**Proposed Solar Farm**<br>**Goolma Road, Wellington, NSW** | PROJECT: 91256.00<br>PLATE No: 12<br>REV: 0 |
| | CLIENT: First Solar (Australia) Pty Ltd | DATE: 22-Feb-18 |


Pit 13

| | | | |
|---|---|---|---|
| Douglas Partners Geotechnics / Environment / Groundwater | **Geotechnical Investigation** | PROJECT: | 91256.00 |
| | **Proposed Solar Farm** | PLATE No: | 13 |
| | **Goolma Road, Wellington, NSW** | REV: | 0 |
| | CLIENT: First Solar (Australia) Pty Ltd | DATE: | 22-Feb-18 |

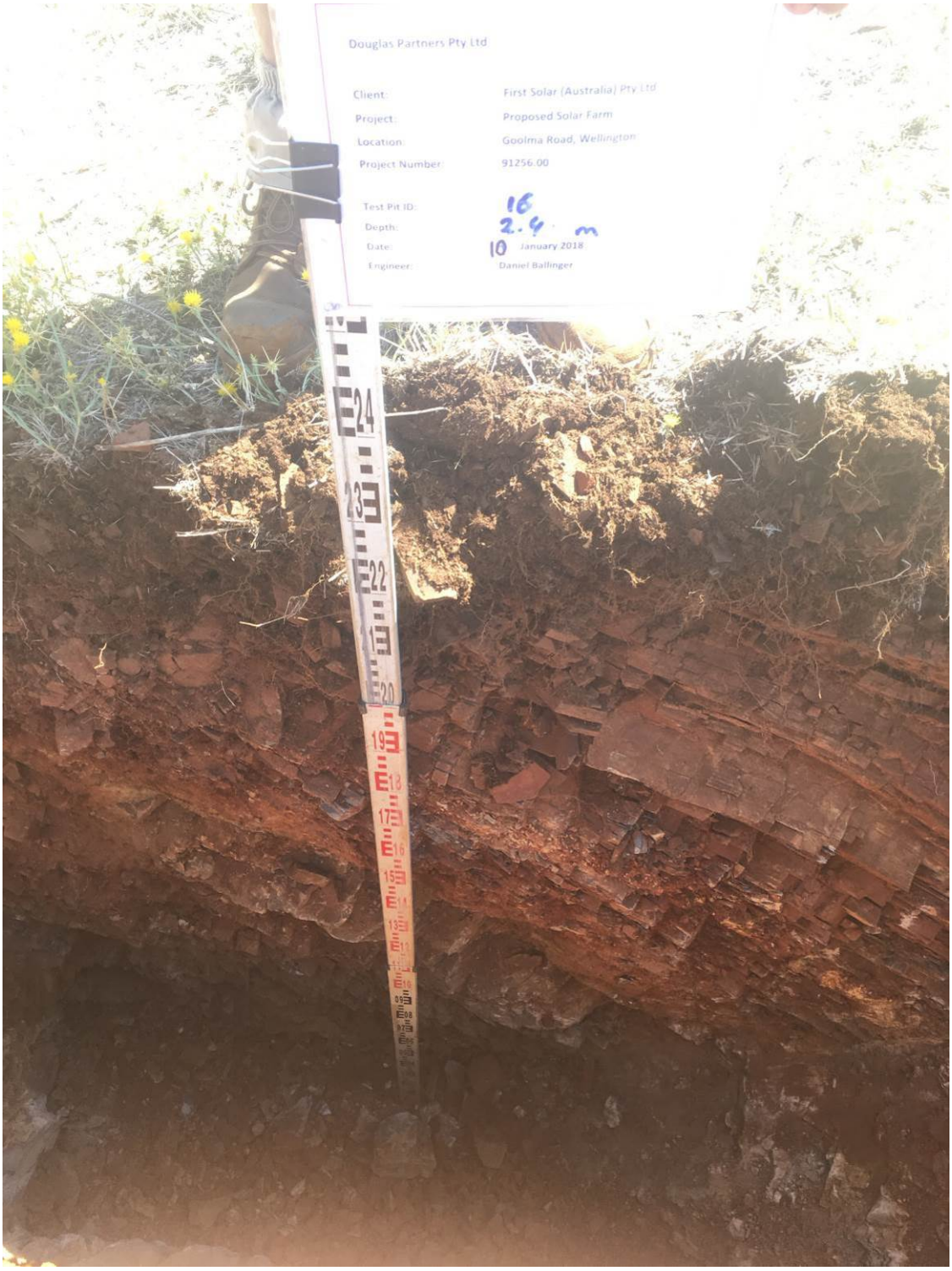

Pit 14

| | | | |
|---|---|---|---|
| Douglas Partners Geotechnics / Environment / Groundwater | **Geotechnical Investigation** | PROJECT: | 91256.00 |
| | **Proposed Solar Farm** | PLATE No: | 14 |
| | **Goolma Road, Wellington, NSW** | REV: | 0 |
| | CLIENT: First Solar (Australia) Pty Ltd | DATE: | 22-Feb-18 |




Pit 15

| | | | |
|---|---|---|---|
| Douglas Partners Geotechnics / Environment / Groundwater | **Geotechnical Investigation** | PROJECT: | 91256.00 |
| | **Proposed Solar Farm** | PLATE No: | 15 |
| | **Goolma Road, Wellington, NSW** | REV: | 0 |
| | CLIENT: First Solar (Australia) Pty Ltd | DATE: | 22-Feb-18 |




Pit 16

| | | |
|---|---|---|
| Douglas Partners Geotechnics / Environment / Groundwater | **Geotechnical Investigation**<br>**Proposed Solar Farm**<br>**Goolma Road, Wellington, NSW** | PROJECT: 91256.00<br>PLATE No: 16<br>REV: 0 |
| | CLIENT: First Solar (Australia) Pty Ltd | DATE: 22-Feb-18 |


Pit 17

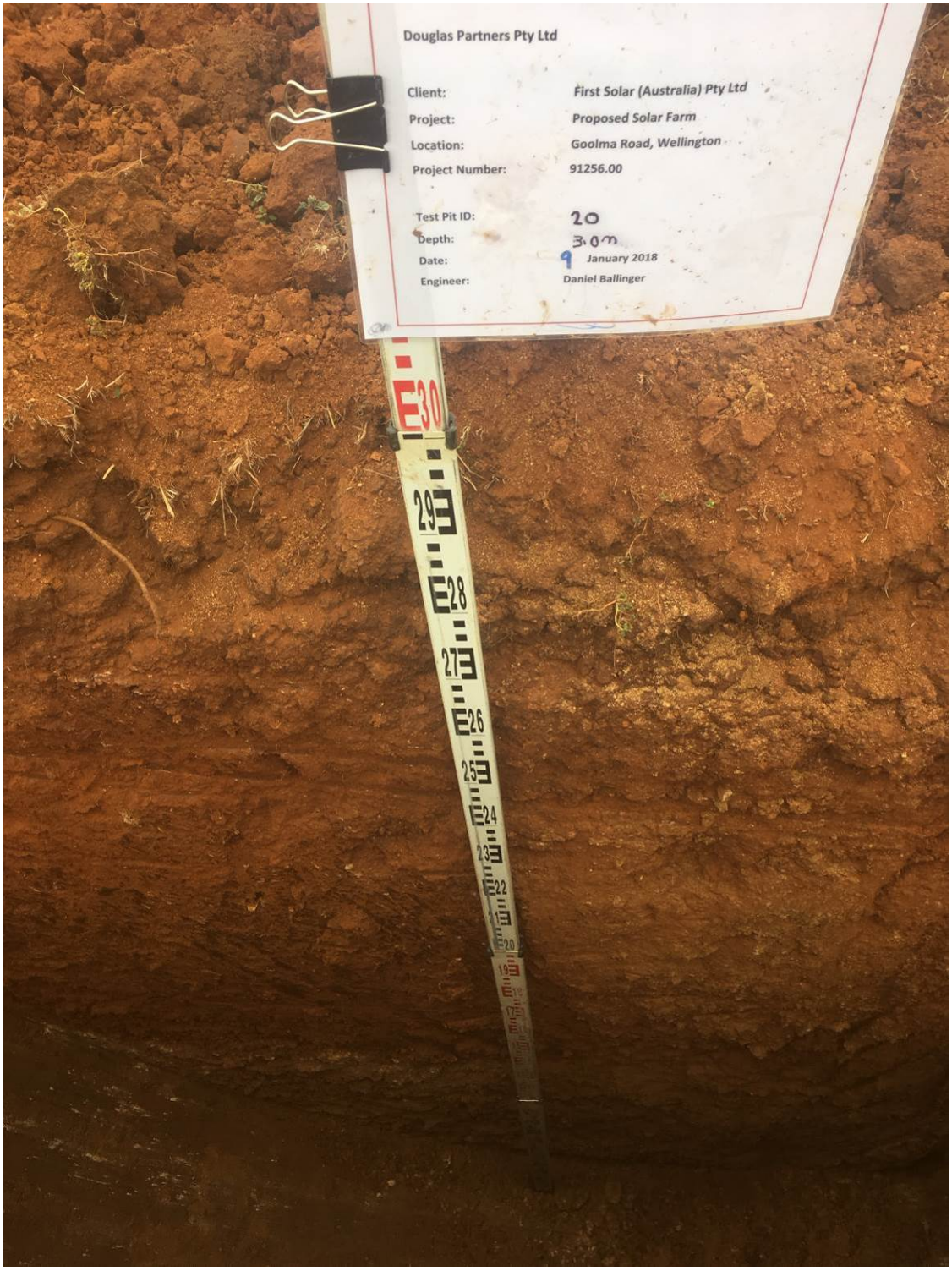
| | | | |
|---|---|---|---|
| Douglas Partners<br>Geotechnics / Environment / Groundwater | **Geotechnical Investigation**<br>**Proposed Solar Farm**<br>**Goolma Road, Wellington, NSW** | PROJECT: | 91256.00 |
| | | PLATE No: | 17 |
| | | REV: | 0 |
| | CLIENT: First Solar (Australia) Pty Ltd | DATE: | 22-Feb-18 |


Pit 18

| | | |
|---|---|---|
| Douglas Partners Geotechnics / Environment / Groundwater | **Geotechnical Investigation** | PROJECT: 91256.00 |
| | **Proposed Solar Farm** | PLATE No: 18 |
| | **Goolma Road, Wellington, NSW** | REV: 0 |
| | CLIENT: First Solar (Australia) Pty Ltd | DATE: 22-Feb-18 |


Pit 19

| | | | |
|---|---|---|---|
| Douglas Partners<br>Geotechnics / Environment / Groundwater | **Geotechnical Investigation**<br>**Proposed Solar Farm**<br>**Goolma Road, Wellington, NSW** | PROJECT: | 91256.00 |
| | | PLATE No: | 19 |
| | | REV: | 0 |
| | CLIENT: First Solar (Australia) Pty Ltd | DATE: | 22-Feb-18 |




Pit 20

| | | | |
|---|---|---|---|
| Douglas Partners Geotechnics / Environment / Groundwater | **Geotechnical Investigation** | PROJECT: | 91256.00 |
| | **Proposed Solar Farm** | PLATE No: | 20 |
| | **Goolma Road, Wellington, NSW** | REV: | 0 |
| | CLIENT: First Solar (Australia) Pty Ltd | DATE: | 22-Feb-18 |

# BOREHOLE LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 685248
**NORTHING:** 6401373
**DIP/AZIMUTH:** 90°/--

**BORE No:** 21
**PROJECT No:** 91256.00
**DATE:** 11/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 0mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | SILTY CLAY - Hard, red-brown silty clay, with trace fine to coarse grained sand and subrounded gravel (siltstone fragments) up to 10mm in size, M<Wp | | A | 0.1 | | | | |
| | | | | $U_{50}$ | 0.4 | | | | |
| | | | | | 0.69 | | pp >400 | | |
| | 1 | From 0.9m, grading to rock | | S | 1.0 | | 10,21,21 N = 42 | | |
| | | | | | 1.45 | | | | |
| | 2 | 2.0 SILTSTONE - (Extremely low to very low strength, extremely weathered to highly weathered) red-brown mottled off-white siltstone | | | | | | | |
| | | | | S | 2.5 | | 9,21,15/70 refusal | | |
| | 3 | | | | 2.87 | | | | |
| | | 3.5 SILTSTONE - (Low to medium strength, moderately weathered to slightly weathered), grey and brown siltstone | | | | | | | |
| | 4 | | | S | 4.0 4.05 | | 12/50,-,- refusal | | |
| | 5 | 5.0 Bore discontinued at 5.0m, limit of investigation | | | | | | | |

**RIG:** Douglas CMG Scout **DRILLER:** Hennessey **LOGGED:** Ballinger **CASING:** Uncased

**TYPE OF BORING:** Solid flight auger (TC-bit) to 5m

**WATER OBSERVATIONS:** No free groundwater observed while bore remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

Douglas Partners
Geotechnics / Environment / Groundwater

# BOREHOLE LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 684577
**NORTHING:** 6401685
**DIP/AZIMUTH:** 90°/--

**BORE No:** 22
**PROJECT No:** 91256.00
**DATE:** 11/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 0mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.02 | TOPSOIL - Brown slightly sandy silt topsoil, fine to medium grained, with trace clay and subrounded gravel, abundant organics | | A | 0.01 | | | | |
| | | GRAVELLY SILTY CLAY - Hard, red-brown gravelly silty clay, gravel portion subrounded up to 30mm in size, trace fine to medium grained sand, M<Wp | | A | 0.5 | | | | |
| | 0.7 | META SILTSTONE - (Very low to low strength, highly weathered to moderately weathered), grey and brown meta siltstone | | A | 0.85 | | | | |
| | 1 | | | S | 1.0<br>1.05 | | 15/50mm,-,-<br>refusal | | |
| | | From 1.5m, (low to medium strength, moderately weathered to slightly weathered), increased drilling resistance | | | | | | | |
| | 2 | | | A | 2.0 | | | | |
| | 3 | | | | | | | | |
| | 4 | | | A | 4.5 | | | | |
| | 5 | 5.0 Bore discontinued at 5.0m, limit of investigation | | | | | | | |

Dynamic Penetrometer Test (blows per 0mm): 5, 10, 15, 20

**RIG:** Douglas CMG Scout **DRILLER:** Hennessey **LOGGED:** Ballinger **CASING:** Uncased

**TYPE OF BORING:** Solid flight auger (TC-bit) to 5m

**WATER OBSERVATIONS:** No free groundwater observed while bore remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

Douglas Partners
Geotechnics / Environment / Groundwater

# BOREHOLE LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 683937
**NORTHING:** 6401781
**DIP/AZIMUTH:** 90°/--

**BORE No:** 23
**PROJECT No:** 91256.00
**DATE:** 10/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 0mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | SILTY CLAY - (Hard), red-brown silty clay, with trace fine sized subangular gravel, M<Wp | | A | 0.1 | | | | |
| | | | | A | 0.5 | | | | |
| | 1 | From 1.0m, medium to coarse sized subangular gravel (meta-siltstone) (increased drilling resistance in parts) | | S | 1.0<br>1.15 | | 25<br>refusal | | |
| | 2 | | | S | 2.5<br>2.8 | | 11,25,-<br>refusal | | |
| | 3 | | | | | | | | |
| | 4 | From 4.0m, some rock structure evident | | S | 4.0<br>4.34 | | 10,25,10/40mm<br>refusal | | |
| | 5 | | | A | 4.95 | | | | |
| | 5.0 | Bore discontinued at 5.0m, limit of investigation | | | | | | | |

**RIG:** Douglas CMG Scout **DRILLER:** Hennessey **LOGGED:** Fulham **CASING:** Uncased

**TYPE OF BORING:** Solid flight auger (TC-bit) to 5m

**WATER OBSERVATIONS:** No free groundwater observed while bore remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | U$_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

Douglas Partners
Geotechnics / Environment / Groundwater

# BOREHOLE LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 683091
**NORTHING:** 6401472
**DIP/AZIMUTH:** 90°/--

**BORE No:** 24
**PROJECT No:** 91256.00
**DATE:** 10/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 0mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.0 | SILTY CLAY - (Hard), red-brown silty clay, with some fine grained sand and trace fine to medium sized subangular gravel, M≤Wp | | A | 0.1 | | | | |
| | | | | A | 0.5 | | | | |
| | 0.8 | SILTY CLAY - Hard, pale brown silty clay, with trace fine grained sand (extremely weathered siltstone), M<Wp | | A | 0.85 | | | | |
| | 1 | | | | 1.0 | | | | 1 |
| | | | | S | | | 9,13,15<br>N = 28 | | |
| | | | | | 1.45 | | | | |
| | 2 | | | | | | | | 2 |
| | | | | | 2.5 | | | | |
| | | | | S | | | 16,24,5/20mm<br>refusal<br>(bouncing) | | |
| | 2.8 | SILTSTONE - Very low to low strength, highly weathered, pale brown siltstone | | | 2.82 | | | | |
| | 3 | | | | | | | | 3 |
| | 4 | | | S | 4.0<br>4.07 | | 12/70mm<br>refusal<br>(bouncing) | | 4 |
| | | | | A | 4.45 | | | | |
| | 4.5 | Bore discontinued at 4.5m, TC-bit refusal | | | | | | | |
| | 5 | | | | | | | | 5 |

**RIG:** Douglas CMG Scout **DRILLER:** Hennessey **LOGGED:** Fulham **CASING:** Uncased

**TYPE OF BORING:** Solid flight auger (TC-bit) to 4.5m

**WATER OBSERVATIONS:** No free groundwater observed while bore remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

Douglas Partners
Geotechnics / Environment / Groundwater

# BOREHOLE LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 683990
**NORTHING:** 6401289
**DIP/AZIMUTH:** 90°/--

**BORE No:** 25
**PROJECT No:** 91256.00
**DATE:** 11/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 150mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | SILTY CLAY - Hard, red-brown silty clay, with trace fine grained sand and fine sized subangular gravel, M<Wp | | A | 0.1 | | | | |
| | | | | A | 0.5 | | | | |
| | 1 | | | | 1.0 | | | | |
| | | | | S | | | 10,14,15<br>N = 29 | | |
| | | | | | 1.45 | | | | |
| | 2 | | | | | | | | |
| | 2.0 | META SILTSTONE - (Very low to low strength, highly weathered to moderately weathered), grey and brown meta siltstone | | | | | | | |
| | | | | | 2.5 | | | | |
| | | | | S | | | 35,-,-<br>refusal | | |
| | | | | | 2.65 | | | | |
| | 3 | | | | | | | | |
| | | From 3.5m, (low to medium strength, moderately weathered to slightly weathered) | | | | | | | |
| | 4 | | | S | 4.0<br>4.04 | | 10/40mm,-,-<br>refusal<br>(bouncing) | | |
| | | | | A | 4.5 | | | | |
| | 4.7 | Bore discontinued at 4.7m, TC-bit refusal | | | | | | | |
| | 5 | | | | | | | | |

**RIG:** Douglas CMG Scout **DRILLER:** Hennessey **LOGGED:** Ballinger **CASING:** Uncased

**TYPE OF BORING:** Solid flight auger (TC-bit) to 4.7m

**WATER OBSERVATIONS:** No free groundwater observed while bore remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# BOREHOLE LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 684690
**NORTHING:** 6401075
**DIP/AZIMUTH:** 90°/--

**BORE No:** 26
**PROJECT No:** 91256.00
**DATE:** 11/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 0mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.02 | TOPSOIL - Brown clayey silt topsoil, with trace to some fine to coarse grained sand, abundant rootlets | | D | 0.01 | | | | |
| | | | | D | 0.1 | | | | |
| | | SILTY CLAY - Hard, red-brown silty clay, with trace fine to medium grained sand and subrounded gravel (siltstone fragments) up to 10mm in size, M<Wp | | | 0.25 | | | | |
| | | | | $U_{50}$ | | | | | |
| | | | | | 0.63 | | | | |
| | 1 | From 1.0m, grading to rock | | | 1.0 | | | | 1 |
| | 1.2 | META SILTSTONE - (Extremely low to very low strength, extremely weathered to highly weathered), grey and brown meta siltstone | | | | | 13,19,20 N = 39 | | |
| | | From 1.5m, (low to medium strength, moderately weathered to slightly weathered) | | | 1.45 | | | | |
| | | | | D | 1.6 | | | | |
| | 2 | | | | | | | | 2 |
| | 2.0 | Bore discontinued at 2.0m, TC-bit refusal | | | | | | | |
| | 3 | | | | | | | | 3 |
| | 4 | | | | | | | | 4 |
| | 5 | | | | | | | | 5 |

**RIG:** Douglas CMG Scout **DRILLER:** Hennessey **LOGGED:** Ballinger **CASING:** Uncased

**TYPE OF BORING:** Solid flight auger (TC-bit) to 2m

**WATER OBSERVATIONS:** No free groundwater observed while bore remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# BOREHOLE LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 682026
**NORTHING:** 6401320
**DIP/AZIMUTH:** 90°/--

**BORE No:** 27
**PROJECT No:** 91256.00
**DATE:** 10/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20 |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | SILTY CLAY - (Hard) red brown silty clay, with trace fine to medium grained sand, M ≤ Wp | | A | 0.1 | | | | |
| | | | | A | 0.5 | | | | |
| | 1 | | | | 1.0 | | | | 1 |
| | | From 1.3m, trace fine sized gravel | | S | | | 6,8,13<br>N = 21 | | |
| | | | | | 1.45 | | | | |
| | 2 | | | | | | | | 2 |
| | | | | | 2.5 | | | | |
| | | | | S | | | pp >400<br>15,21,26<br>N = 47 | | |
| | 3 | | | | 2.95 | | | | 3 |
| | 3.5 | CLAYEY GRAVEL - Medium dense, red-brown, fine sized subangular clayey gravel, moist to wet | | | | | | | |
| | 4 | | | | 4.0 | | | | 4 |
| | | | | S | | | 6,8,5<br>N = 13 | | |
| | | | | | 4.45 | | | | |
| | 5 | | | A | 4.95 | | | | 5 |
| | 5.0 | Bore discontinued at 5.0m, limit of investigation | | | | | | | |

**RIG:** Douglas CMG Scout **DRILLER:** Hennessey **LOGGED:** Fulham **CASING:** Uncased

**TYPE OF BORING:** Solid flight auger (TC-bit) to 5m

**WATER OBSERVATIONS:** No free groundwater observed while bore remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# BOREHOLE LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 682980
**NORTHING:** 6400975
**DIP/AZIMUTH:** 90°/--

**BORE No:** 28
**PROJECT No:** 91256.00
**DATE:** 10/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 0mm) |
|---|---|---|---|---|---|---|---|---|---|
| | | SILTY CLAY - (Very stiff), red-brown silty clay, with trace fine grained sand, M⩽Wp | | A | 0.1 | | | | |
| | | From 0.5m, hard | | A | 0.5 | | pp = 350 | | |
| | | | | | 0.73 | | pp = 500-550 | | |
| | 1 | From 1m, very stiff to hard lenses of fine to medium grained sand and fine sized subrounded gravels | | S | 1.0 | | 3,4,8<br>N = 12 | | |
| | | | | | 1.45 | | | | |
| | 2 2.0 | SILTY CLAY - Hard, red-brown silty clay, slightly gravelly, with fine to medium sized subangular / subrounded gravel, M<Wp | | A | 2.0 | | | | |
| | | From 2.5m, some rock structure evident | | S | 2.5 | | 12,14,18<br>N = 32 | | |
| | 3 | | | | 2.95 | | | | |
| | | | | A | 3.4 | | | | |
| | | | | S | | | 10,20,25/120<br>refusal | | |
| | 3.82 | Bore discontinued at 3.82m, TC-bit refusal (on possible bedrock) | | | 3.82 | | | | |
| | 4 | | | | | | | | |
| | 5 | | | | | | | | |

**RIG:** Douglas CMG Scout **DRILLER:** Hennessey **LOGGED:** Fulham **CASING:** Uncased

**TYPE OF BORING:** Solid flight auger (TC-bit) to 3.4m, SPT sampler to 3.82m

**WATER OBSERVATIONS:** No free groundwater observed while bore remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# BOREHOLE LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 683315
**NORTHING:** 6400844
**DIP/AZIMUTH:** 90°/--

**BORE No:** 29
**PROJECT No:** 91256.00
**DATE:** 9 - 10/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 0mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | SILTY CLAY - (Hard), red-brown silty clay, with trace fine grained sand, rootlets in top 500mm | | A | 0.1 | | | | |
| | | | | A | 0.5 | | | | |
| | 1 | | | $U_{50}$ | 1.0 | | | | |
| | | | | | 1.2 | | pp >600 | | |
| | | | | | 1.5 | | | | |
| | | | | S | | | pp >400<br>6,9,11<br>N = 20 | | |
| | 2 | From 2.0m, trace to some fine sized gravel | | | 1.95 | | | | |
| | | | | | 2.5 | | | | |
| | | | | S | | | pp >500<br>6,8,14<br>N = 22 | | |
| | 3 | | | | 2.95 | | | | |
| | | | | | 4.0 | | | | |
| | 4 | | | S | | | pp >600<br>8,16,20<br>N = 36 | | |
| | | | | | 4.45 | | | | |
| | | | | A | 4.95 | | | | |
| | 5 | 5.0 Bore discontinued at 5.0m, limit of investigation | | | | | | | |

**RIG:** Douglas CMG Scout **DRILLER:** Hennessey **LOGGED:** Fulham **CASING:** Uncased

**TYPE OF BORING:** Solid flight auger (TC-bit) to 5m

**WATER OBSERVATIONS:** No free groundwater observed while bore remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# BOREHOLE LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 683659
**NORTHING:** 6400545
**DIP/AZIMUTH:** 90°/--

**BORE No:** 30
**PROJECT No:** 91256.00
**DATE:** 9/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 0mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.15 | TOPSOIL - Brown silty clay topsoil, with some rootlets, dry to humid | | A | 0.1 | | | | |
| | | SILTY CLAY - (Hard), pale brown silty clay, with trace fine to medium sized gravel, M<Wp | | A | 0.5 | | | | |
| | 1 | | | S | 1.0 | | 29/140mm refusal | | |
| | 1.15 | META SANDSTONE - (Low strength, highly weathered), light brown, meta sandstone | | | 1.15 | | | | |
| | | | | A | 1.5 | | | | |
| | 1.8 | Bore discontinued at 1.8m, slow progress with TC-bit | | A | 1.8 | | | | |
| | 2 | | | | | | | | |
| | 3 | | | | | | | | |
| | 4 | | | | | | | | |
| | 5 | | | | | | | | |

Dynamic Penetrometer Test (blows per 0mm): 5, 10, 15, 20

**RIG:** Douglas CMG Scout **DRILLER:** Hennessey **LOGGED:** Fulham **CASING:** Uncased

**TYPE OF BORING:** Solid flight auger (TC-bit) to 1.8m

**WATER OBSERVATIONS:** No free groundwater observed while bore remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# BOREHOLE LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 684164
**NORTHING:** 6400640
**DIP/AZIMUTH:** 90°/--

**BORE No:** 31
**PROJECT No:** 91256.00
**DATE:** 11/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 0mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.02 | TOPSOIL - Brown slightly sandy silt topsoil, fine to coarse grained, with trace to some clay and subangular gravel / cobbles abundant organics | | D | 0.2 | | | | |
| | | SILTY CLAY - Hard, red-brown silty clay, with some subrounded gravel (siltstone fragments) up to 20mm in size, M<Wp | | | 0.3 | | | | |
| | | | | $U_{50}$ | 0.61 | | | | |
| | 0.8 | META SILTSTONE - (Extremely low to very low strength, extremely weathered to highly weathered), grey and brown meta siltstone | | | | | | | |
| | 1 | From 1.1m, (very low to low and medium strength, moderately weathered to slightly weathered) | | S | 1.0 | | 27,-,- refusal | | 1 |
| | | | | | 1.15 | | | | |
| | 2 | | | D | 2.0 | | | | 2 |
| | | | | | 2.5 | | 25,12/50mm,- refusal | | |
| | | | | S | 2.7 | | | | |
| | 3 | | | | | | | | 3 |
| | 4 | From 4.3m, (low to medium strength, slightly weathered) | | | | | | | 4 |
| | 4.9 | Bore discontinued at 4.9m, TC-bit refusal | | | | | | | |
| | 5 | | | | | | | | 5 |

**RIG:** Douglas CMG Scout **DRILLER:** Hennessey **LOGGED:** Ballinger **CASING:** Uncased

**TYPE OF BORING:** Solid flight auger (TC-bit) to 4.9m

**WATER OBSERVATIONS:** No free groundwater observed while bore remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# BOREHOLE LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 683672
**NORTHING:** 6400107
**DIP/AZIMUTH:** 90°/--

**BORE No:** 32
**PROJECT No:** 91256.00
**DATE:** 9/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 0mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | SILTY CLAY - (Hard), red-brown silty clay, with trace fine grained sand, M<Wp | | A | 0.1 | | | | |
| | | | | A / $U_{50}$ | 0.5 | | | | |
| | | | | | 0.73 | | pp >600 | | |
| | 1 | | | S | 1.0 | | 8,17,18<br>N = 35 | | |
| | | | | | 1.45 | | | | |
| | 2 | From 2.0m, trace medium sized subangular gravel | | A | 2.0 | | | | |
| | | | | | 2.5 | | | | |
| | 3 | | | S | 2.89 | | 4,12,8/90mm<br>refusal | | |
| | 3.1 | Bore discontinued at 3.1m, TC-bit refusal (on possible bedrock) | | | | | | | |
| | 4 | | | | | | | | |
| | 5 | | | | | | | | |

Dynamic Penetrometer Test (blows per 0mm): 5, 10, 15, 20

**RIG:** Douglas CMG Scout **DRILLER:** Hennessey **LOGGED:** Fulham **CASING:** Uncased

**TYPE OF BORING:** Solid flight auger (TC-bit) to 3.1m

**WATER OBSERVATIONS:** No free groundwater observed while bore remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# BOREHOLE LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 684057
**NORTHING:** 6399769
**DIP/AZIMUTH:** 90°/--

**BORE No:** 33
**PROJECT No:** 91256.00
**DATE:** 11/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 0mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | SILTY CLAY - Hard, red-brown silty clay, with trace fine to medium grained sand and subrounded gravel up to 10mm in size, M<Wp | | D | 0.1 | | | | |
| | | | | $U_{50}$ | 0.3 – 0.55 | | | | |
| | 1 | | | S | 1.0 | | 9,10,12 N = 22 | | |
| | | From 1.4m, grey and brown, with trace to some sand and gravel / cobbles (medium to high strength meta siltstone) | | D | 1.45 – 1.5 | | | | |
| | 2 | | | | | | | | |
| | | | | S | 2.5 – 2.95 | | 7,11,20 N = 31 | | |
| | 3 | From 3.4m, increased drilling resistance (probable increase in gravel / cobble proportion) | | | | | | | |
| | 4 | | | S | 4.0 – 4.01 | | 5/10mm,-,- refusal | | |
| | 4.0 | META SILTSTONE - (Medium strength, slightly weathered), grey and brown meta siltstone | | | | | | | |
| | 4.2 | Bore discontinued at 4.2m, TC-bit refusal | | | | | | | |
| | 5 | | | | | | | | |

**RIG:** Douglas CMG Scout **DRILLER:** Ballinger **LOGGED:** Ballinger **CASING:** Uncased

**TYPE OF BORING:** Solid flight auger (TC-bit) to 4.2m

**WATER OBSERVATIONS:** No free groundwater observed while bore remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

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# BOREHOLE LOG

**CLIENT:** First Solar (Australia) Pty Ltd
**PROJECT:** Proposed Solar Farm
**LOCATION:** Goolma Road, Wellington

**SURFACE LEVEL:** --
**EASTING:** 684878
**NORTHING:** 6400346
**DIP/AZIMUTH:** 90°/--

**BORE No:** 34
**PROJECT No:** 91256.00
**DATE:** 11/1/2018
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 0mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | SILTY CLAY - Hard, red-brown silty clay, with trace to some fine to coarse grained sand and subrounded gravel up to 10mm in size, M<Wp | | D | 0.1 | | | | |
| | 1 | From 0.7m to 1.2m, (high strength) meta siltstone cobbles | | | | | | | |
| | 2 | | | D | 2.0 | | | | |
| | | | | | 2.5 | | 12,15,21 N = 36 | | |
| | 3 | | | | 2.95 | | | | |
| | 4 | From 4.0m, brown and grey (completely weathered rock) | | | 4.0 | | 16,21,15/50 refusal | | |
| | | | | | 4.35 | | | | |
| | 5 | 5.0 Bore discontinued at 5.0m, limit of investigation | | | | | | | |

**RIG:** Douglas CMG Scout **DRILLER:** Hennessey **LOGGED:** Ballinger **CASING:** Uncased

**TYPE OF BORING:** Solid flight auger (TC-bit) to 5m

**WATER OBSERVATIONS:** No free groundwater observed while bore remained open

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| A | Auger sample | G | Gas sample | PID | Photo ionisation detector (ppm) |
| B | Bulk sample | P | Piston sample | PL(A) | Point load axial test Is(50) (MPa) |
| BLK | Block sample | $U_x$ | Tube sample (x mm dia.) | PL(D) | Point load diametral test Is(50) (MPa) |
| C | Core drilling | W | Water sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | ▷ | Water seep | S | Standard penetration test |
| E | Environmental sample | ▼ | Water level | V | Shear vane (kPa) |

Douglas Partners
Geotechnics / Environment / Groundwater

**Attachment 02**: *Laboratory results*

**Envirolab Services Pty Ltd**
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# CERTIFICATE OF ANALYSIS 184415

## Client Details

| | |
|---|---|
| **Client** | Douglas Partners Newcastle |
| **Attention** | Michael Gawn |
| **Address** | Box 324 Hunter Region Mail Centre, Newcastle, NSW, 2310 |

## Sample Details

| | |
|---|---|
| **Your Reference** | **91256.00** |
| **Number of Samples** | 24 Soil |
| **Date samples received** | 02/02/2018 |
| **Date completed instructions received** | 02/02/2018 |

## Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

**Please refer to the last page of this report for any comments relating to the results.**

## Report Details

| | |
|---|---|
| **Date results requested by** | 13/02/2018 |
| **Date of Issue** | 15/02/2018 |

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**Results Approved By**
Long Pham, Team Leader, Metals
Nick Sarlamis, Inorganics Supervisor

**Authorised By**

David Springer, General Manager

| Misc Inorg - Soil | | | | | | |
|---|---|---|---|---|---|---|
| Our Reference | | 184415-1 | 184415-2 | 184415-3 | 184415-4 | 184415-5 |
| Your Reference | UNITS | 3 | 8 | 9 | 12 | 13 |
| Depth | | 0.05 | 0.05 | 0.1 | 0.01 | 0.01 |
| Date Sampled | | 09/01/2018 | 09/01/2018 | 09/01/2018 | 09/01/2018 | 09/01/2018 |
| Type of sample | | Soil | Soil | Soil | Soil | Soil |
| Date prepared | - | 05/02/2018 | 05/02/2018 | 05/02/2018 | 05/02/2018 | 05/02/2018 |
| Date analysed | - | 05/02/2018 | 05/02/2018 | 05/02/2018 | 05/02/2018 | 05/02/2018 |
| pH 1:5 soil:water | pH Units | 7.2 | 6.8 | 7.0 | 5.5 | 5.9 |
| Electrical Conductivity 1:5 soil:water | µS/cm | 100 | 100 | 91 | 300 | 160 |
| Phosphorus (Colwell) | mg/kg | 25 | 31 | 63 | 97 | 30 |
| Phosphorus Buffer Index | mg/kg | 760 | 570 | 480 | 560 | 600 |

| Misc Inorg - Soil | | | | | | |
|---|---|---|---|---|---|---|
| Our Reference | | 184415-6 | 184415-7 | 184415-8 | 184415-9 | 184415-10 |
| Your Reference | UNITS | 17 | 18 | 22 | 1 | 3 |
| Depth | | 0.05 | 0.01 | 0.05 | 0.5 | 0.5 |
| Date Sampled | | 09/01/2018 | 09/01/2018 | 09/01/2018 | 09/01/2018 | 09/01/2018 |
| Type of sample | | Soil | Soil | Soil | Soil | Soil |
| Date prepared | - | 05/02/2018 | 05/02/2018 | 05/02/2018 | 05/02/2018 | 05/02/2018 |
| Date analysed | - | 05/02/2018 | 05/02/2018 | 05/02/2018 | 05/02/2018 | 05/02/2018 |
| pH 1:5 soil:water | pH Units | 6.3 | 5.5 | 6.1 | 6.9 | 6.7 |
| Electrical Conductivity 1:5 soil:water | µS/cm | 150 | 340 | 110 | 21 | 34 |
| Emerson Aggregate | - | [NA] | [NA] | [NA] | 3b | 5.0 |
| Phosphorus (Colwell) | mg/kg | 42 | 58 | 58 | [NA] | [NA] |
| Phosphorus Buffer Index | mg/kg | 560 | 350 | 1,600 | [NA] | [NA] |

| Misc Inorg - Soil | | | | | | |
|---|---|---|---|---|---|---|
| Our Reference | | 184415-11 | 184415-12 | 184415-13 | 184415-14 | 184415-15 |
| Your Reference | UNITS | 4 | 7 | 7 | 9 | 13 |
| Depth | | 0.5 | 0.5 | 2.0 | 0.9 | 00.5 |
| Date Sampled | | 09/01/2018 | 09/01/2018 | 09/01/2018 | 09/01/2018 | 09/01/2018 |
| Type of sample | | Soil | Soil | Soil | Soil | Soil |
| Date prepared | - | 05/02/2018 | 05/02/2018 | 05/02/2018 | 05/02/2018 | 05/02/2018 |
| Date analysed | - | 05/02/2018 | 05/02/2018 | 05/02/2018 | 05/02/2018 | 05/02/2018 |
| pH 1:5 soil:water | pH Units | 7.1 | 6.9 | 8.3 | 8.3 | 7.9 |
| Electrical Conductivity 1:5 soil:water | µS/cm | 38 | 41 | 75 | 72 | 64 |
| Emerson Aggregate | - | 5.0 | 5.0 | 3b | 5.0 | 7.0 |

| Misc Inorg - Soil | | | | | | |
|---|---|---|---|---|---|---|
| Our Reference | | 184415-16 | 184415-17 | 184415-18 | 184415-19 | 184415-20 |
| Your Reference | UNITS | 14 | 13 | 14 | 17 | 18 |
| Depth | | 0.6 | 1.2 | 0.9 | 0.3 | 2.2 |
| Date Sampled | | 09/01/2018 | 09/01/2018 | 09/01/2018 | 09/01/2018 | 09/01/2018 |
| Type of sample | | Soil | Soil | Soil | Soil | Soil |
| Date prepared | - | 05/02/2018 | 05/02/2018 | 05/02/2018 | 05/02/2018 | 05/02/2018 |
| Date analysed | - | 05/02/2018 | 05/02/2018 | 05/02/2018 | 05/02/2018 | 05/02/2018 |
| pH 1:5 soil:water | pH Units | 7.9 | 8.7 | 8.4 | 7.6 | 8.6 |
| Electrical Conductivity 1:5 soil:water | µS/cm | 42 | 500 | 120 | 28 | 270 |
| Emerson Aggregate | - | 3b | 4.0 | 3b | 5.0 | 1.0 |

| Misc Inorg - Soil | | | | | |
|---|---|---|---|---|---|
| Our Reference | | 184415-21 | 184415-22 | 184415-23 | 184415-24 |
| Your Reference | UNITS | 19 | 24 | 32 | 32 |
| Depth | | 1.0 | 2.5-2.85 | 00.5 | 2.0 |
| Date Sampled | | 09/01/2018 | 09/01/2018 | 09/01/2018 | 09/01/2018 |
| Type of sample | | Soil | Soil | Soil | Soil |
| Date prepared | - | 05/02/2018 | 05/02/2018 | 05/02/2018 | 05/02/2018 |
| Date analysed | - | 05/02/2018 | 05/02/2018 | 05/02/2018 | 05/02/2018 |
| pH 1:5 soil:water | pH Units | 8.1 | 9.1 | 7.5 | 8.2 |
| Electrical Conductivity 1:5 soil:water | µS/cm | 24 | 73 | 15 | 110 |
| Emerson Aggregate | - | 3b | 4.0 | 5.0 | 4.0 |

| Acid Extractable Cations in Soil | | | | | | |
|---|---|---|---|---|---|---|
| Our Reference | | 184415-1 | 184415-2 | 184415-3 | 184415-4 | 184415-5 |
| Your Reference | UNITS | 3 | 8 | 9 | 12 | 13 |
| Depth | | 0.05 | 0.05 | 0.1 | 0.01 | 0.01 |
| Date Sampled | | 09/01/2018 | 09/01/2018 | 09/01/2018 | 09/01/2018 | 09/01/2018 |
| Type of sample | | Soil | Soil | Soil | Soil | Soil |
| Date prepared | - | 06/02/2018 | 06/02/2018 | 06/02/2018 | 06/02/2018 | 06/02/2018 |
| Date analysed | - | 06/02/2018 | 06/02/2018 | 06/02/2018 | 06/02/2018 | 06/02/2018 |
| Calcium | mg/kg | 3,100 | 2,900 | 4,000 | 1,900 | 2,700 |
| Magnesium | mg/kg | 1,900 | 2,400 | 1,200 | 3,000 | 1,900 |

| Acid Extractable Cations in Soil | | | | |
|---|---|---|---|---|
| Our Reference | | 184415-6 | 184415-7 | 184415-8 |
| Your Reference | UNITS | 17 | 18 | 22 |
| Depth | | 0.05 | 0.01 | 0.05 |
| Date Sampled | | 09/01/2018 | 09/01/2018 | 09/01/2018 |
| Type of sample | | Soil | Soil | Soil |
| Date prepared | - | 06/02/2018 | 06/02/2018 | 06/02/2018 |
| Date analysed | - | 06/02/2018 | 06/02/2018 | 06/02/2018 |
| Calcium | mg/kg | 2,900 | 1,700 | 1,400 |
| Magnesium | mg/kg | 1,400 | 1,800 | 1,800 |

| ESP/CEC | | | | | | |
|---|---|---|---|---|---|---|
| Our Reference | | 184415-1 | 184415-2 | 184415-3 | 184415-4 | 184415-5 |
| Your Reference | UNITS | 3 | 8 | 9 | 12 | 13 |
| Depth | | 0.05 | 0.05 | 0.1 | 0.01 | 0.01 |
| Date Sampled | | 09/01/2018 | 09/01/2018 | 09/01/2018 | 09/01/2018 | 09/01/2018 |
| Type of sample | | Soil | Soil | Soil | Soil | Soil |
| Date prepared | - | 05/02/2018 | 05/02/2018 | 05/02/2018 | 05/02/2018 | 05/02/2018 |
| Date analysed | - | 06/02/2018 | 06/02/2018 | 06/02/2018 | 06/02/2018 | 06/02/2018 |
| Exchangeable Ca | meq/100g | 15 | 13 | 19 | 6.6 | 10 |
| Exchangeable K | meq/100g | 3.1 | 2.2 | 3.3 | 2.5 | 2.3 |
| Exchangeable Mg | meq/100g | 3.7 | 3.9 | 3.7 | 1.7 | 3.4 |
| Exchangeable Na | meq/100g | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Cation Exchange Capacity | meq/100g | 22 | 19 | 26 | 11 | 16 |
| ESP | % | <1 | <1 | <1 | <1 | <1 |

| ESP/CEC | | | | |
|---|---|---|---|---|
| Our Reference | | 184415-6 | 184415-7 | 184415-8 |
| Your Reference | UNITS | 17 | 18 | 22 |
| Depth | | 0.05 | 0.01 | 0.05 |
| Date Sampled | | 09/01/2018 | 09/01/2018 | 09/01/2018 |
| Type of sample | | Soil | Soil | Soil |
| Date prepared | - | 05/02/2018 | 05/02/2018 | 05/02/2018 |
| Date analysed | - | 06/02/2018 | 06/02/2018 | 06/02/2018 |
| Exchangeable Ca | meq/100g | 13 | 7.5 | 9.3 |
| Exchangeable K | meq/100g | 3.9 | 2.4 | 2.1 |
| Exchangeable Mg | meq/100g | 3.2 | 2.1 | 2.3 |
| Exchangeable Na | meq/100g | <0.1 | <0.1 | <0.1 |
| Cation Exchange Capacity | meq/100g | 20 | 12 | 14 |
| ESP | % | <1 | <1 | <1 |

| Moisture | | | | | | |
|---|---|---|---|---|---|---|
| Our Reference | | 184415-1 | 184415-2 | 184415-3 | 184415-4 | 184415-5 |
| Your Reference | UNITS | 3 | 8 | 9 | 12 | 13 |
| Depth | | 0.05 | 0.05 | 0.1 | 0.01 | 0.01 |
| Date Sampled | | 09/01/2018 | 09/01/2018 | 09/01/2018 | 09/01/2018 | 09/01/2018 |
| Type of sample | | Soil | Soil | Soil | Soil | Soil |
| Date prepared | - | 06/02/2018 | 06/02/2018 | 06/02/2018 | 06/02/2018 | 06/02/2018 |
| Date analysed | - | 07/02/2018 | 07/02/2018 | 07/02/2018 | 07/02/2018 | 07/02/2018 |
| Moisture | % | 20 | 8.9 | 8.8 | 15 | 19 |

| Moisture | | | | |
|---|---|---|---|---|
| Our Reference | | 184415-6 | 184415-7 | 184415-8 |
| Your Reference | UNITS | 17 | 18 | 22 |
| Depth | | 0.05 | 0.01 | 0.05 |
| Date Sampled | | 09/01/2018 | 09/01/2018 | 09/01/2018 |
| Type of sample | | Soil | Soil | Soil |
| Date prepared | - | 06/02/2018 | 06/02/2018 | 06/02/2018 |
| Date analysed | - | 07/02/2018 | 07/02/2018 | 07/02/2018 |
| Moisture | % | 17 | 15 | 7.3 |

| Method ID | Methodology Summary |
|---|---|
| **Ext-054** | Analysed by MPL Envirolab |
| **Ext-062** | Analysed by East West Enviroag |
| **Inorg-001** | pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times. |
| **Inorg-002** | Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons. |
| **Inorg-008** | Moisture content determined by heating at 105+/-5 °C for a minimum of 12 hours. |
| **Metals-009** | Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-AES analytical finish. |
| **Metals-020** | Determination of various metals by ICP-AES. |

| QUALITY CONTROL: Misc Inorg - Soil | | | | | | Duplicate | | | Spike Recovery % | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Description | Units | PQL | Method | Blank | # | Base | Dup. | RPD | LCS-1 | [NT] |
| Date prepared | - | | | 05/02/2018 | 1 | 05/02/2018 | 05/02/2018 | | 05/02/2018 | [NT] |
| Date analysed | - | | | 05/02/2018 | 1 | 05/02/2018 | 05/02/2018 | | 05/02/2018 | [NT] |
| pH 1:5 soil:water | pH Units | | Inorg-001 | [NT] | 1 | 7.2 | 7.1 | 1 | 101 | [NT] |
| Electrical Conductivity 1:5 soil:water | µS/cm | 1 | Inorg-002 | <1 | 1 | 100 | 84 | 17 | 101 | [NT] |
| Emerson Aggregate | - | 0 | Ext-062 | [NT] | 11 | 5.0 | [NT] | | [NT] | [NT] |
| Phosphorus (Colwell) | mg/kg | 1 | Ext-054 | <1 | 1 | 25 | 24 | 4 | 111 | [NT] |
| Phosphorus Buffer Index | mg/kg | 2 | Ext-054 | <2 | 1 | 760 | 780 | 3 | 102 | [NT] |

| QUALITY CONTROL: Misc Inorg - Soil | | | | | | Duplicate | | | Spike Recovery % | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Description | Units | PQL | Method | Blank | # | Base | Dup. | RPD | LCS-2 | [NT] |
| Date prepared | - | | | [NT] | 11 | 05/02/2018 | 05/02/2018 | | 05/02/2018 | [NT] |
| Date analysed | - | | | [NT] | 11 | 05/02/2018 | 05/02/2018 | | 05/02/2018 | [NT] |
| pH 1:5 soil:water | pH Units | | Inorg-001 | [NT] | 11 | 7.1 | 7.1 | 0 | 101 | [NT] |
| Electrical Conductivity 1:5 soil:water | µS/cm | 1 | Inorg-002 | [NT] | 11 | 38 | 34 | 11 | 102 | [NT] |
| Emerson Aggregate | - | 0 | Ext-062 | [NT] | 21 | 3b | [NT] | | [NT] | [NT] |

| QUALITY CONTROL: Misc Inorg - Soil | | | | | | Duplicate | | | Spike Recovery % | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Description | Units | PQL | Method | Blank | # | Base | Dup. | RPD | [NT] | [NT] |
| Date prepared | - | | | [NT] | 21 | 05/02/2018 | 05/02/2018 | | [NT] | [NT] |
| Date analysed | - | | | [NT] | 21 | 05/02/2018 | 05/02/2018 | | [NT] | [NT] |
| pH 1:5 soil:water | pH Units | | Inorg-001 | [NT] | 21 | 8.1 | 8.0 | 1 | [NT] | [NT] |
| Electrical Conductivity 1:5 soil:water | µS/cm | 1 | Inorg-002 | [NT] | 21 | 24 | 24 | 0 | [NT] | [NT] |

| QUALITY CONTROL: Acid Extractable Cations in Soil | | | | | | Duplicate | | | Spike Recovery % | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Description | Units | PQL | Method | Blank | # | Base | Dup. | RPD | LCS-9 | 184415-2 |
| Date prepared | - | | | 06/02/2018 | 1 | 06/02/2018 | 06/02/2018 | | 06/02/2018 | 06/02/2018 |
| Date analysed | - | | | 06/02/2018 | 1 | 06/02/2018 | 06/02/2018 | | 06/02/2018 | 06/02/2018 |
| Calcium | mg/kg | 5 | Metals-020 | <5 | 1 | 3100 | 2800 | 10 | 97 | # |
| Magnesium | mg/kg | 5 | Metals-020 | <5 | 1 | 1900 | 1500 | 24 | 98 | # |

| QUALITY CONTROL: ESP/CEC | | | | | | Duplicate | | | Spike Recovery % | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Description | Units | PQL | Method | Blank | # | Base | Dup. | RPD | LCS-1 | [NT] |
| Date prepared | - | | | 05/02/2018 | 1 | 05/02/2018 | 05/02/2018 | | 05/02/2018 | [NT] |
| Date analysed | - | | | 06/02/2018 | 1 | 06/02/2018 | 06/02/2018 | | 06/02/2018 | [NT] |
| Exchangeable Ca | meq/100g | 0.1 | Metals-009 | <0.1 | 1 | 15 | 15 | 0 | 103 | [NT] |
| Exchangeable K | meq/100g | 0.1 | Metals-009 | <0.1 | 1 | 3.1 | 3.1 | 0 | 109 | [NT] |
| Exchangeable Mg | meq/100g | 0.1 | Metals-009 | <0.1 | 1 | 3.7 | 3.7 | 0 | 103 | [NT] |
| Exchangeable Na | meq/100g | 0.1 | Metals-009 | <0.1 | 1 | <0.1 | <0.1 | 0 | 100 | [NT] |
| ESP | % | 1 | Metals-009 | [NT] | 1 | <1 | <1 | 0 | [NT] | [NT] |

## Result Definitions

| | |
|---|---|
| **NT** | Not tested |
| **NA** | Test not required |
| **INS** | Insufficient sample for this test |
| **PQL** | Practical Quantitation Limit |
| **<** | Less than |
| **>** | Greater than |
| **RPD** | Relative Percent Difference |
| **LCS** | Laboratory Control Sample |
| **NS** | Not specified |
| **NEPM** | National Environmental Protection Measure |
| **NR** | Not Reported |

## Quality Control Definitions

| | |
|---|---|
| **Blank** | This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples. |
| **Duplicate** | This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable. |
| **Matrix Spike** | A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist. |
| **LCS (Laboratory Control Sample)** | This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample. |
| **Surrogate Spike** | Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples. |

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

## Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

## Report Comments

Acid Extractable Metals in Soil: # Percent recovery is not possible to report due to the high concentration of the element/s in the sample/s. However an acceptable recovery was obtained for the LCS.

Colwell Phosphorus & Phosphorus Buffer Index analysed by MPL Laboratories. Report No.206405.

Emerson Aggregate analysed by East West. Report no. EW180592
3b = moderate to slight dispersion of the remould.

**Envirolab Services Pty Ltd**
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# CERTIFICATE OF ANALYSIS 183838

## Client Details

| | |
|---|---|
| **Client** | Douglas Partners Newcastle |
| **Attention** | Michael Gawn |
| **Address** | Box 324 Hunter Region Mail Centre, Newcastle, NSW, 2310 |

## Sample Details

| | |
|---|---|
| **Your Reference** | **91256.00, Wellington** |
| **Number of Samples** | 14 Soil |
| **Date samples received** | 24/01/2018 |
| **Date completed instructions received** | 24/01/2018 |

## Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

**Please refer to the last page of this report for any comments relating to the results.**

## Report Details

| | |
|---|---|
| **Date results requested by** | 01/02/2018 |
| **Date of Issue** | 31/01/2018 |

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**Results Approved By**
Priya Samarawickrama, Senior Chemist

**Authorised By**

David Springer, General Manager

| Misc Inorg - Soil | | | | | | |
|---|---|---|---|---|---|---|
| Our Reference | | 183838-1 | 183838-2 | 183838-3 | 183838-4 | 183838-5 |
| Your Reference | UNITS | 1 | 2 | 4 | 5 | 6 |
| Depth | | 1.3 | 2.0 | 0.2 | 0.4 | 2.0 |
| Date Sampled | | 09/01/2018 | 09/01/2018 | 09/01/2018 | 09/01/2018 | 09/01/2018 |
| Type of sample | | Soil | Soil | Soil | Soil | Soil |
| Date prepared | - | 25/01/2018 | 25/01/2018 | 25/01/2018 | 25/01/2018 | 25/01/2018 |
| Date analysed | - | 25/01/2018 | 25/01/2018 | 25/01/2018 | 25/01/2018 | 25/01/2018 |
| pH 1:5 soil:water | pH Units | 7.5 | 6.9 | 7.0 | 6.8 | 9.2 |
| Electrical Conductivity 1:5 soil:water | µS/cm | 40 | 500 | 30 | 10 | 180 |
| Chloride, Cl 1:5 soil:water | mg/kg | 10 | 570 | 10 | <10 | 80 |
| Sulphate, SO4 1:5 soil:water | mg/kg | <10 | 120 | <10 | <10 | 45 |

| Misc Inorg - Soil | | | | | | |
|---|---|---|---|---|---|---|
| Our Reference | | 183838-6 | 183838-7 | 183838-8 | 183838-9 | 183838-10 |
| Your Reference | UNITS | 8 | 8 | 9 | 11 | 12 |
| Depth | | 0.7 | 2.0 | 0.6 | 1.5 | 1.2 |
| Date Sampled | | 09/01/2018 | 09/01/2018 | 09/01/2018 | 09/01/2018 | 09/01/2018 |
| Type of sample | | Soil | Soil | Soil | Soil | Soil |
| Date prepared | - | 25/01/2018 | 25/01/2018 | 25/01/2018 | 25/01/2018 | 25/01/2018 |
| Date analysed | - | 25/01/2018 | 25/01/2018 | 25/01/2018 | 25/01/2018 | 25/01/2018 |
| pH 1:5 soil:water | pH Units | 7.9 | 9.0 | 8.1 | 8.7 | 8.0 |
| Electrical Conductivity 1:5 soil:water | µS/cm | 23 | 51 | 100 | 72 | 15 |
| Chloride, Cl 1:5 soil:water | mg/kg | <10 | 20 | <10 | <10 | <10 |
| Sulphate, SO4 1:5 soil:water | mg/kg | <10 | <10 | <10 | <10 | <10 |

| Misc Inorg - Soil | | | | | |
|---|---|---|---|---|---|
| Our Reference | | 183838-11 | 183838-12 | 183838-13 | 183838-14 |
| Your Reference | UNITS | 14 | 15 | 18 | 19 |
| Depth | | 0.2 | 1.0 | 1.5 | 2.0 |
| Date Sampled | | 09/01/2018 | 09/01/2018 | 09/01/2018 | 09/01/2018 |
| Type of sample | | Soil | Soil | Soil | Soil |
| Date prepared | - | 25/01/2018 | 25/01/2018 | 25/01/2018 | 25/01/2018 |
| Date analysed | - | 25/01/2018 | 25/01/2018 | 25/01/2018 | 25/01/2018 |
| pH 1:5 soil:water | pH Units | 5.7 | 7.5 | 8.4 | 8.3 |
| Electrical Conductivity 1:5 soil:water | µS/cm | 67 | 77 | 62 | 120 |
| Chloride, Cl 1:5 soil:water | mg/kg | 79 | 21 | <10 | <10 |
| Sulphate, SO4 1:5 soil:water | mg/kg | 22 | 21 | <10 | <10 |

| Method ID | Methodology Summary |
|---|---|
| **Inorg-001** | pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times. |
| **Inorg-002** | Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons. |
| **Inorg-081** | Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Alternatively determined by colourimetry/turbidity using Discrete Analyer. |

| QUALITY CONTROL: Misc Inorg - Soil | | | | | | Duplicate | | | Spike Recovery % | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Description | Units | PQL | Method | Blank | # | Base | Dup. | RPD | LCS-1 | 183838-2 |
| Date prepared | - | | | 25/01/2018 | 1 | 25/01/2018 | 25/01/2018 | | 25/01/2018 | 25/01/2018 |
| Date analysed | - | | | 25/01/2018 | 1 | 25/01/2018 | 25/01/2018 | | 25/01/2018 | 25/01/2018 |
| pH 1:5 soil:water | pH Units | | Inorg-001 | [NT] | 1 | 7.5 | 7.8 | 4 | 102 | [NT] |
| Electrical Conductivity 1:5 soil:water | µS/cm | 1 | Inorg-002 | <1 | 1 | 40 | 38 | 5 | 102 | [NT] |
| Chloride, Cl 1:5 soil:water | mg/kg | 10 | Inorg-081 | <10 | 1 | 10 | 10 | 0 | 109 | # |
| Sulphate, SO4 1:5 soil:water | mg/kg | 10 | Inorg-081 | <10 | 1 | <10 | <10 | 0 | 103 | # |

| QUALITY CONTROL: Misc Inorg - Soil | | | | | | Duplicate | | | Spike Recovery % | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Description | Units | PQL | Method | Blank | # | Base | Dup. | RPD | [NT] | [NT] |
| Date prepared | - | | | [NT] | 11 | 25/01/2018 | 25/01/2018 | | [NT] | [NT] |
| Date analysed | - | | | [NT] | 11 | 25/01/2018 | 25/01/2018 | | [NT] | [NT] |
| pH 1:5 soil:water | pH Units | | Inorg-001 | [NT] | 11 | 5.7 | 5.8 | 2 | [NT] | [NT] |
| Electrical Conductivity 1:5 soil:water | µS/cm | 1 | Inorg-002 | [NT] | 11 | 67 | 66 | 2 | [NT] | [NT] |
| Chloride, Cl 1:5 soil:water | mg/kg | 10 | Inorg-081 | [NT] | 11 | 79 | 63 | 23 | [NT] | [NT] |
| Sulphate, SO4 1:5 soil:water | mg/kg | 10 | Inorg-081 | [NT] | 11 | 22 | 22 | 0 | [NT] | [NT] |

## Result Definitions

| | |
|---|---|
| **NT** | Not tested |
| **NA** | Test not required |
| **INS** | Insufficient sample for this test |
| **PQL** | Practical Quantitation Limit |
| **<** | Less than |
| **>** | Greater than |
| **RPD** | Relative Percent Difference |
| **LCS** | Laboratory Control Sample |
| **NS** | Not specified |
| **NEPM** | National Environmental Protection Measure |
| **NR** | Not Reported |

## Quality Control Definitions

| | |
|---|---|
| **Blank** | This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples. |
| **Duplicate** | This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable. |
| **Matrix Spike** | A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist. |
| **LCS (Laboratory Control Sample)** | This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample. |
| **Surrogate Spike** | Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples. |

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

## Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

## Report Comments

# Percent recovery is not possible to report due to the high concentration of the element/s in the sample/s. However an acceptable recovery was obtained for the LCS.