Douglas PARTNERS

GROUNDED EXPERTISE

Report on Salinity and Sodicity Management Plan

Proposed School Redevelopment

300 Murton Street, Broken Hill NSW

Prepared for School Infrastructure NSW

Project 230601.01

30 May 2025

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Document History

Details

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Revision 0	Natalie McPherson, School Infrastructure NSW

The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

Signature	Date
Author 	30 May 2025
Reviewer 	30 May 2025

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Report on Salinity and Sodicity Management Plan
Proposed School Redevelopment
300 Murton Street, Broken Hill NSW

1. Introduction

This report has been prepared by Douglas Partners (Douglas) on behalf of the Department of Education (the Proponent) to assess the potential environmental impacts that could arise from the redevelopment of Willyama High School at 300 Murton Street, Broken Hill Lot 5858 DP757298 (the site).

This report has been prepared to provide a summary of the results of a geotechnical investigation undertaken by Douglas (relevant to salinity) and to provide a salinity and sodicity management plan for the site.

This report accompanies a Review of Environmental Factors (REF) that seeks approval for the redevelopment of Willyama High School, which involves the following works:

- Construction of new three-storey school buildings along the McGowen Lane frontage, including learning hubs, specialist facilities, an administration and library.
- Construction of a multi-purpose hall with frontage to Murton Street.
- Tree removal.
- Construction of car parking, waste storage and loading area.
- Associated site landscaping and open space improvements.
- Public domain works including kiss and drop zone and service connections.

For a detailed project description, refer to the Review of Environmental Factors (REF) prepared by EPM Projects.

This assessment was commissioned by School Infrastructure NSW (SINSW) and was completed in accordance with Douglas' proposal 230601.01.P.001.Rev1 dated 10 April 2025.

The report includes field work and laboratory results collected as part of a geotechnical investigation for the proposed redevelopment of Willyama High School. Reference should be made to the geotechnical report (ref: 230601.00.R.003.Rev0) for a complete list of details related to borehole test locations and the site's overall subsurface profile. A summary of the field work methods, field work results and laboratory test results relevant to the salinity assessment is summarised in Sections 3. Further comments on the effects and management of saline soils are provided in Sections 4 and 5.

2. Site Description

The site has frontage to Murton Street (200 metres along the south-west), McGowen Lane (400m metres along the south), Radium Street (165 metres along the north-west) and the desert to the north-east and east. The site (Figure 1 and Figure 2) comprises a single allotment, legally described as Lot 5858 in deposited plan (DP) 757298, with an approximate site area of 8.1 ha. The site is in the northeastern part of Broken Hill City, approximately 1.8 km from the city centre and 2.4 km from the Broken Hill railway station.

The existing school grounds are currently occupied by two main three-storey classrooms and school buildings, single-storey buildings and sheds, covered sporting courts, playing fields and grassed areas, hard surface open spaces and car park areas.

The Willyama High School site falls gently eastward from about RL 293 mAHD at the western side of the site to about RL 291 mAHD at the eastern side of site.

Figure 1: Aerial of the site (Nearmap 27 Sept 2024)

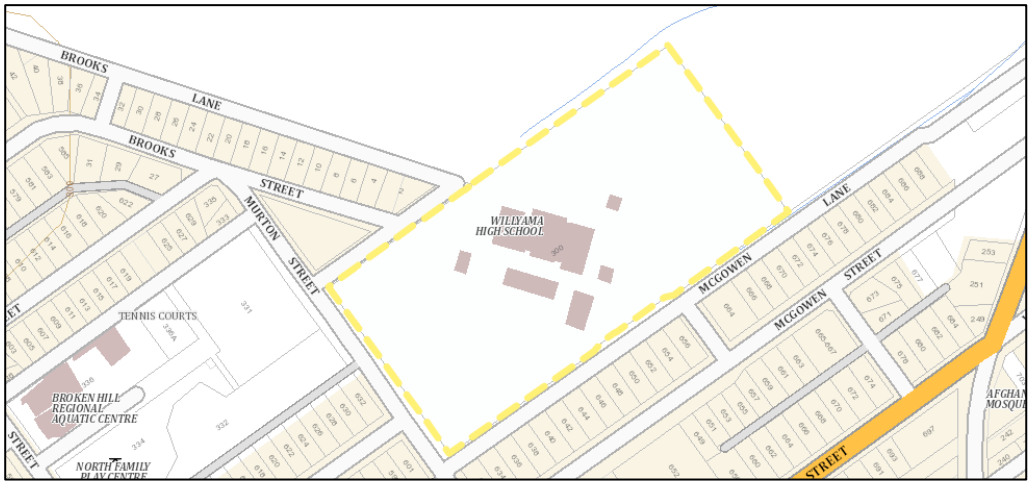

Figure 2: Map of the site (NSW Spatial Viewer)

3. Field Work Summary

3.1 Field Work Methods

Field work included the drilling of twenty-seven (27) boreholes over two separate investigation mobilisations in 2024 and 2025.

The 2024 field investigation was carried out on the 14 August and 15 August 2024 and included: the drilling of sixteen (16) boreholes (identified as BH101 to BH116), to depths of between 0.5 m and 5.6 m using a 9 tonne excavator fitted with a 300 mm pendulum auger. The overall purpose of the assessment included a preliminary assessment for salinity and sodicity.

A supplementary investigation was carried out between 6 May 2025 and 9 May 2025 and included the drilling of an additional eleven (11) boreholes (BH201 to BH211) to depths of between 1.5 m and 10.5 m using a truck-mounted drilling rig. The boreholes were commenced using solid flight augers with Standard Penetration Tests (SPTs) undertaken in soil at regular depth intervals. Five of the boreholes (BH201 to BH205) included NMLC-sized diamond drilling to obtain cores samples of the bedrock for geotechnical logging and strength testing. A detailed assessment of salinity and sodicity was undertaken as part of the 2025 investigation to supplement the preliminary assessment.

3.2 Subsurface Conditions

The general subsurface profile encountered at the test locations may summarised as follows:

FILL (Topsoil Material)	Typically Sandy Silt within the sports field and Clayey Sand in remaining areas of the site, all containing some organics (rootlets). These are inferred to be fill / disturbed soils rather than a naturally occurring topsoil.
FILL	Red-brown Sandy Clay of medium plasticity with fine grained sand and metasediment gravel.
COLLUVIUM (COL)	Typically very stiff red-brown Sandy Clay of medium plasticity with fine grained sand and fine to medium grained metasediment gravel. Of similar appearance to the overlying fill.
RESIDUAL (RS)	Pale grey Sandy Clay of medium plasticity with fine grained sand and fine to medium grained metasediment gravel typically of very stiff consistency.
GNEISS (XWM)	Extremely weathered (XW) material from metasediment bedrock, with soil-like appearance and consistency. Identified as pale grey Sandy Clay and Clay of medium plasticity with fine grained sand, fine to medium grained metasediment gravel and micaceous material of very stiff and hard consistency.
GNEISS	Dark grey and grey (and pink), distinctly foliated gneiss of typically medium to very high strength, highly weathered then moderately to slightly weathered and typically slightly fractured with fractured zones. Some bands of moderate alteration.

Groundwater seepage was observed at a depth of 3.1 m (RL 288.2 m AHD) at BH110 several hours after augering, as well as during augering at location BH205 at 5.3 m depth (RL 285 m AHD). The groundwater observed at these locations is considered to be localised seepage rather than an indicator of a regional groundwater table. The groundwater table is likely to be below the bedrock surface with seepage only expected to occur near the rock surface and through joints and partings within the bedrock.

3.3 Laboratory Testing

Testing was undertaken for the following analytes within each sample:

- Aggressivity – chloride ions, sulphate ions and pH.
- Cation exchange capacity (CEC) – sodium, calcium, magnesium and potassium.
- Exchangeable sodium percentage (ESP) – sodicity and Emerson crumb for dispersion.
- Salinity – electrical conductivity and soil texture classification.

The detailed laboratory test results are presented in Appendix D and are presented as maximum and minimum values in Table 1 together with the number of samples tested for each parameter.

Aggressivity to concrete was determined using pH values and sulphate concentrations and aggressivity to steel was determined using pH values, chloride concentrations and resistivities. The salinity class was inferred from EC_e values using the method of Richards (1954) and sodicity was determined using the cation exchange capacity (CEC) and exchangeable sodium concentration.

Table 1: Summary of Salinity Test Results

Parameter		Unit	Samples	Minimum	Maximum
pH		pH units	39	7.4	9.5
Chlorides		mg/kg	28	20	5600
Sulphates		mg/kg	28	<10	3000
Aggressivity	To Concrete	(AS 2159, 2009)	28	Non-aggressive	Non-aggressive
	To Steel	(AS 2159, 2009)	28	Non-aggressive	Moderately aggressive
Exchangeable Sodium (Na)		meq/100g	21	<0.1	5.1
CEC (cation exchange capacity)		meq/100g	21	12	42
Sodicity [Na/CEC]		ESP%	21	<1	21
Sodicity Class		[after DLWC]	21	Non-Sodic	Highly Sodic
$EC_{1:5}$		dS/m	37	0.1	10

Parameter	Unit	Samples	Minimum	Maximum
EC_e [M x $EC_{1:5}$][1]	(dS/m)	37	<2	92
Salinity Class	[after Richards 1954]	37	Non-Saline	Highly Saline

The results indicate that the samples collected from the site are predominantly:

- Mildly alkaline to very strongly alkaline (Bruce & Rayment, 1982);
- Non-aggressive to buried concrete AS 2159 (2009);
- Moderately aggressive to buried steel (AS 2159 (2009) mainly due to apparent soil resistivity);
- Very to highly saline (effectively across the entire site); and,
- Non-sodic to sodic, with localised zones of high sodicity.

4. Effects of Site Materials on the Proposed Development

The presence of very to highly saline materials, and the sodic soils are naturally occurring features of the local landscape and are not considered significant impediments to the proposed development, provided appropriate management techniques are adopted.

Salinity and aggressivity affect the durability of concrete and steel by causing premature breakdown of concrete and corrosion of steel and hence impacts the longevity of structures in contact with these materials. As a result, management will be required (refer to Section 5).

Sodic soils have a low permeability due to the infilling of interstices with fine clay particles during the weathering process, restricting infiltration of surface water and potentially creating perched water tables, seepage in cut faces, or ponding of water in flat open areas. In addition, sodic soils tend to erode when exposed. Management of sodic soils is therefore required to prevent these adverse effects.

5. Salinity and Sodicity Management Plan

The following management strategies are confined to the management of those factors with the potential to impact the development.

- Management should focus on the capping of the upper surface of the sodic soils, both exposed by excavation and placed as filling, with a more permeable material to prevent ponding, reduce capillary rise, act as a drainage layer and reduce the potential for erosion.
- When possible, place excavated materials in fill areas with similar salinity characteristics (i.e. place material onto in-situ soils with a similar or higher aggressivity or salinity classification). With respect to imported fill, testing should be undertaken prior to importation to determine the salinity characteristics of the soil, which should be restricted to non-aggressive and non-saline to slightly saline soils.
- Sodic soils can also be managed by maintaining vegetation where possible and planting new salt tolerant species. The addition of organic matter, gypsum and lime can also be

considered where appropriate (i.e. within landscaped areas). After gypsum addition, reduction of sodicity levels may require some time for sufficient infiltration and leaching of sodium soils into the subsoils, however, capping of exposed sodic soil should remain the primary management method. Topsoil added at the completion of bulk earthworks is, in effect, also adding organic matter which may help infiltration and leaching of sodium.

- Avoid water collecting in low lying areas, in depressions, or behind fill. This can lead to water logging of the soils, evaporation and the concentration of salts, and the eventual breakdown in soil structure resulting in accelerated erosion.
- Pavements should be designed to be well drained of surface water. There should not be excessive concentrations of runoff or ponding that would lead to waterlogging of the pavement or additional recharge to the groundwater through any more permeable zones in the underlying fill.
- Surface drains should generally be provided along the top of batter slopes to reduce the potential for concentrated flows of water down slopes possibly causing scour.
- Salt tolerant grasses and trees should be considered for landscaping, to reduce soil erosion and to maintain the existing evapotranspiration and groundwater levels. Reference should be made to an experienced landscape planner or agronomist.

The following additional strategies are recommended for the completion of services installation including, but not limited to, roads, drainage and services. These strategies should be complementary to standard good building practices recommended within the Building Code of Australia, including cover to reinforcement within concrete.

- For soils that are non-aggressive to concrete, piles should have a minimum strength of 25 MPa (or 32 MPa for reinforced piles) and a minimum cover to reinforcement of 45 mm (for cast in place piles with a 50 year design life) to limit the corrosive effects of the surrounding materials (in accordance with AS 2159 (2009)).
- With regard to concrete structures in highly saline soils (with salinities of >16 dS/m) an exposure classification of B2 should be adopted, in which case slabs and foundations should have a minimum strength of 40 MPa, a minimum cover to reinforcement of 55 mm from unprotected ground, and should be allowed to cure for a minimum of three days (as per AS3600 (2018)) to limit the corrosive effects of the surrounding soils.
- Wet cast concrete pipes and currently manufactured spun concrete pipes are understood to have estimated compressive strengths of 50 MPa and 60 MPa to 70 MPa, respectively, in excess of the requirements for mass concrete, as above.

  Reference to the maximum and minimum test results of Table 1: Summary of Salinity Test Results (in Section 3.3 above), and to Tables E1 and 3.1 of AS4058 (2007) 'Precast concrete pipes' indicates that the site falls within the AS 4058 Clay/Stagnant (high sulphate) soil type (where chlorides <= 20,000 ppm, pH >= 4.5, and sulphates < 10,000 ppm) and (in the absence of tidal water flow) falls within the AS4058 Normal durability environment. Under these conditions, AS4058 compliant reinforced concrete pipes using sulphate resistant (SR) type Portland cement, with a minimum cover to reinforcement of 10 mm, are expected to have a design life in excess of 100 years.

  Hence, any concrete pipes installed within the site should employ AS4058 (2007)compliant steel reinforced pipes of sulphate resistant (SR) Portland cement, with minimum cover to reinforcement of 10 mm, or should be fibre reinforced.

- For soils that are moderately aggressive to steel (<1000 Ohm-cm) a corrosion allowance (as per AS2159 – (2009) of 0.02 – 0.04 mm/year should be taken into account by the designer. In instances where a corrosion protection coating is applied, if the design life of the structure is greater than the design life of the coating, consideration must be given to the corrosion of the structure in accordance with the above allowance.

6. References

AS 2159. (2009). *Piling - Design and Installation.* Standards Australia.

AS 3600. (2018). *Concrete Structures.* including Amendment 1:2018 and Amendment 2:2021: Standard Australia.

AS 4058. (2007). *Precast Concrete Pipe (Pressure and Non-Pressure).* Australian Standard.

Bruce, R. C., & Rayment, G. E. (1982). *Analytical Methods and Interpretations Used by the Agricultural Chemistry Branch for Soil and Land Use Surveys.* Indooroopilly: Queensland Department of Primary Industries.

Richards, L. A. (1954). *Diagnosis of Saline and Alkaline Soils.* Washington D.C: US Department of Agriculture.

7. Limitations

Douglas Partners Pty Ltd (Douglas) has prepared this report for this project at 300 Murton Street, Broken Hill NSW in line with Douglas' proposal dated 10 April 2025. The work was carried out under Standing Offer Deed DDWO06377/24 (dated July 2024). This report is provided for the exclusive use of School Infrastructure NSW for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of Douglas, does so entirely at its own risk and without recourse to Douglas for any loss or damage. In preparing this report Douglas has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after Douglas' field testing has been completed.

Douglas' advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by Douglas in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

The assessment of atypical safety hazards arising from this advice is restricted to the geotechnical components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. Douglas cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by Douglas. This is because this report has been written as advice and opinion rather than instructions for construction.

The scope of work for this investigation/report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of fill of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such fill may contain contaminants and hazardous building materials.

Appendix A

About this Report

About this Report

November 2023

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

continued next page

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

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Appendix B

Drawings

REV	DESCRIPTION/COMMENT	DATE	DRAWN BY
0	INITIAL ISSUE	30.05.2025	EC

SCALE: 0 20 40 60 80 m
1:1800 @ A3

Douglas PARTNERS
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CLIENT: **School Infrastructure NSW**

NOTE:
1: Basemap from Metromap (Dated 30.07.2024)

COORDINATE REFERENCE SYSTEM: GDA2020 / MGA zone 54

PROJECT NAME: **Proposed School Redevelopment**

PROJECT ADDRESS: **300 Murton Street, Broken Hill**

DRAWING TITLE: **Test Location Plan**

PROJECT NO: **230601.01**

DRAWING NO: **1**

REVISION: **0**

Appendix C

Summary of Laboratory Results

Table 2: Summary of aggressivity test results

Sample ID	Depth (m)	Sample Type	Soil Type	Exposure Classification				
				Concrete		Steel		
				pH	SO_4 (ppm)	pH	Cl (ppm)	Resistivity. (Ωcm)
BH102	0.5-0.6	FILL / Sandy Clay	B	7.9	56	7.9	64	5260
BH102	2.0-2.1	COL / Sandy Clay	B	9.2	78	9.2	20	3850
BH107	0.5-0.6	FILL / Sandy Clay	B	9.3	26	9.3	54	4350
BH107	2.0-2.1	RS / Sandy Clay	B	8.5	2,600	8.5	2,100	420
BH110	0.5-0.6	FILL / Sandy Clay	B	8.4	40	8.4	45	4550
BH111	1.0-1.1	COL / Sandy Clay	B	8.8	1,100	8.8	1,700	590
BH112	1.1-1.1	FILL / Sandy Clay	B	8.4	110	8.4	190	2500
BH201	0.5	FILL / Clay w/ sand	B	8.3	220	8.3	1100	909
BH201	1.0	RS / Clay w/ gravel	B	8.7	400	8.7	930	909
BH203	0.5	COL / Sandy Clay	B	8.2	490	8.2	5600	217
BH203	1.0	COL / Sandy Clay	B	8.3	1400	8.3	4300	244
BH203	2.0	RS->XWM / Sandy Clay	B	8.6	1200	8.6	1600	526
BH204	1.0	COL / Clay w/ sand	B	8.5	1400	8.5	1300	526
BH204	3.5	XWM / Clay w/ sand	B	8.8	1700	8.8	1200	526
BH204	6.5	XWM / Clay w/ sand	B	9.2	180	9.2	320	2273
BH205	1.0	FILL / Clay w/ sand	B	8.3	3000	8.3	3700	227
BH205	2.0	COL / Clay w/sand	B	8.4	1900	8.4	2200	357
BH205	3.5	COL / Clay w/sand	B	8.6	1800	8.6	1500	435
BH205	5.0	XWM / Sandy Clay	B	9.5	160	9.5	180	3125
BH208	1.0	FILL / Clay	B	8.4	2100	8.4	1500	417
BH208	3.5	XWM / Sandy Clay	B	8.8	490	8.8	700	1000
BH209	0.5	FILL / Clay w/ sand	B	8.3	<10	8.3	20	5556
BH209	1.0	FILL / Clay w/ sand	B	8.7	41	8.7	47	5263
BH210	0.5	COL / Clay w/ sand	B	8.4	1200	8.4	2100	400
BH210	1.0	COL / Clay w/ sand	B	8.6	1500	8.6	1500	455

Sample ID	Depth (m)	Sample Type	Soil Type	Exposure Classification				
				Concrete		Steel		
				pH	SO_4 (ppm)	pH	Cl (ppm)	Resistivity. (Ωcm)
BH211	0.5	COL / Clay w/ gravel	B	8.3	1200	8.3	4800	222
BH211	1.0	COL / Clay w/ gravel	B	8.3	1900	8.3	3700	256
BH211	2.0	COL / Clay w/ gravel	B	8.5	1600	8.5	3000	294

Notes: Soil Type based on guideline presented in AS 2159-2009 and summarise below:
Soil Type A – High permeability soils (eg sands and gravels) which are in groundwater.
Soil Type B – Low permeability soils (eg silts and clays) or all soils above groundwater.
Scale of aggressivity based on threshold values given in AS 2159-2019

Non-aggressive	Mild	Moderate	Severe	Very Severe

Table 3: Summary of salinity test results

Sample ID	Depth (m)	Sample Type	Soil Texture	EC (µS/cm)	ECe (dS/m)	Classification
BH102	0.5-0.6	FILL / Sandy Clay	Clay Loam	160	<2	Non-Saline
BH102	2.0-2.1	COL / Sandy Clay	Medium Clay	260	<2	Non-Saline
BH107	0.5-0.6	FILL / Sandy Clay	Clay Loam	230	2	Slightly Saline
BH107	2.0-2.1	RS / Sandy Clay	Medium Clay	2,400	17	Highly Saline
BH111	1.0-1.1	COL / Sandy Clay	Medium Clay	1,700	12	Very Saline
BH116	1.0-1.1	COL / Sandy Clay	Medium Clay	270	<2	Non-Saline
BH201	0.5	FILL / Clay w/ sand	Clay Loam	1100	10	Very Saline
BH201	1	RS / Clay w/ gravel	Clay Loam	1100	9.8	Very Saline
BH202	0.2	FILL / Clay w/ sand	Clay Loam	310	2.8	Slightly Saline
BH202	0.5	FILL / Clay w/ sand	Clay Loam	210	<2	Non Saline
BH202	1	RS / Clay w/ sand	Clay Loam	330	3.0	Slightly Saline
BH203	0.5	COL / Sandy Clay	Medium Clay	4600	32	Highly Saline
BH203	1	COL / Sandy Clay	Medium Clay	4100	29	Highly Saline
BH203	2	XWM / Sandy Clay	Clay Loam	1900	18	Highly Saline
BH204	1	COL / Clay w/ sand	Clay Loam	1900	17	Highly Saline
BH204	3.5	XWM / Clay w/ sand	Clay Loam	1900	17	Highly Saline
BH204	6.5	XWM / Clay w/ sand	Sandy Loam	440	6.2	Moderately Saline

Sample ID	Depth (m)	Sample Type	Soil Texture	EC (µS/cm)	ECe (dS/m)	Classification
BH205	1	FILL / Clay w/ sand	Medium Clay	4400	30	Highly Saline
BH205	2	COL / Clay w/sand	Medium Clay	2800	20	Highly Saline
BH205	3.5	COL / Clay w/sand	Medium Clay	2300	16	Highly Saline
BH205	5	XWM / Sandy Clay	Sandy Loam	320	4.5	Moderately Saline
BH206	0.5	FILL / Sandy Clay	Medium Clay	2900	20	Highly Saline
BH207	0.2	FILL / Sandy Clay	Clay Loam	3000	27	Highly Saline
BH207	0.5	FILL / Sandy Clay	Light Medium Clay	2400	19	Highly Saline
BH208	0.2	TOP / Sandy Clay	Clay Loam	320	2.9	Slightly Saline
BH208	0.5	FILL / Clay w/ sand	Clay Loam	230	2.0	Slightly Saline
BH209	0.2	TOP / Sandy Clay	Clay Loam	420	3.8	Slightly Saline
BH209	0.5	FILL / Clay w/ sand	Clay Loam	180	<2	Non Saline
BH209	1	FILL / Clay w/ sand	Clay Loam	190	<2	Non Saline
BH210	0.2	TOP / Sandy Clay	Clay Loam	97	<2	Non Saline
BH210	0.5	COL / Clay w/ sand	Medium Clay	2500	17	Highly Saline
BH210	1	COL / Clay w/ sand	Medium Clay	2200	15	Very Saline
BH210	2	COL / Clay w/ gravel	Medium Clay	3300	23	Highly Saline
BH211	0.2	TOP / Gravelly CLAY	Clay Loam	10000	92	Highly Saline
BH211	0.5	COL / Clay w/ sand	Clay Loam	4500	40	Highly Saline
BH211	1	COL / Clay w/ sand	Medium Clay	3900	28	Highly Saline
BH211	2	COL / Clay w/ gravel	Medium Clay	3400	24	Highly Saline

Notes: Classification for salinity based on Richards (1954):

Table 4: Summary of sodicity test results

Sample ID	Depth (m)	Sample Type	Emerson Class No.	ESP (%)	Classification
BH102	0.5-0.6	FILL / Sandy Clay	-	<1	Non-sodic
BH107	0.5-0.6	FILL / Sandy Clay	-	5	Sodic
BH111	1.0-1.1	COL / Sandy Clay	-	19	Highly Sodic
BH201	0.2	FILL / Sandy Clay	4.0	<1	Non-sodic

BH201	0.5	FILL / Clay w/ sand	6.0	4	Non-sodic
BH202	0.2	FILL / Clay w/ sand	7.0	<1	Non-sodic
BH202	0.5	FILL / Clay w/ sand	2.0	4	Non-sodic
BH203	0.5	COL / Sandy Clay	4.0	5	Sodic
BH203	1	COL / Sandy Clay	4.0	4	Non-sodic
BH204	1	COL / Clay w/ sand	4.0	8	Sodic
BH206	0.5	FILL / Sandy Clay	4.0	13	Sodic
BH207	0.2	FILL / Sandy Clay	4.0	2	Non-sodic
BH207	0.5	FILL / Sandy Clay	2.0	9	Sodic
BH208	0.2	TOP / Sandy Clay	5.0	<1	Non-sodic
BH208	0.5	FILL / Clay w/ sand	4.0	<1	Non-sodic
BH209	0.2	TOP / Sandy Clay	4.0	<1	Non-sodic
BH209	0.5	FILL / Clay w/ sand	5.0	<1	Non-sodic
BH210	0.2	TOP / Sandy Clay	4.0	<1	Non-sodic
BH210	0.5	COL / Clay w/ sand	6.0	21	Highly Sodic
BH211	0.2	TOP / Gravelly CLAY	4.0	<1	Non-sodic
BH211	0.5	COL / Clay w/ sand	4.0	4	Non-sodic

Notes: Classification for sodicity based on DLWC (2002)

Appendix D

Laboratory Results

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CERTIFICATE OF ANALYSIS 380719

Client Details

Client	Douglas Partners Pty Ltd
Attention	Matthew Bobby
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**230601.01, Broken Hill**
Number of Samples	41 Soil
Date samples received	13/05/2025
Date completed instructions received	15/05/2025

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	20/05/2025
Date of Issue	23/05/2025

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Results Approved By
Diego Bigolin, Inorganics Supervisor
Jenny He, Inorganic Team Leader
Loren Bardwell, Development Chemist
Stuart Chen, Asbestos Approved Identifier/Report coordinator

Authorised By
Nancy Zhang, Laboratory Manager

Misc Inorg - Soil						
Our Reference		380719-1	380719-2	380719-3	380719-4	380719-5
Your Reference	UNITS	BH201	BH201	BH201	BH202	BH202
Depth		0.2	0.5	1	0.2	0.5
Date Sampled		08/05/2025	08/05/2025	08/05/2025	08/05/2025	08/05/2025
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
Date analysed	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
pH 1:5 soil:water	pH Units	[NA]	8.3	8.7	7.4	8.4
Chloride, Cl 1:5 soil:water	mg/kg	[NA]	1,100	930	[NA]	[NA]
Sulphate, SO4 1:5 soil:water	mg/kg	[NA]	220	400	[NA]	[NA]
Emerson Class No.	-	4.0	6.0	[NA]	7.0	2.0

Misc Inorg - Soil						
Our Reference		380719-6	380719-7	380719-8	380719-9	380719-11
Your Reference	UNITS	BH202	BH203	BH203	BH203	BH204
Depth		1	0.5	1	2	1
Date Sampled		08/05/2025	08/05/2025	08/05/2025	08/05/2025	08/05/2025
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
Date analysed	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
pH 1:5 soil:water	pH Units	9.1	8.2	8.3	8.6	8.5
Chloride, Cl 1:5 soil:water	mg/kg	[NA]	5,600	4,300	1,600	1,300
Sulphate, SO4 1:5 soil:water	mg/kg	[NA]	490	1,400	1,200	1,400
Emerson Class No.	-	[NA]	4.0	4.0	[NA]	4.0

Misc Inorg - Soil						
Our Reference		380719-13	380719-14	380719-16	380719-17	380719-18
Your Reference	UNITS	BH204	BH204	BH205	BH205	BH205
Depth		3.5	6.5	1	2	3.5
Date Sampled		08/05/2025	08/05/2025	07/05/2025	07/05/2025	07/05/2025
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
Date analysed	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
pH 1:5 soil:water	pH Units	8.8	9.2	8.3	8.4	8.6
Chloride, Cl 1:5 soil:water	mg/kg	1,200	320	3,700	2,200	1,500
Sulphate, SO4 1:5 soil:water	mg/kg	1,700	180	3,000	1,900	1,800

Misc Inorg - Soil						
Our Reference		380719-19	380719-20	380719-22	380719-23	380719-24
Your Reference	UNITS	BH205	BH206	BH207	BH207	BH208
Depth		5	0.5	0.2	0.5	0.2
Date Sampled		07/05/2025	07/05/2025	07/05/2025	07/05/2025	07/05/2025
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
Date analysed	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
pH 1:5 soil:water	pH Units	9.5	8.5	8.3	8.6	7.8
Chloride, Cl 1:5 soil:water	mg/kg	180	[NA]	[NA]	[NA]	[NA]
Sulphate, SO4 1:5 soil:water	mg/kg	160	[NA]	[NA]	[NA]	[NA]
Emerson Class No.	-	[NA]	4.0	4.0	2.0	5.0

Misc Inorg - Soil						
Our Reference		380719-25	380719-26	380719-28	380719-29	380719-30
Your Reference	UNITS	BH208	BH208	BH208	BH209	BH209
Depth		0.5	1	3.5	0.2	0.5
Date Sampled		07/05/2025	07/05/2025	07/05/2025	07/05/2025	07/05/2025
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
Date analysed	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
pH 1:5 soil:water	pH Units	8.6	8.4	8.8	7.9	8.3
Chloride, Cl 1:5 soil:water	mg/kg	[NA]	1,500	700	[NA]	20
Sulphate, SO4 1:5 soil:water	mg/kg	[NA]	2,100	490	[NA]	<10
Emerson Class No.	-	4.0	[NA]	[NA]	4.0	5.0

Misc Inorg - Soil						
Our Reference		380719-31	380719-33	380719-34	380719-35	380719-38
Your Reference	UNITS	BH209	BH210	BH210	BH210	BH211
Depth		1	0.2	0.5	1	0.2
Date Sampled		07/05/2025	07/05/2025	07/05/2025	07/05/2025	07/05/2025
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
Date analysed	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
pH 1:5 soil:water	pH Units	8.7	8.8	8.4	8.6	8.2
Chloride, Cl 1:5 soil:water	mg/kg	47	[NA]	2,100	1,500	[NA]
Sulphate, SO4 1:5 soil:water	mg/kg	41	[NA]	1,200	1,500	[NA]
Emerson Class No.	-	[NA]	4.0	6.0	[NA]	4.0

Misc Inorg - Soil				
Our Reference		380719-39	380719-40	380719-41
Your Reference	UNITS	BH211	BH211	BH211
Depth		0.5	1	2
Date Sampled		07/05/2025	07/05/2025	07/05/2025
Type of sample		Soil	Soil	Soil
Date prepared	-	19/05/2025	19/05/2025	19/05/2025
Date analysed	-	19/05/2025	19/05/2025	19/05/2025
pH 1:5 soil:water	pH Units	8.3	8.3	8.5
Chloride, Cl 1:5 soil:water	mg/kg	4,800	3,700	3,000
Sulphate, SO4 1:5 soil:water	mg/kg	1,200	1,900	1,600
Emerson Class No.	-	4.0	[NA]	[NA]

Texture and Salinity*						
Our Reference		380719-2	380719-3	380719-4	380719-5	380719-6
Your Reference	UNITS	BH201	BH201	BH202	BH202	BH202
Depth		0.5	1	0.2	0.5	1
Date Sampled		08/05/2025	08/05/2025	08/05/2025	08/05/2025	08/05/2025
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
Date analysed	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
Electrical Conductivity 1:5 soil:water	µS/cm	1,100	1,100	310	210	330
Texture Value	-	9.0	9.0	9.0	9.0	9.0
Texture	-	CLAY LOAM	CLAY LOAM	CLAY LOAM	CLAY LOAM	CLAY LOAM
ECe	dS/m	10	9.8	2.8	<2	3.0
Class	-	VERY SALINE	VERY SALINE	SLIGHTLY SALINE	NON SALINE	SLIGHTLY SALINE

Texture and Salinity*						
Our Reference		380719-7	380719-8	380719-9	380719-11	380719-13
Your Reference	UNITS	BH203	BH203	BH203	BH204	BH204
Depth		0.5	1	2	1	3.5
Date Sampled		08/05/2025	08/05/2025	08/05/2025	08/05/2025	08/05/2025
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
Date analysed	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
Electrical Conductivity 1:5 soil:water	µS/cm	4,600	4,100	1,900	1,900	1,900
Texture Value	-	7.0	7.0	9.0	9.0	9.0
Texture	-	MEDIUM CLAY	MEDIUM CLAY	CLAY LOAM	CLAY LOAM	CLAY LOAM
ECe	dS/m	32	29	18	17	17
Class	-	HIGHLY SALINE	HIGHLY SALINE	HIGHLY SALINE	HIGHLY SALINE	HIGHLY SALINE

Texture and Salinity*						
Our Reference		380719-14	380719-16	380719-17	380719-18	380719-19
Your Reference	UNITS	BH204	BH205	BH205	BH205	BH205
Depth		6.5	1	2	3.5	5
Date Sampled		08/05/2025	07/05/2025	07/05/2025	07/05/2025	07/05/2025
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
Date analysed	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
Electrical Conductivity 1:5 soil:water	µS/cm	440	4,400	2,800	2,300	320
Texture Value	-	14	7.0	7.0	7.0	14
Texture	-	SANDY LOAM	MEDIUM CLAY	MEDIUM CLAY	MEDIUM CLAY	SANDY LOAM
ECe	dS/m	6.2	30	20	16	4.5
Class	-	MODERATELY SALINE	HIGHLY SALINE	HIGHLY SALINE	HIGHLY SALINE	MODERATELY SALINE

Texture and Salinity*						
Our Reference		380719-20	380719-22	380719-23	380719-24	380719-25
Your Reference	UNITS	BH206	BH207	BH207	BH208	BH208
Depth		0.5	0.2	0.5	0.2	0.5
Date Sampled		07/05/2025	07/05/2025	07/05/2025	07/05/2025	07/05/2025
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
Date analysed	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
Electrical Conductivity 1:5 soil:water	µS/cm	2,900	3,000	2,400	320	230
Texture Value	-	7.0	9.0	8.0	9.0	9.0
Texture	-	MEDIUM CLAY	CLAY LOAM	LIGHT MEDIUM CLAY	CLAY LOAM	CLAY LOAM
ECe	dS/m	20	27	19	2.9	2.0
Class	-	HIGHLY SALINE	HIGHLY SALINE	HIGHLY SALINE	SLIGHTLY SALINE	SLIGHTLY SALINE

Texture and Salinity*						
Our Reference		380719-26	380719-28	380719-29	380719-30	380719-31
Your Reference	UNITS	BH208	BH208	BH209	BH209	BH209
Depth		1	3.5	0.2	0.5	1
Date Sampled		07/05/2025	07/05/2025	07/05/2025	07/05/2025	07/05/2025
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
Date analysed	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
Electrical Conductivity 1:5 soil:water	µS/cm	2,400	1,000	420	180	190
Texture Value	-	[NA]	[NA]	9.0	9.0	9.0
Texture	-	[NA]	[NA]	CLAY LOAM	CLAY LOAM	CLAY LOAM
ECe	dS/m	[NA]	[NA]	3.8	<2	<2
Class	-	[NA]	[NA]	SLIGHTLY SALINE	NON SALINE	NON SALINE

Texture and Salinity*						
Our Reference		380719-33	380719-34	380719-35	380719-36	380719-38
Your Reference	UNITS	BH210	BH210	BH210	BH210	BH211
Depth		0.2	0.5	1	2	0.2
Date Sampled		07/05/2025	07/05/2025	07/05/2025	07/05/2025	07/05/2025
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
Date analysed	-	19/05/2025	19/05/2025	19/05/2025	19/05/2025	19/05/2025
Electrical Conductivity 1:5 soil:water	µS/cm	97	2,500	2,200	3,300	10,000
Texture Value	-	9.0	7.0	7.0	7.0	9.0
Texture	-	CLAY LOAM	MEDIUM CLAY	MEDIUM CLAY	MEDIUM CLAY	CLAY LOAM
ECe	dS/m	<2	17	15	23	92
Class	-	NON SALINE	HIGHLY SALINE	VERY SALINE	HIGHLY SALINE	HIGHLY SALINE

Texture and Salinity*				
Our Reference		380719-39	380719-40	380719-41
Your Reference	UNITS	BH211	BH211	BH211
Depth		0.5	1	2
Date Sampled		07/05/2025	07/05/2025	07/05/2025
Type of sample		Soil	Soil	Soil
Date prepared	-	19/05/2025	19/05/2025	19/05/2025
Date analysed	-	19/05/2025	19/05/2025	19/05/2025
Electrical Conductivity 1:5 soil:water	µS/cm	4,500	3,900	3,400
Texture Value	-	9.0	7.0	7.0
Texture	-	CLAY LOAM	MEDIUM CLAY	MEDIUM CLAY
ECe	dS/m	40	28	24
Class	-	HIGHLY SALINE	HIGHLY SALINE	HIGHLY SALINE

ESP/CEC						
Our Reference		380719-1	380719-2	380719-4	380719-5	380719-7
Your Reference	UNITS	BH201	BH201	BH202	BH202	BH203
Depth		0.2	0.5	0.2	0.5	0.5
Date Sampled		08/05/2025	08/05/2025	08/05/2025	08/05/2025	08/05/2025
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	20/05/2025	20/05/2025	20/05/2025	20/05/2025	20/05/2025
Date analysed	-	20/05/2025	20/05/2025	20/05/2025	20/05/2025	20/05/2025
Exchangeable Ca	meq/100g	25	19	7.5	9.9	29
Exchangeable K	meq/100g	0.7	1.7	1.4	1.9	1.0
Exchangeable Mg	meq/100g	1.9	8.6	3.0	5.9	7.3
Exchangeable Na	meq/100g	<0.1	1.3	<0.1	0.7	2.1
Cation Exchange Capacity	meq/100g	28	30	12	18	40
ESP	%	<1	4	<1	4	5

ESP/CEC						
Our Reference		380719-8	380719-11	380719-20	380719-22	380719-23
Your Reference	UNITS	BH203	BH204	BH206	BH207	BH207
Depth		1	1	0.5	0.2	0.5
Date Sampled		08/05/2025	08/05/2025	07/05/2025	07/05/2025	07/05/2025
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	20/05/2025	20/05/2025	20/05/2025	20/05/2025	20/05/2025
Date analysed	-	20/05/2025	20/05/2025	20/05/2025	20/05/2025	20/05/2025
Exchangeable Ca	meq/100g	32	16	16	30	28
Exchangeable K	meq/100g	0.7	1	1.1	0.6	1.0
Exchangeable Mg	meq/100g	7.5	5.9	8.0	2.7	6.9
Exchangeable Na	meq/100g	1.6	2.1	3.7	0.7	3.7
Cation Exchange Capacity	meq/100g	42	25	29	34	40
ESP	%	4	8	13	2	9

ESP/CEC						
Our Reference		380719-24	380719-25	380719-29	380719-30	380719-33
Your Reference	UNITS	BH208	BH208	BH209	BH209	BH210
Depth		0.2	0.5	0.2	0.5	0.2
Date Sampled		07/05/2025	07/05/2025	07/05/2025	07/05/2025	07/05/2025
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	20/05/2025	20/05/2025	20/05/2025	20/05/2025	20/05/2025
Date analysed	-	20/05/2025	20/05/2025	20/05/2025	20/05/2025	20/05/2025
Exchangeable Ca	meq/100g	16	20	27	12	23
Exchangeable K	meq/100g	1.2	1.3	1	1.7	0.5
Exchangeable Mg	meq/100g	3.5	3.9	2.6	3.3	1.3
Exchangeable Na	meq/100g	<0.1	0.1	<0.1	0.1	<0.1
Cation Exchange Capacity	meq/100g	20	25	31	17	25
ESP	%	<1	<1	<1	<1	<1

ESP/CEC				
Our Reference		380719-34	380719-38	380719-39
Your Reference	UNITS	BH210	BH211	BH211
Depth		0.5	0.2	0.5
Date Sampled		07/05/2025	07/05/2025	07/05/2025
Type of sample		Soil	Soil	Soil
Date prepared	-	20/05/2025	20/05/2025	20/05/2025
Date analysed	-	20/05/2025	20/05/2025	20/05/2025
Exchangeable Ca	meq/100g	11	33	27
Exchangeable K	meq/100g	1.4	0.4	0.7
Exchangeable Mg	meq/100g	7.3	2.2	4.6
Exchangeable Na	meq/100g	5.1	0.2	1.2
Cation Exchange Capacity	meq/100g	24	36	33
ESP	%	21	<1	4

Acid Sulphate Soil Suite						
Our Reference		380719-2	380719-3	380719-8	380719-9	380719-15
Your Reference	UNITS	BH201	BH201	BH203	BH203	BH205
Depth		0.5	1	1	2	0.5
Date Sampled		08/05/2025	08/05/2025	08/05/2025	08/05/2025	07/05/2025
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	15/05/2025	15/05/2025	15/05/2025	15/05/2025	15/05/2025
Date analysed	-	16/05/2025	16/05/2025	16/05/2025	16/05/2025	16/05/2025
pH $_{kcl}$	pH units	8.4	9.0	8.7	9.1	8.4
s-TAA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
TAA pH 6.5	moles H^+ /t	<5	<5	<5	<5	<5
a-Chromium Reducible Sulfur	moles H^+ /t	5	<3	5	5	5
Chromium Reducible Sulfur	%w/w	0.008	<0.005	0.008	0.008	0.008
S_{KCl}	%w/w S	[NT]	[NT]	[NT]	[NT]	[NT]
S_{HCl}	%w/w S	[NT]	[NT]	[NT]	[NT]	[NT]
S_{NAS}	%w/w S	[NT]	[NT]	[NT]	[NT]	[NT]
ANC_{BT}	% $CaCO_3$	3.6	3.1	9.6	3.7	3.0
s-ANC_{BT}	%w/w S	1.1	0.99	3.1	1.2	0.94
s-Net Acidity excluding ANC	%w/w S	0.0080	<0.005	0.0080	0.0080	0.0080
a-Net Acidity excluding ANC	moles H^+ /t	5.0	<5	5.0	5.0	5.0
Liming rate excluding ANC	kg $CaCO_3$ /t	<0.75	<0.75	<0.75	<0.75	<0.75
s-Net Acidity including ANC	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
a-Net Acidity including ANC	moles H^+ /t	<5	<5	<5	<5	<5
Liming rate including ANC	kg $CaCO_3$ /t	<0.75	<0.75	<0.75	<0.75	<0.75

Acid Sulphate Soil Suite						
Our Reference		380719-17	380719-18	380719-19	380719-34	380719-35
Your Reference	UNITS	BH205	BH205	BH205	BH210	BH210
Depth		2	3.5	5	0.5	1
Date Sampled		07/05/2025	07/05/2025	07/05/2025	07/05/2025	07/05/2025
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	15/05/2025	15/05/2025	15/05/2025	15/05/2025	15/05/2025
Date analysed	-	16/05/2025	16/05/2025	16/05/2025	16/05/2025	16/05/2025
pH $_{kcl}$	pH units	8.8	8.9	8.1	8.1	8.7
s-TAA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
TAA pH 6.5	moles H^+ /t	<5	<5	<5	<5	<5
a-Chromium Reducible Sulfur	moles H^+ /t	<3	5	5	5	5
Chromium Reducible Sulfur	%w/w	<0.005	0.008	0.008	0.008	0.008
S_{KCl}	%w/w S	[NT]	[NT]	[NT]	[NT]	[NT]
S_{HCl}	%w/w S	[NT]	[NT]	[NT]	[NT]	[NT]
S_{NAS}	%w/w S	[NT]	[NT]	[NT]	[NT]	[NT]
ANC_{BT}	% $CaCO_3$	8.7	3.4	2.8	1.7	2.0
s-ANC_{BT}	%w/w S	2.8	1.1	0.91	0.54	0.62
s-Net Acidity excluding ANC	%w/w S	<0.005	0.0080	0.0080	0.0080	0.0080
a-Net Acidity excluding ANC	moles H^+ /t	<5	5.0	5.0	5.0	5.0
Liming rate excluding ANC	kg $CaCO_3$ /t	<0.75	<0.75	<0.75	<0.75	<0.75
s-Net Acidity including ANC	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
a-Net Acidity including ANC	moles H^+ /t	<5	<5	<5	<5	<5
Liming rate including ANC	kg $CaCO_3$ /t	<0.75	<0.75	<0.75	<0.75	<0.75

Acid Sulphate Soil Suite			
Our Reference		380719-36	380719-37
Your Reference	UNITS	BH210	BH210
Depth		2	3.5
Date Sampled		07/05/2025	07/05/2025
Type of sample		Soil	Soil
Date prepared	-	15/05/2025	15/05/2025
Date analysed	-	16/05/2025	16/05/2025
pH $_{kcl}$	pH units	8.9	9.0
s-TAA pH 6.5	%w/w S	<0.01	<0.01
TAA pH 6.5	moles H^+ /t	<5	<5
a-Chromium Reducible Sulfur	moles H^+ /t	<3	5
Chromium Reducible Sulfur	%w/w	<0.005	0.008
S_{KCl}	%w/w S	[NT]	[NT]
S_{HCl}	%w/w S	[NT]	[NT]
S_{NAS}	%w/w S	[NT]	[NT]
ANC_{BT}	% $CaCO_3$	8.4	5.0
s-ANC_{BT}	%w/w S	2.7	1.6
s-Net Acidity excluding ANC	%w/w S	<0.005	0.0080
a-Net Acidity excluding ANC	moles H^+ /t	<5	5.0
Liming rate excluding ANC	kg $CaCO_3$ /t	<0.75	<0.75
s-Net Acidity including ANC	%w/w S	<0.005	<0.005
a-Net Acidity including ANC	moles H^+ /t	<5	<5
Liming rate including ANC	kg $CaCO_3$ /t	<0.75	<0.75

Method ID	Methodology Summary
Ext-037	Analysed by Sydney Environmental & Soil Laboratory
Inorg-001	pH - Measured using pH meter and electrode. 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.
Inorg-068	Determination of Acid Sulphate Soil analysis - a sample is analysed by traditional titration method and ICP-OES analysis. Based on Acid Sulfate Soils Laboratory Methods Guidelines, latest edition. There is no documented official holding time, we have assigned an arbitrary 180 days to frozen samples. neutralising value (NV) of 100% is assumed for liming rate. Net Acidity with ANC calculation should only be used when corroborated by other data that demonstrates the soil material does not experience acidification during complete oxidation under field conditions. The recommendation that the SHCL concentration be multiplied by a factor of 2 to ensure retained acidity is not underestimated, has not been applied in the SHCL results reported.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
INORG-123	Determined using a "Texture by Feel" method.
Metals-020	Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-OES analytical finish.

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	380719-3
Date prepared	-			19/05/2025	2	19/05/2025	19/05/2025		19/05/2025	19/05/2025
Date analysed	-			19/05/2025	2	19/05/2025	19/05/2025		19/05/2025	19/05/2025
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	2	8.3	8.3	0	101	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	2	1100	1100	0	97	#
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	2	220	220	0	93	#
Emerson Class No.	-	0	Ext-037	[NT]	2	6.0	[NT]		[NT]	[NT]

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-2	380719-40
Date prepared	-			[NT]	13	19/05/2025	19/05/2025		19/05/2025	19/05/2025
Date analysed	-			[NT]	13	19/05/2025	19/05/2025		19/05/2025	19/05/2025
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	13	8.8	8.8	0	102	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	[NT]	13	1200	1200	0	95	#
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	[NT]	13	1700	1800	6	91	78
Emerson Class No.	-	0	Ext-037	[NT]	39	4.0	[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]	26	19/05/2025	19/05/2025		[NT]	[NT]
Date analysed	-			[NT]	26	19/05/2025	19/05/2025		[NT]	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	26	8.4	8.5	1	[NT]	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	[NT]	26	1500	1400	7	[NT]	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	[NT]	26	2100	2100	0	[NT]	[NT]

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	39	19/05/2025	19/05/2025		[NT]	[NT]
Date analysed	-			[NT]	39	19/05/2025	19/05/2025		[NT]	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	39	8.3	8.3	0	[NT]	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	[NT]	39	4800	4600	4	[NT]	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	[NT]	39	1200	1400	15	[NT]	[NT]

QUALITY CONTROL: Texture and Salinity*						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			19/05/2025	2	19/05/2025	19/05/2025		19/05/2025	[NT]
Date analysed	-			19/05/2025	2	19/05/2025	19/05/2025		19/05/2025	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	2	1100	1100	0	102	[NT]
Texture Value	-		INORG-123	[NT]	2	9.0	9.0	0	[NT]	[NT]

QUALITY CONTROL: Texture and Salinity*						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-2	[NT]
Date prepared	-			[NT]	13	19/05/2025	19/05/2025		19/05/2025	[NT]
Date analysed	-			[NT]	13	19/05/2025	19/05/2025		19/05/2025	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	[NT]	13	1900	2000	5	101	[NT]
Texture Value	-		INORG-123	[NT]	13	9.0	9.0	0	[NT]	[NT]

QUALITY CONTROL: Texture and Salinity*						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	26	19/05/2025	19/05/2025		[NT]	[NT]
Date analysed	-			[NT]	26	19/05/2025	19/05/2025		[NT]	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	[NT]	26	2400	2300	4	[NT]	[NT]
Texture Value	-		INORG-123	[NT]	39	9.0	9.0	0	[NT]	[NT]

QUALITY CONTROL: Texture and Salinity*						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	39	19/05/2025	19/05/2025		[NT]	[NT]
Date analysed	-			[NT]	39	19/05/2025	19/05/2025		[NT]	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	[NT]	39	4500	4300	5	[NT]	[NT]

QUALITY CONTROL: ESP/CEC						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	380719-2
Date prepared	-			20/05/2025	1	20/05/2025	20/05/2025		20/05/2025	20/05/2025
Date analysed	-			20/05/2025	1	20/05/2025	20/05/2025		20/05/2025	20/05/2025
Exchangeable Ca	meq/100g	0.1	Metals-020	<0.1	1	25	25	0	93	110
Exchangeable K	meq/100g	0.1	Metals-020	<0.1	1	0.7	0.7	0	96	85
Exchangeable Mg	meq/100g	0.1	Metals-020	<0.1	1	1.9	1.9	0	93	111
Exchangeable Na	meq/100g	0.1	Metals-020	<0.1	1	<0.1	<0.1	0	86	83
ESP	%	1	Metals-020	[NT]	1	<1	<1	0	[NT]	[NT]

QUALITY CONTROL: ESP/CEC						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	30	20/05/2025	20/05/2025		[NT]	[NT]
Date analysed	-			[NT]	30	20/05/2025	20/05/2025		[NT]	[NT]
Exchangeable Ca	meq/100g	0.1	Metals-020	[NT]	30	12	12	0	[NT]	[NT]
Exchangeable K	meq/100g	0.1	Metals-020	[NT]	30	1.7	1.7	0	[NT]	[NT]
Exchangeable Mg	meq/100g	0.1	Metals-020	[NT]	30	3.3	3.3	0	[NT]	[NT]
Exchangeable Na	meq/100g	0.1	Metals-020	[NT]	30	0.1	0.1	0	[NT]	[NT]
ESP	%	1	Metals-020	[NT]	30	<1	<1	0	[NT]	[NT]

QUALITY CONTROL: Acid Sulphate Soil Suite						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			15/05/2025	9	15/05/2025	15/05/2025		15/05/2025	[NT]
Date analysed	-			16/05/2025	9	16/05/2025	16/05/2025		16/05/2025	[NT]
pH $_{kcl}$	pH units		Inorg-068	[NT]	9	9.1	9.0	1	98.0	[NT]
s-TAA pH 6.5	%w/w S	0.01	Inorg-068	<0.01	9	<0.01	<0.01	0	[NT]	[NT]
TAA pH 6.5	moles H^+ /t	5	Inorg-068	<5	9	<5	<5	0	92	[NT]
a-Chromium Reducible Sulfur	moles H^+ /t	3	Inorg-068	<3	9	5	5	0	99	[NT]
Chromium Reducible Sulfur	%w/w	0.005	Inorg-068	<0.005	9	0.008	0.008	0	[NT]	[NT]
S_{KCl}	%w/w S	0.005	Inorg-068	<0.005	9	[NT]	[NT]		[NT]	[NT]
S_{HCl}	%w/w S	0.005	Inorg-068	<0.005	9	[NT]	[NT]		[NT]	[NT]
S_{NAS}	%w/w S	0.005	Inorg-068	<0.005	9	[NT]	[NT]		[NT]	[NT]
ANC_{BT}	% $CaCO_3$	0.05	Inorg-068	<0.05	9	3.7	3.7	0	96	[NT]
s-ANC_{BT}	%w/w S	0.05	Inorg-068	<0.05	9	1.2	1.2	0	[NT]	[NT]
s-Net Acidity excluding ANC	%w/w S	0.005	Inorg-068	<0.005	9	0.0080	0.0080	0	[NT]	[NT]
a-Net Acidity excluding ANC	moles H^+ /t	5	Inorg-068	<5	9	5.0	5.0	0	[NT]	[NT]
Liming rate excluding ANC	kg $CaCO_3$ /t	0.75	Inorg-068	<0.75	9	<0.75	<0.75	0	[NT]	[NT]
s-Net Acidity including ANC	%w/w S	0.005	Inorg-068	<0.005	9	<0.005	<0.005	0	[NT]	[NT]
a-Net Acidity including ANC	moles H^+ /t	5	Inorg-068	<5	9	<5	<5	0	[NT]	[NT]
Liming rate including ANC	kg $CaCO_3$ /t	0.75	Inorg-068	<0.75	9	<0.75	<0.75	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.

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: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-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.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Air volumes are typically provided by customers (often as flow rate(s) and sampling time(s) and/or simply volumes) sampled or exposure times (determines 'volume' passive badges are exposed to)). Hence in such circumstances the volume measurement is inevitably not covered by Envirolab's NATA accreditation. An exception may occur where Envirolab Newcastle does the sampling where accreditation exists for certain types of sampling and hence volume determination(s). Note air volumes are often used to determine concentrations for dust and/or analyses on filters, sorbents and in impingers. For canister sampling, the air volume is covered by Envirolab's NATA accreditation.

Urine Analysis - The BEI values listed are taken from the 2022 edition of "TLVs and BEIs Threshold Limits" by ACGIH.

Report Comments

MISC_INORG_DRY: # Percent recovery is not applicable due to the high concentration of the analyte/s in the sample/s. However an acceptable recovery was obtained for the LCS.

Emerson class analysed by GSG Laboratories. Report no. EW251071.