Board of Inquiry into the McCrae Landslide

McCrae Landslide

Causation Report

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McCrae Landslide
Causation Report

Board of Inquiry into the McCrae Landslide

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	Name	**Date**	**Signature**
Prepared by:	Darren Paul	21 July 2025	
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WSP acknowledges that every project we work on takes place on First Peoples lands.
We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

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21 July 2025

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Georgie Austin
Solicitor Assisting
Board of Inquiry into the McCrae Landlslide

Dear Georgie

McCrae Landslide
Causation Report

Please find enclosed our report into the causes of the McCrae Landslide.

We trust this is suitable for you requirements and look forward to discussing the contents of this report with you further.

Yours sincerely

Darren Paul
Technical Director - Engineering Geology

Table of contents

Abbreviations

AHD	Australian Height Datum
EC	Electrical Conductivity
EMO	Erosion Management Overlay
GHD	Gutteridge, Haskins, Davey
K	Hydraulic Conductivity
MPSC	Mornington Peninsula Shire Counsel
PSM	Pells Sullivan Meynink
SEW	South East Water
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
WQM	Water Quality Measurement

Glossary

Anthropogenic	Caused by humans.
Aquifer	A body permeable rock of soil that contains water in which pore spaces or discontinuities are sufficiently connected to allow water to flow through the soil or rock matrix.
Causal Factors	Events or circumstances that might trigger a landslide. Causal factors determine when a landslide might occur.
Colluvium	Soils deposited on or at the base of slopes by gravity driven processes such as soil creep, landslides and surface wash.
Colluvial channel	A channel naturally filled with colluvium.
Discontinuities	A break or defect in a rock mass such as a joint, bedding, fault or bedding parting.
Escarpment	A long, steep slope, especially one at the edge of a plateau or separating areas of land at different elevations.
Exfiltration Point	A location at which subsurface water exits to the surface. For example natural springs.
Flux	The rate at which water passes through a given surface area.
Groundwater	Water held underground in the pores spaces of soil and rock.
Hanging Valley	A valley which is cut across by a deeper valley, cliff or escarpment.
Headscarp	A prominent steep slope or cliff like feature that marks the upper boundary of a landslide
Hydrogeology	The study of subsurface water and movement of water through the subsurface.
Infiltration Point	A location at which surface water enters the subsurface.
Landslide	The movement, or the potential movement of a mass of rock, debris or soil down a slope.
Mitigation	Works undertaken to reduce the risk from landslide.
Partial Saturation	The condition in the ground above the water table where both air and water are present within the pores of the soil or rock.
Pore water pressure	The pressure of water within the space between soil particles (pore spaces) that is exerted on the surrounding soil particles.
Preparatory Factors	Features of the landscape that make it susceptible to landslide. Preparatory factors determine where a landslide might occur and what might happen if it does occur.
Remediation	Works undertaken to repair damage caused by landslide.
Saturation	The condition in the ground below the water table where pores are fully filled with water.
Suction	Force developed between soil particles as a result of the surface tension properties of water in the pores of soil.
Surcharge Load	A load applied to the ground surface, for example from heavy plant and machinery or the placement of soil.
Surface of Rupture	The plane along which the displaced soils mass travels from the zone of depletion to the zone of accumulation.
Toe	The base or lowermost point of a slope of landslide.
Zone of Depletion	The area from which soil is removed or detaches in the event of a landslide.
Zone of Accumulation	The area from which soil is deposited in the event of a landslide.

Executive summary

I have undertaken an assessment into the causes of landslides that occurred on the McCrae escarpment on 15 November 2022 and on 5 and 14 January 2025 the latter of which caused the destruction of the house at 3 Penny Lane. The 5 and 14 January 2025 landslides occurred at the same location, namely the eastern side of 10-12 View Point Road and can be considered separate stages of the one event. I refer to those two landslides collectively as the January 2025 landslides. My assessment is based on evidence provided to the Board of Inquiry into the McCrae Landslide including expert reports, historical records, witness statements, site investigation records and maintenance records. I have also gathered my own evidence which includes a site visit and groundwater sampling and testing. I have been assisted in my inquiries by a geochemist (Dr. Hong Vu) and a hydrogeologist (Mr. Stephen Makin).

Preparatory Factors for the November 2022 and January 2025 Landslides at McCrae

Preparatory factors are features of the landscape that make it susceptible to landslide and determine where a landslide might occur and what might happen if it does. These are discussed in the report at Section 7. The McCrae escarpment is a steep slope that runs parallel to the shoreline of Port Philip Bay. It is characterised by relatively flat ground at the crest and toe whilst the escarpment itself has a steep slope angle of about 35° to 40° as measured from the horizontal. The steepness of the McCrae escarpment is a reason it is susceptible to landslide as discussed at Section 7.2.

The McCrae escarpment is underlain at depth by granite rock, the uppermost portions of which have weathered to a residual, clay rich, relatively impermeable soil. Over geological time, landslides and debris flows have occurred on the north facing slopes of Arthurs Seat causing debris arising from those landslides to infill natural channels in the surface of the granite. These infilled channels contain permeable transported soils which contrast with the relative impermeable underlying residual granite. The infilled channels are natural subsurface flow paths which are recharged by rainfall (or other external sources of water). There may be multiple points by which water can infiltrate from the surface into these flow paths, including on the slopes of Arthurs Seat, and through transported soils upslope of the escarpment. For example, there are observations of water infiltrating through kerbing in View Point Road. The water, once infiltrated, then flows down gradient through the transported soils and discharges at various points on the slopes of the McCrae escarpment at the interface between the transported soils and the underlying residual granite resulting in a series of natural springs. The presence of subsurface pathways are a preparatory factor that make the McCrae escarpment susceptible to landslide. Furthermore, intermittent flow along these pathways can serve to keep the soil moist and so it then takes less water infiltration to cause the pore pressure increase needed to trigger landslide. This is discussed in Sections 6 and 7.3.

The residual granitic and transported soils (colluvium) underlying the McCrae escarpment are susceptible to rapid loss of strength upon wetting. Given the relatively steep slope angle of the escarpment, a loss of strength in the soils underlying the escarpment can cause the soils to detach from the escarpment then travel downslope depositing debris at the toe of the escarpment. This is discussed at Section 7.1.

Development in an area susceptible to landslides can change the susceptibility of the slope to landslide with inappropriate development having the potential to increase landslide susceptibility. Development in the vicinity of the McCrae escarpment that has likely increased the susceptibility of the escarpment to landslide includes:

- Earthworks including the placement of fill on and at the crest of the escarpment which applies a surcharge load to the slope. This is discussed at Section 7.5.1.
- Vegetation removal which can allow water content to build up in the soil because of loss of evaporation and transpiration which results in a loss of suction in the underlying soils. This is discussed at Section 7.4.
- The installation of service trenches and the placement of coarse backfill materials such as gravels in those trenches which can act as conduits for preferential subsurface water flow towards the escarpment. This is discussed at Section 7.5.2

Furthermore, development increases the risk from landslide because as is the case at McCrae, it involves the construction of houses in areas where they could be impacted by landslide. Within Victoria, a planning control, the Erosion Management Overlay can be applied by local government with the objective of preventing inappropriate development that could make a slope more susceptible to landslide or that could unduly place people and assets at risk from landslide. There was no erosion management overlay applied to the McCrae escarpment at the time of the November 2022 and the January 2025 landslides. This is discussed at Section 7.6.

Causal Factors for the November 2022 and January 2025 Landslides at McCrae

Causal factors refer to factors that determine when a landslide might occur, also called triggers. Multiple potential causal factors of the November 2022 and January 2025 landslides were assessed including earthquake, anthropogenic changes such as surcharge loading, erosion and water infiltration. The causal factors for each landslide are discussed below.

Causes of the November 2022 Landslide

Based on earthquake records, there was no earthquake coincident with the occurrence of the November 2022 landslide and I have very high confidence that earthquake was not the cause of that landslide. Furthermore, there is no evidence that there was erosion at the toe of the landslide or the application of a surcharge load at the time of that landslides. I am moderately certain that the contribution of those two factors, erosion and anthropogenic changes, to causing the November 2022 landslide is insignificant. My certainty level is moderate as the lack of evidence with respect to these matters limits the confidence with which my opinion can be expressed.

There is a strong correlation between the timing of extreme rainfall that occurred on the day preceding the landslide and the occurrence of the landslide at 10-12 View Point Road on 15 November 2022. This indicates that rainfall was a factor in causing that landslide, through direct infiltration to the escarpment, infiltration upslope of the landslide (for example infiltration from kerbing and stormwater drainage infrastructure upslope of the landslide and migration to the location of the landslide) or both. Coincident with the extreme rainfall, a pipe burst near 23 Coburn Road about 120 m upslope of the landslide caused up to 0.9 ML of water to leak into the environment on the day preceding the landslide, some of which must have infiltrated the ground and could have migrated towards the site of the landslide. Furthermore, domestic water usage at 10-12 View Point Road was unusually high in November 2022, and whilst this is inferred to be related to the severance of an irrigation pipe on the property caused by the November 2022 landslide, the timing of the leak relative to the occurrence of the landslide is uncertain.

I have very high confidence that water infiltration was the cause of the November 2022 landslide. However, I am unable to form an opinion at the same level of confidence with respect to:

(i) the source of the water; and,

(ii) the means by which the water infiltrated the slope.

That is because I do not have information available to me with which to make an assessment of relative contributions, for example groundwater monitoring at the time of the landslide, flow rates from the escarpment, flow rates into the escarpment (for example through kerbing) or dye trace tests which could help to assess the nature of flow between the broken pipe or kerb to the landslide site.

On the evidence available, I have moderate confidence that rainfall, whether infiltrating directly through the surface or through kerbing and stormwater drainage was a contributing factor and low confidence that the leaking pipe at 23 Coburn Road contributed to the water infiltration that triggered the November 2022 landslide.

Causes of the January 2025 Landslides

Based on earthquake records, there was no earthquake coincident with the occurrence of the January 2025 landslides. Furthermore, evidence indicates there was no erosion at the toe of the 5 January 2025 landslide or the application of a surcharge load at the crest at the time of that landslide. Notwithstanding this, erosion caused by the 5 January 2025 landslide may have been a minor contributing factor of the 14 January 2025 landslide. With very high confidence and like the November 2022 landslide, both of the January 2025 landslides were caused by water infiltration that caused an increase in pore pressure and associated loss of strength of the soils underlying the McCrae escarpment.

I have considered multiple sources of water that might have caused the increase in pore pressure that triggered the January 2025 landslides, including rainfall, water main leakage and domestic water use.

Unlike the November 2022 landslide, there is no correlation between the timing of extreme rainfall and the occurrence of the January 2025 landslides indicating that rainfall infiltration was not the source of water that caused the increase in pore water pressure needed to trigger the January 2025 landslides. I have high confidence in that assessment.

Domestic water use involving garden irrigation was undertaken in the vicinity of the January 2025 landslides. I have assessed with high confidence that a domestic water source could not have caused the infiltration of a sufficient volume of water necessary to cause the January 2025 landslides because there was no clear pathway for water to migrate to the depth needed. Furthermore, that this source is inconsistent with groundwater pressure monitoring and is inconsistent with the volume of water observed issuing from the landslide escarpment when the landslide occurred and for the months afterwards.

There was a significant water main leak about 450 m uphill from and to the south of the landslide over the 2 months prior to 31 December 2024. It is estimated that the leak discharged 34ML to 39ML of water over that period. Associated with that leak and at the time the leak occurred, there were anomalous groundwater observations made at locations between the water main leak and the January 2025 landslides including excessive flow along stormwater pipes, water exfiltrating at the road surface from the ground in the vicinity of sewer trenches, water seeping up through the ground surface and an increased need to pump from residential basement sumps. Water was also observed seeping from the McCrae escarpment at the location of the landslides after January 2025 and for several months afterwards and groundwater monitoring near the escarpment indicated a reduction in groundwater pressures at shallow depth over the 3 months following repair of the leak.

I have considered plausible subsurface flow paths between the pipe burst location and the site of the January 2025 landslides including:

- Along stormwater pipes, before exiting the stormwater pipes. At least one breach in a stormwater pipe, upslope of the landslide was detected about 3 months after the January 2025 landslides which could have been present prior to that landslide.
- Along the granular backfill of sewer and stormwater trenches.
- Along natural subsurface flow paths through permeable colluvial soils.

In my opinion water migrated along one or multiple of these flow paths between the time the pipe started leaking and when the landslides occurred in January 2025. With very high confidence, I consider that subsurface flow paths exist that could convey water from the pipe burst to location to the site of the January 2025 landslide, although it is not reasonably practical to identify with certainty the exact flow path, or what proportion of the water that leaked from the pipe might have migrated along which flow paths. I estimate that the volume of water needed to cause the January 2025 landslide was about 0.1% of the total volume estimated to have leaked from the pipe.

Sampling and testing of water were conducted to investigate potential water sources that could have infiltrated the escarpment and then caused the January 2025 landslides. Field monitoring and laboratory data was collected from various water sources between the pipe burst location and the 2025 landslides, including stormwater pits, rainwater tanks, and a groundwater bore. The chemistry of the water that seeped from the escarpment formed by the January 2025 landslide (higher concentrations of sodium, potassium, calcium, and slightly alkaline pH and moderate TDS) is inconsistent with it being derived from a single source, such as just mains water, stormwater, rainwater or groundwater without some alteration to its chemistry. This suggests a potential mixed source and an accumulation of ions in the water as it migrated through soils along subsurface pathways before issuing at the site of the January 2025 landslides.

In my opinion, water that issued from the burst water main, flowed through one or more subsurface pathways, including through soil to the McCrae escarpment, mixing with other subsurface water on the way, adsorbing and absorbing ions which altered its chemical composition by the time it reached the McCrae escarpment. I conclude with high confidence that the increase of pore pressure in the soils underlying the McCrae escarpment that triggered the January 2025 landslides was caused by the pipe burst and that without the infiltration of that water the landslides on 5 and 14 January 2025 would not have occurred when they did.

My opinion on the causes of the November 2022, 5 January 2025 and 14 January 2025 landslides is summarised in Table ES.1.

Response to 5 January Landslide

Once the landslide occurred on 5 January 2025 forming a steep headscarp below the retaining wall at 10-12 View Point Road, no works were undertaken to prevent further landslides. Possible actions that could have been considered to reduce the likelihood of further landslides subsequent to the 5 January landslide include the interception of subsurface water flow upslope of the site of the landslide and its direction away from the landslide or excavating soil that had been placed on the escarpment near the headscarp of the landslide. Actions that could have been considered to reduce risk by addressing landslide consequences could have included the placement of protective barriers in front of houses or elements at risk from further landslides.

Given the hazardous situation and uncertainty around when or if further landslides might occur, it may not have been safe to approach the landslide with equipment that would allow soil removal or barrier placement making water interception or diversion upslope of the landslide the most practical option to attempt to reduce risks from further landslides. Hypothetically, removing water from the escarpment at the landslide location and lowering pore water pressure after the 5 January landslide could have reduced the probability of occurrence and potentially prevented the 14 January landslide. However, given the time period available between 5 and 14 January, the number of uncertainties at that time as to the source of water and subsurface flow paths and the methods that were available to intercept and divert water, I cannot provide an opinion on whether attempts to intercept or divert water upslope of the 5 January 2025 landslide would have been successful, nor whether the 14 January 2025 landslide would have been prevented if subsurface water was intercepted and removed.

Remediation

Remediation of the January 2025 landslides could be effected by buttressing the escarpment, for example using rockfill and removing some fill from on the escarpment and the escarpment crest. Mitigation (works to prevent future landslide occurrence or undesirable consequences arising from landslide) could include introducing and where practical, retrospectively applying planning controls typical of development within an erosion management overlay such as removing fill on and near the escarpment, constructing barriers between the toe of the escarpment and houses on Point Nepean Road, remediating service trenches or installing wells at the crest of the escarpment designed to allow water extraction from the ground in the event that elevated groundwater pressures are detected.

Table ES.1 Summary of Causal Factors that lead to the November 2022, 5 and 14 January 2025 landslides

Landslide Event	Potential Causal Factors[2]	Magnitude of Contribution[7]	Confidence in assessment[3]	Source of Water	Likelihood of Contribution[6]	Confidence in assessment[3]	Cross reference
15 November 2022	Earthquake	Insignificant	Very High	N/A			8.2
	Anthropogenic	Insignificant	Moderate				8.4
	Erosion	Insignificant					8.3
	Water Infiltration	Very significant	Very High	Rainfall[1]	Significant	Moderate	8.5
				Domestic water use	Unable to assess[7].		8.6
				Pipe Leakage[6]	Medium	Low	8.5
5 January 2025	Earthquake	Insignificant	Very High	N/A			8.2
	Anthropogenic	Insignificant					8.4
	Erosion	Insignificant					8.3
	Water Infiltration	Very significant	Very High	Rainfall	Minor	Moderate	8.5
				Domestic water use	Minor	High	8.6
				Pipe Leakage[4]	Significant	High	8.7
14 January 2025	Earthquake	Insignificant	Very High	N/A			8.2
	Anthropogenic	Insignificant					8.4
	Erosion	Minor[5]	High	N/A			8.3
	Water Infiltration	Very significant	Very High	Rainfall	Minor	Moderate	8.5
				Domestic water use	Minor	High	8.6
				Pipe Leakage[4]	Significant	High	8.7

1 – Includes rainfall that might have directly infiltrated the escarpment and rainfall that could have infiltrated upslope of the escarpment including through the kerb at 10-12 View Point Road.

2 – Factors that trigger the landslide. These are factors that influence when a landslide might occur.

3 – See Table 3.1 which sets out definitions of confidence terms used.

4 – Based on water leakage from main near the corner of Outlook and Bayview Road, approximately 450 m south of the McCrae Escarpment.

5 – Due to steepening of escarpment following 5 January 2025 landslide.

6 – Based on water main leak observed at 23 Coburn Avenue, 125 m upslope of the November 2022 landslide observed on the day before the landslide.

7 – The November 2022 landslide is inferred to have severed an irrigation line. However, the timing of that with respect to the landslide is unknown. If the severance happened after the landslide, it would have had no contribution. However, this is now known and so I am unable to provide an opinion on the contribution of domestic water use.

8 – Degree of Contribution – Indicative contribution levels:

Insignificant – 0% - 1%

Minor – 1% - 10%

Medium – 10% - 30%

Major – 30% - 80%

Significant – 80% - 100%

1 Introduction and Qualifications

1.1 Qualifications

1) My name is Darren Ross Paul, Technical Director at WSP Australia Pty. Ltd. of Level 11, 567 Collins Street, Melbourne.

2) I am an engineering geologist with over 25 years' experience in the assessment of slope stability and landslide related hazards. My formal qualifications and a summary of my experience are set out in my resume which is attached to this report at Appendix A.

3) Throughout my career I have been involved in slope stability and landslide assessments for many different applications including for town planning, roads, rail, coasts and pipelines. I have undertaken slope stability and slope risk assessments in South Australia, Victoria, Tasmania, New South Wales, Queensland, Papua New Guinea and Indonesia. I have provided continuing expert advice with respect to the development of Erosion Management Overlays (EMO) for a number of local government jurisdictions in Victoria, including for Moreland (now Merri-bek), Shire of Yarra Ranges, Colac-Otway Shire, City of Frankston, Alpine Resorts, Shire of Towong and Shire of East Gippsland.

4) I have published and presented peer reviewed papers on planning for landslides and am regularly called on to provide peer review of geotechnical and landslide risk assessments. I am the manager and instructor of the Australian Geomechanics Society (AGS) 'Applied Landslide Risk Assessment' course, a past national chair of the Australian Geomechanics Society and am active within the landslide assessment community within Australia. I am currently chair of the committee to update the Australian Geomechanics Society Guidelines for Landslide Risk Management (previously published in 2007).

5) I have been engaged by the Board of Inquiry into the McCrae Landslide (BOI) to investigate the causes of that landslide which resulted in the destruction of the house at 3 Penny Lane McCrae on 14 January 2025.

6) The letter of instruction provided to me by Solicitors Assisting the BOI (dated 14 May 2025) in relation to the causes of the McCrae landslide is attached to this statement at Appendix B. The letter of instruction presents the background to the matter and references a brief of documents provided to me electronically and as set out in Appendix H this report. The brief instructs me to consider these documents when compiling my expert report.

7) The BOI has requested that I:

a. review the materials available and identify any further primary investigation work that could be required, in particular any further testing and whether a site investigation is required.

b. prepare a report (this report) that considers the cause(s) of the McCrae Landslide and addresses the following matters:

i. my professional qualifications and experience.

ii. the conditions that generate landslide risk generally, but not limited to geological conditions, vegetation and landslide history.

iii. the conditions that I consider likely to have generated a landslide at the site of the McCrae landslide, including, but not limited to earthworks, water and de-vegetation.

iv. the factors that I consider likely to have triggered the McCrae landslide.

v. Any other matters that I consider relevant.

8) The information that has been made available to me and on which the opinions set out in this report are based is set out in Appendix H.

9) In preparing this statement I have consulted with Dr Hong Vu, Principal Geochemist and Mr Stephen Makin Principal Hydrogeologist, both of WSP, who have provided expertise specific to their respective disciplines. I have been assisted in the preparation of this report by Ms Alana Dubowik, Associate Engineering Geologist at WSP and the report has been subject to internal peer review by Dr. Chris Haberfield of WSP. The formal qualifications and summary of experience of the aforementioned persons who I have consulted with in the preparation of this report are provided in Appendix A.

10) Except where stated, the views expressed in this report are my own opinions and are not provisional opinions.

11) The Solicitors Assisting the BOI have been provided me with a copy of the Information Guide for Witnesses which I have reviewed and complied with in preparing this report.

1.2 Scope of Assessment

12) In accordance with the LOI and background information that I have been provided with, this report addresses the causes of three landslides that occurred on the McCrae escarpment:

a. A translational landslide that occurred on 15 November 2022 which detached from the McCrae escarpment on the western side of the property at 10-12 View Point Road causing landslide debris to cross the property boundary and enter 2 Penny Lane. No damage to any dwelling arose from this landslide. This landslide is referred to as the November 2022 landslide.

b. A translational landslide that occurred on 5 January 2025 on the eastern side of the property at 10-12 View Point Road and which caused approximately 15 m^3 to 25 m^3 of landslide debris (MSC.5047.0001.0001) to travel downslope and into the property at 3 Penny Lane, impacting, but not destroying the dwelling on that property. This landslide is referred to as the 5 January landslide.

c. A translational landslide that occurred on 14 January 2025 on the eastern side of the property at 10-12 View Point Road and caused approximately 300 m^3 (MSC.5047.0001.0001) of debris to detach and travel across the property boundary at 3 Penny Lane. This landslide caused the destruction of the dwelling on that property. The 14 January 2025 landslide occurred at the same location as the 5 January landslide and was a regression of that landslide. The 14 January Landslide is the largest of the three landslides and had the most impact. It is also referred to in this report as the McCrae Landslide.

13) The 5 January and 14 January 2025 landslides can be considered separate stages of the one landslide event. I collectively refer to them in this report as the January 2025 landslides or separately as the 5 January and 14 January landslides respectively.

14) For context, Figure 1.1 and Figure 1.2, indicate the locations and scale of the November 2022 and January 2025 landslides.

Figure 1.1 Comparison of McCrae escarpment before and after the landslides of November 2022 and January 2025. Left: Nearmap image dated 18 October 2022, Right: Nearmap image dated 6 January 2025.

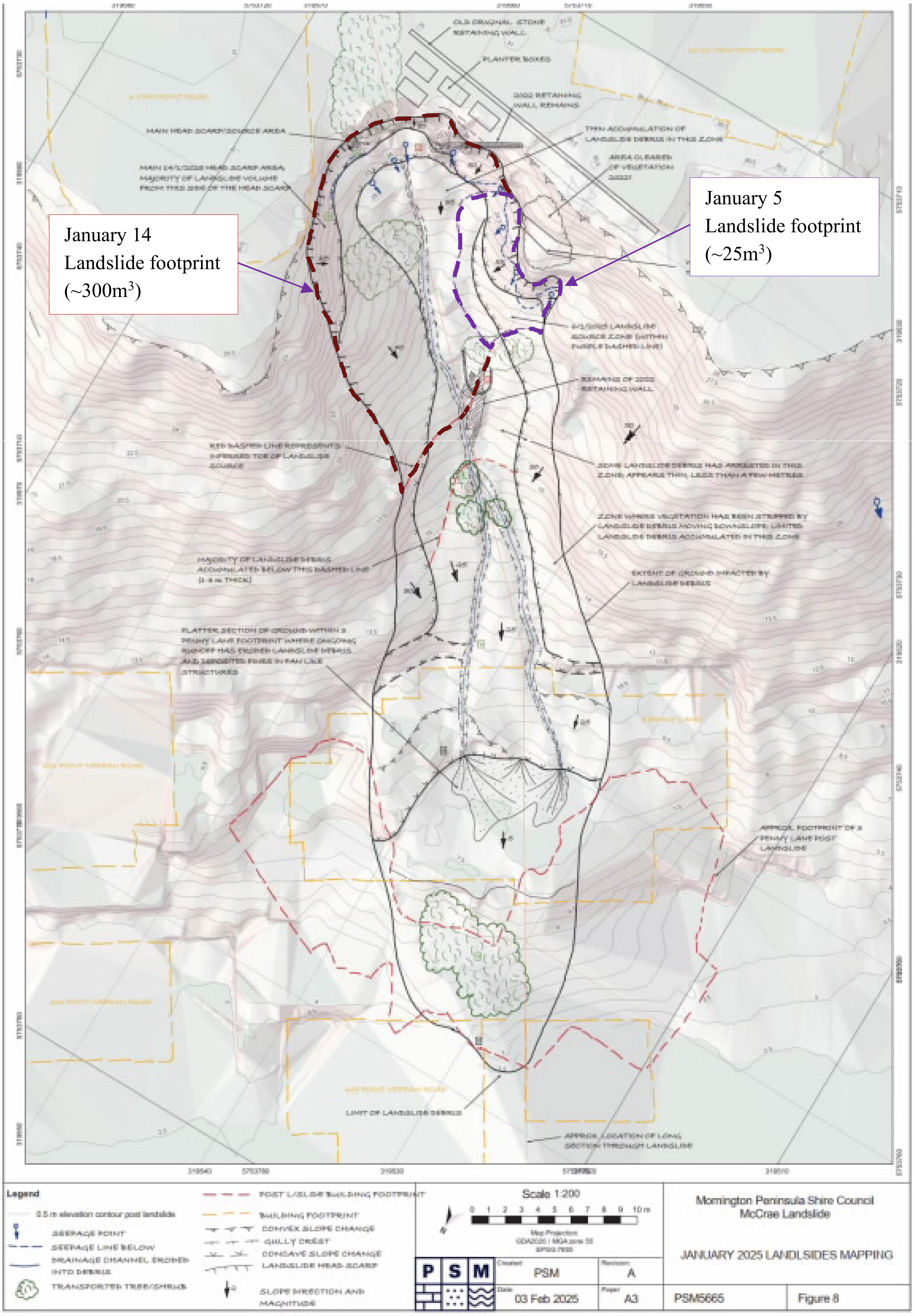

Figure 1.2 Extract from PSM risk to life assessment showing geomorphic features of January 2025 landslides (MSC.5047.0001.0001). My annotation added to provide emphasis to locations of landslide sources.

2 Information Provided

15) I have been provided with digital access to relevant reports and information as set out Appendix H of this report.

16) I attended the site on Friday 23 May 2025 and visited several locations between the upper slopes of Arthurs Seat and the coast of Port Philip Bay including:

    a. Chapman's Point Lookout on Arthurs Seat.

    b. The Boulevard Reserve at the base of Arthurs Seat.

    c. The reserve between Bayview Road and the Mornington Peninsula Freeway, downslope of The Boulevard Reserve.

    d. Private Properties at 4, 6, 10-12 and 14-16 View Point Road, 2 and 3 Penny Lane and 607-609 Point Nepean Road.

    e. Public Roads between the Mornington Peninsula Freeway and Point Nepean Road including Waller Place, Charlesworth Street, Coburn Avenue, Prospect Hill Road and View Point Road.

17) A plan showing the sites I visited is included as Figure 2.1.

Figure 2.1 Locations visited during site visit on 23 May 2025

18) I have reviewed selected transcripts of evidence presented at the hearings conducted by the Solicitors Assisting the BOI between 7 May and 16 May 2025 and 20 June and 23 June 2025.

19) I have relied upon the briefing and letter of instruction provided to me by Counsel assisting the BOI, my own observations and the documentation referenced at Appendix H to develop the opinions set out in this report.

3 Approach to Identifying Cause

3.1 Factors that contribute to landslide

20) A landslide in a general sense is the movement or the potential movement of a mass of rock, debris or earth down a slope[1]. (AGS 2007, GeoGuide LR1).

21) There are multiple factors that contribute to landslides and the undesirable consequences that can arise from landslides. In preparing this report, I have categorised the factors that can lead to landslides and more specifically that have led to the January 2025 landslides into two broad groups, *preparatory factors* and *causal factors*.

22) *Preparatory factors* are factors that make the landscape susceptible or prone to landslide. Identification and assessment of preparatory factors can allow suitably trained professionals to identify *where* landslides might occur and *what* might happen if they do occur. An understanding of preparatory factors is key to the development of landslide susceptibility maps and associated planning controls such as an Erosion Management Overlay (EMO).

23) *Causal factors* are those that trigger landslides. They determine *when* a landslide might occur. Amongst other things, landslide risk mitigation might focus on reducing the potential for causal factors to trigger a landslide.

24) I have structured this report to separately discuss preparatory and causal factors in general and as they relate to the January 2025 landslides. My reason for doing this is that preparatory factors relate mainly to planning related matters and causal factors relate to landslide triggers. Responsibility for the former would generally lie with the local government, in this case Mornington Peninsula Shire Council, whereas responsibility for landslide triggers can be (but is not exclusively) related to water bearing infrastructure including stormwater, sewer and water mains which is usually the responsibility of the relevant asset owner. I understand the BOI is considering each of these matters.

3.2 Engineering Geological Models and Certainty

25) Engineering geology is concerned with the interaction of the built environment with the ground. Landslide management is an important part of that discipline. Engineering geologists seek to develop an engineering geological model (EGM) for the ground. The EGM seeks to communicate what is known about the ground, including the composition of the ground, its geological and hydrogeological characteristics and what processes (including landslides) might be acting on or within the ground. In this report at Section 6, I present an EGM for the ground at and surrounding the McCrae escarpment and sites of the November 2022 and January 2025 landslides which is a fundamental step towards identifying factors that contributed to those landslides.

26) Whilst an EGM should be based upon the best evidence available, it is not possible to know everything about the ground. An EGM presents a hypothesis based on the evidence available and as such there will always be inherent uncertainty. In general, the more corroborating evidence collected, including observations and testing of the ground, the more certain the model becomes.

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[1] Australian Geomechanics Society (2007) Guidelines for Landslide Risk Management, Australian Geomechanics No. 42, GeoGuide LR1, March 2007.

27) I have sought to communicate the level of certainty I have in the EGM and in the opinions presented in this report that derive from it using the scale set out in Table 3.1. The purpose of this is to provide the BOI with a realistic indication of the hypothesis and the conclusions that I have developed from the available evidence.

Table 3.1 Certainty descriptors used in this report

Degree of Certainty	**Indicative degree of certainty**	**Definition**
Very Low	<20%	Available evidence insufficient to develop a reasonable EGM. Further investigation required to improve certainty.
Low	20% - <40%	Available evidence sufficient to develop a preliminary EGM and to proceed with testing one or more of the hypothesis it presents.
Medium	40% - <60%	Available evidence informs development of an EGM. There may be multiple, but a limited number of feasible hypotheses that can be tested.
High	60% - <80%	Available evidence informs a detailed EGM. Sufficient evidence to make decisions and implement actions arising from the EGM. May be a feasible alternative hypothesis that warrants further investigation.
Very High	80% - 99%	Available evidence informs a detailed EGM. Sufficient evidence to make decisions and to act upon the EGM, for example to undertake design. No feasible alternative hypotheses.

3.3 Landslide Terminology

28) I have used terminology consistent with that defined in AGS 2007[2]. Figure 3.1 is an image showing landslide types, some of which I refer to in this statement. Figure 3.2 is an image showing terms given to parts of a landslide that I also refer to in this statement. Other technical terms used in this document are set out in in the Glossary on Page v.

[2] Australian Geomechanics Society (2007) Guidelines for Landslide Risk Management, Australian Geomechanics No. 42, March 2007.

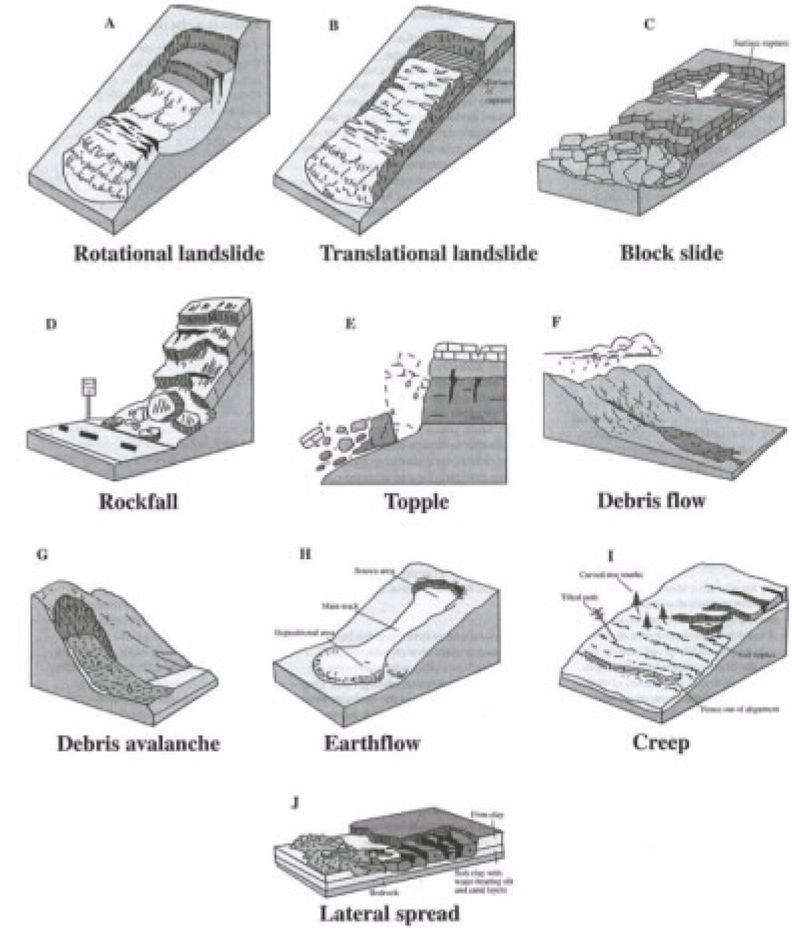

Figure 3.1 Types of Landslide Movement (US Geological Survey Fact Sheet 2004-3072, July 2004, reproduced in AGS 2007).

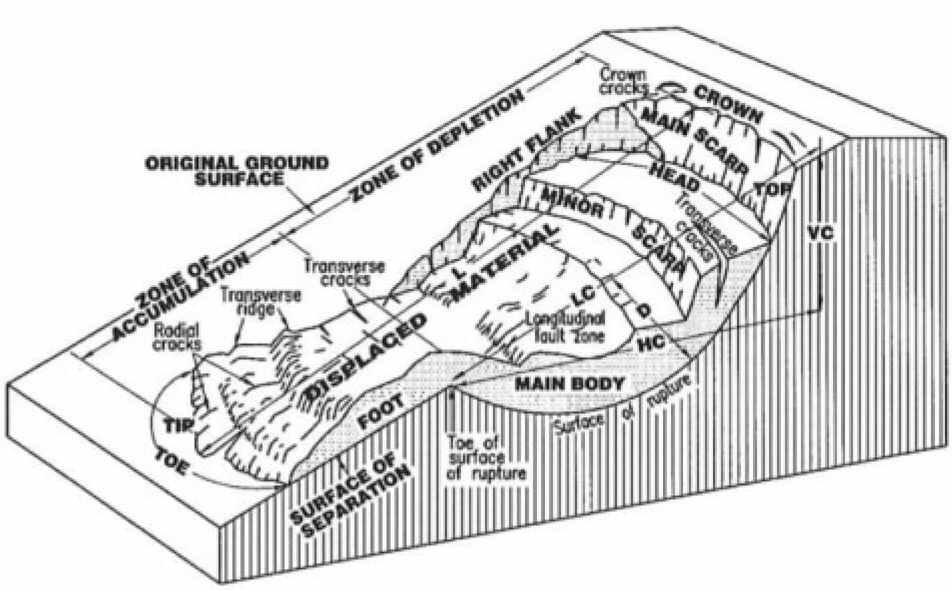

Figure 3.2 Idealised Complex Earth Slide showing terminology used for parts of a landslide (Varnes, D J (1978) Slope Movement Types and Processes. In special Report 176: Landslides: Analysis and Control(R L Schuster & R J Krizeek, eds.), TRB, National Research Council, Washington, DC, pp11-33, reproduced in AGS 2007).

4 General Preparatory Factors for Landslide

29) The following section presents in general terms preparatory factors for landslide. This is not intended to be specific to landslides on the McCrae escarpment which I discuss in further detail in Section 7, but rather for landslides in general.

4.1 Geology and Soil Properties

30) Landslides are a mechanism of landscape erosion because they involve the removal of geological materials (soil and rock) from a location, transport of that material downslope and its deposition at another location. Whilst all soil and rocks are prone to weathering and erosion over geological time (thousands to millions of years), the rate of weathering and erosion and therefore the frequency of landslides varies between different geological materials. For example, the granite forming Arthurs Seat at McCrae was emplaced underground (i.e. a granite intrusion). Through erosion, including landslide processes over geological time, the granite has been exposed at the surface. Softer soils and rocks around the granite are less resistant to weathering and so have eroded at a more rapid rate, leaving the granite proud of the terrain and forming the elevated terrain that is present today. Whilst some of the terrain around the granite is now less prone to landslide because it has denuded down to flatter slope angles, landslide processes on the slopes formed from the granite are ongoing.

31) Resistance of rock and soil to landslides is derived from the strength of bonds and friction between their components (soil or rock grains that form the soil or rock). In the case of rock, the strength between individual crystals or grains is usually very high and landslide susceptibility will be related to discontinuities in the rock mass, for example joints, faults and bedding partings. Whilst soils can also contain discontinuities that influence their susceptibility to landslide, it is usually bonds and frictional resistance between soil particles that provide strength to the soil and resistance to landslide. That strength can arise from:

a. Friction between the soil particles which provides resistance to soil particles moving over or relative to each other. In a dry sand for example, this would be the key property from which the sand derives its strength. Friction is derived from the shape and roughness of the soil particles – soils with rough angular particles like a crushed rock gravel will have high friction whereas soils with rounded particles a lower friction. For practical purposes the friction between the particles of a soil does not change over time.

b. Cohesion between the soil particles which is derived from electrostatic forces between particles. This is analogous to glue that binds the particles. Clay or soils with a higher proportion of clay tend to derive strength from cohesion. Water affects the strength of these forces, with higher water content typically reducing these forces. For example, clayey ground might turn to mud when it is wet in winter and so have low strength, but becomes hard with high strength in summer when its moisture content reduces and the electrostatic attraction between the clay particles increases.

c. Pore water pressure between the soil particles changes what is termed the effective strength of the soil. The space between soil particles (referred to as pores) is filled with air, water or both. If filled with water, increased pressure of the water effectively ‘pushes’ the soils particles apart. If the water pressure exceeds the resistance afforded by cohesion, the frictional strength between particles derived from the weight of soil overlying, the soil loses all strength and liquefies. This is known as a quick condition and can be a precursor to debris flow type landslides whereby the soil mass effectively liquefies and flows downslope as a fluid.

d. If the pores between the soil particles are part filled with air and part with water, the soil may be described as partially saturated. This can occur through capillary rise whereby water is drawn upward from saturated parts of the soil (saturated soil described the state where the pores are fully filled with water) similar to how trees draw water up from the ground. In finer grained soils including clays and silts to fine to medium grained sands, surface tension forces within pores develop helping to bind the soil particles together. This is called *suction*. This characteristic of soils is what makes it possible to build sandcastles with partially saturated soils whereas if the sand is completely dry or completely saturated, the sand does not have enough strength to make sandcastles. The degree of saturation of a soil can change and so too does the suction within the pores, its strength and its ability to resist landslide. This concept is shown in Figure 4.1.

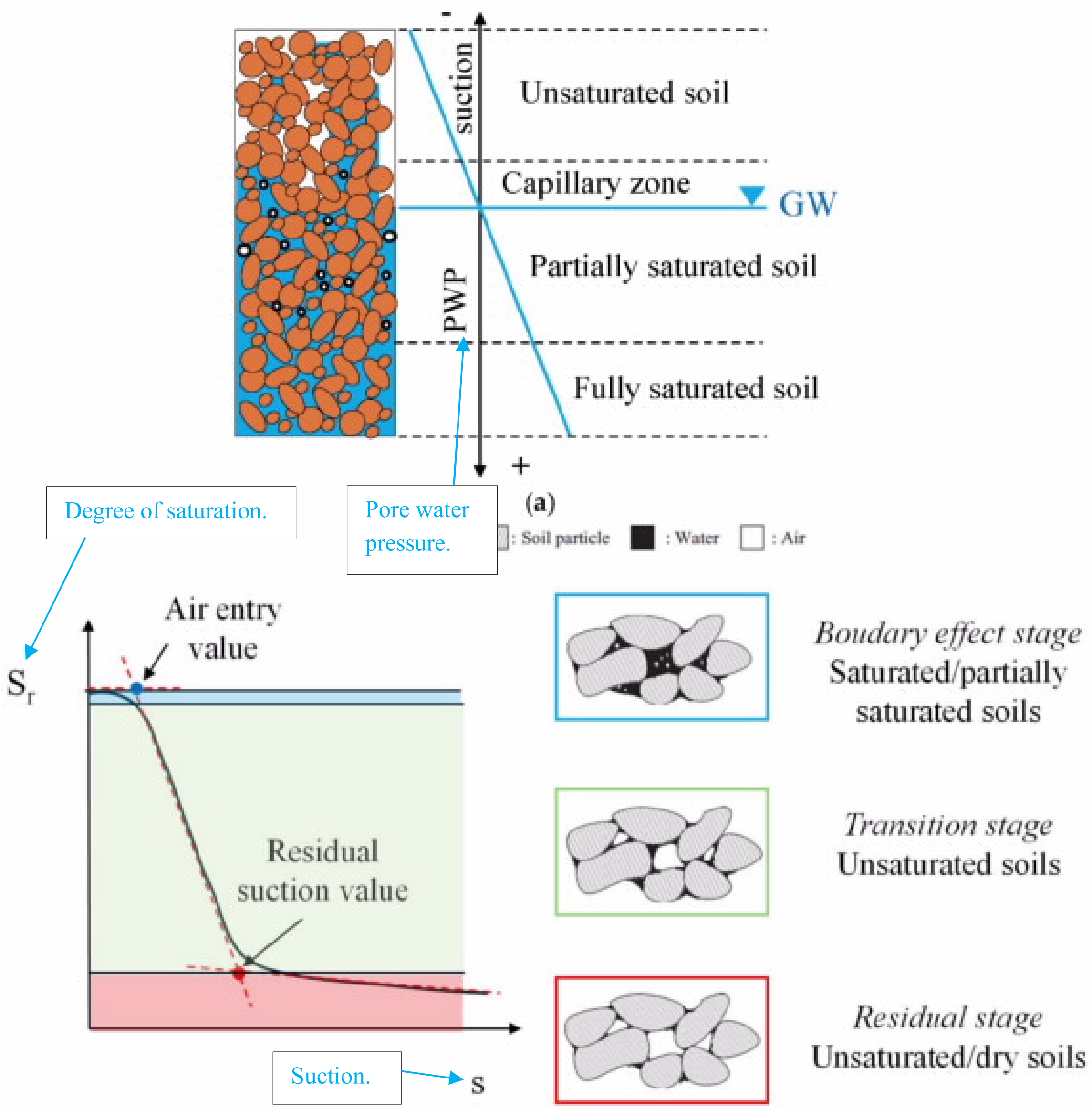

Figure 4.1 Diagram showing principle of soil suction development in partially saturated soils. From Mele et. al. 2024 with my annotations[3].

[3] Mele, L., Lirer, S., Flora, A., (2024) Induced Partial Saturation: From Mechanical Principles to Engineering Design of an Innovative and Eco-Friendly Countermeasure against Earthquake Induced Liquefaction, Geosciences 14(2)

32) Different soil types can develop different levels of suction and strength change in response to changes in pore water pressure. Whilst nature is complex and soil composition is complex, in general, in very coarse grained soils like gravel with large pores, there is less overall particle surface area in the soil and the propensity of partial saturation to induce soil suctions are less. In finer grained soils like fine sands, silts and clays the effects of suction are more significant.

33) Finer grained soils with low cohesion including fine sands and silty sands are prone to debris flow type landslides because they are able to maintain strength when in a state of partial saturation. However, if the moisture content and pore water pressure increases, soil becomes saturated and the strength gained from suction is lost rapidly. Particles can move independently from one another and flow. Soils derived from the weathering of granite are a type of soil that exhibits this characteristic and debris flows are common in granite terrain.

34) Fine grained soils such as clays which have a higher cohesion are less prone to debris flow because the cohesion helps bind the soil particles together if partial saturation is lost. Because of the low permeability of the soil, it takes more time for water to infiltrate causing gradual rather than rapid loss of strength. Landslides in these types of soils tend to be rotational type landslides where blocks of soils remain intact but move relative to each other.

35) The composition of a soil, meaning the size, shape and mineralogy of the particles from which it is comprised, affect the strength of the bonds between particles and how that strength changes in response to moisture content and pore water pressure changes. The soil composition is therefore a *preparatory* factor for landslide.

4.2 Slope angle and terrain

36) Steeper and higher slopes are more prone to landslide. This is because the component of the forces of gravity acting on steeper slopes are greater. The angle of a slope can be measured a variety of ways. However, in landslide assessment, it is usually measured in degrees relative to the horizontal with a 90° slope being a vertical cliff and 0° slope being flat ground. The height is measured as the vertical distance from the toe to the top of the slope. These dimensions are indicated in Figure 4.2.

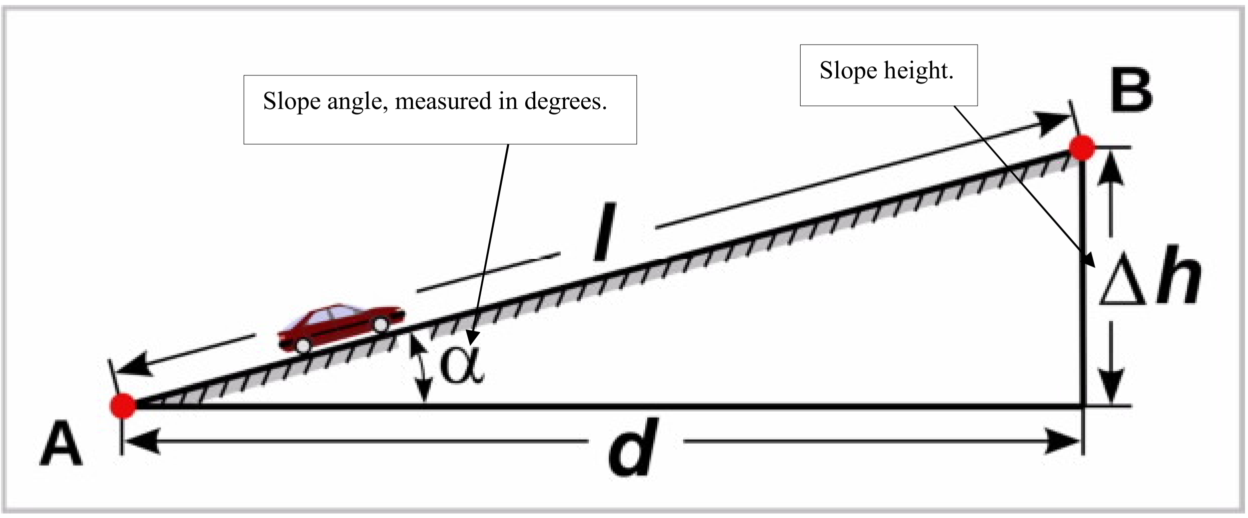

Figure 4.2 Diagram showing means of measuring how steep a slope is (Wikipedia with my annotations).

37) Slope angles and heights can naturally change over time, for example in response to erosion at the base of the slope. That is, active processes can increase susceptibility to landslide by changing the slope height and angle.

38) The angle and height of a slope is one of the key preparatory factors for landslide.

4.3 Past History of Landslide

39) It is often (but not exclusively) the case, that areas where landslides have occurred in the past may be more susceptible to landslide in the future. For example:

a. If a landslide occurs, it might form a steep headscarp which could then be susceptible to further landslide after debris is removed from the toe. This is called regression and is how coastal cliffs might erode as successive landslides steepen the slope.

b. A landslide could occur in cohesive material where soil moves as a block. The weakened soil along the plane on which the block moved could move again. This is called reactivation.

c. Landslide debris will usually have lower strength than it did when it was in situ prior to the landslide because it has disaggregated and dilated through the landslide process. It may also have been deposited at a steep slope angle, possibly close to its maximum stable angle. This weakened soil can be more susceptible to landslide than the parent material from which it is derived.

4.4 Hydrogeology

40) Hydrogeology is the study of water in the ground, including how water moves through the ground and including how it might infiltrate the ground or exfiltrate from the ground as springs.

41) Landslides are commonly triggered by changes in pore water pressure. The hydrogeological characteristics of the ground influence the ability for water to infiltrate into the ground and then move through the ground such that pore water pressure changes are induced in areas susceptible to landslide.

42) It is common for landslides to occur at points where water issues from the ground (springs), in particular if that location is on a slope. This is a point at which the pore water pressure in the ground is being relieved by groundwater flowing to the surface. However, if water is able to infiltrate into the ground at a susceptible area quicker than it can exfiltrate or the flow path or spring is blocked, pore water pressure increase could result.

43) The hydrogeological characteristics of the ground and how water moves through the ground may be very complex and difficult to know with certainty. The hydrogeological characteristics can be further complicated by development, which can serve to intercept, present a barrier to or add to subsurface flows. Figure 4.3 provides an example of hydrogeological characteristics within the weathered granites of Hong Kong to illustrate the hydrogeological complexity that can arise in granitic terrains. In my experience the granites of Victoria exhibit similar hydrogeological characteristics.

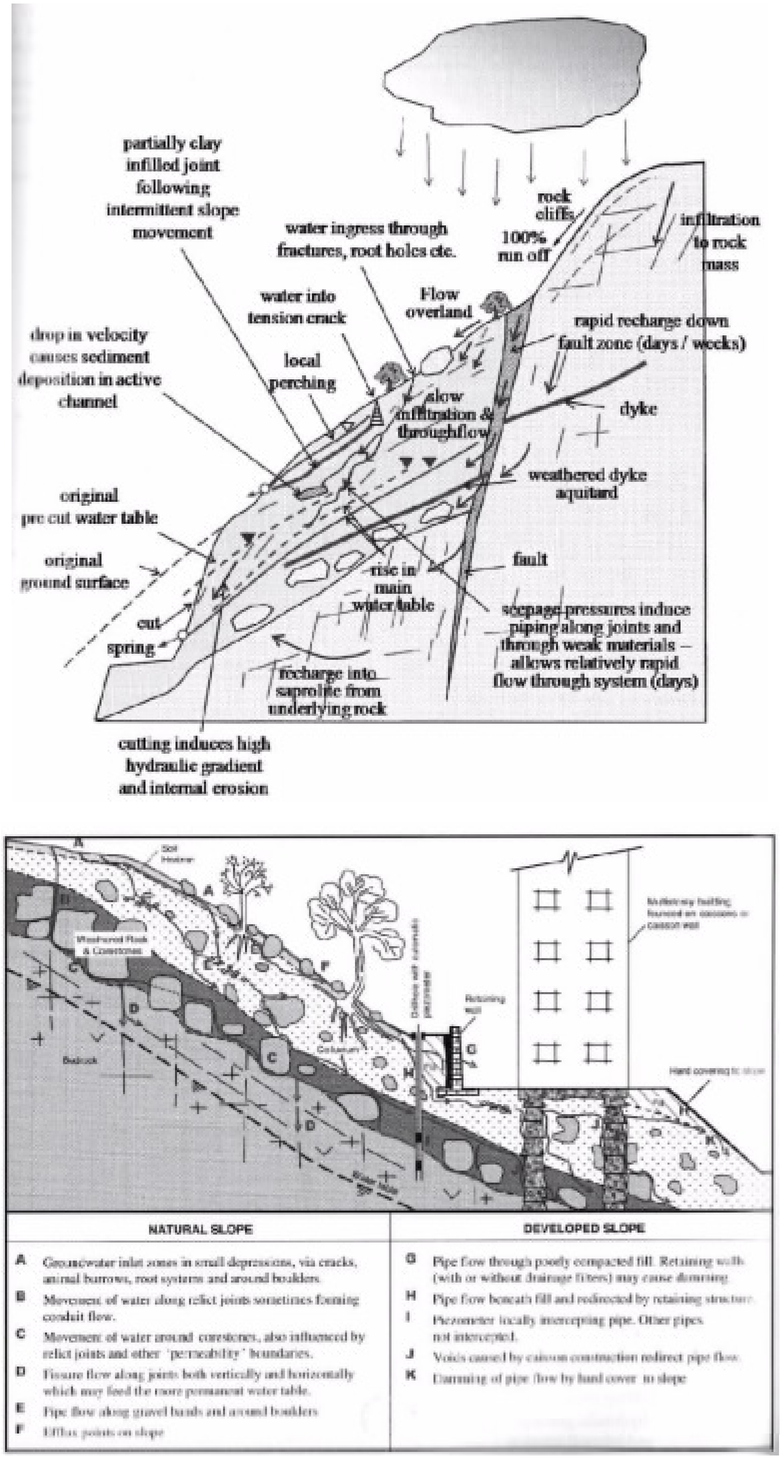

Figure 4.3 Examples of hydrogeological characteristics that could be a contributing factor to landslide in a granitic terrain[4].

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4 Hencher, S.R., Lee, S.G., (2010) Landslide Mechanisms in Hong Kong, in Weathering as a Predisposing Factor to Slope Movements, Geological Society of London Special Publication No. 23.

44) The hydrogeological characteristics of the ground, including how water flows through the ground from an infiltration to exfiltration point such as a spring are preparatory factors for landslide.

4.5 Vegetation

45) The presence of vegetation helps to improve the stability of slopes in soils through the following means:

a. Trees draw water up from the ground through capillary action which draws water out of the soil helping to maintain partially saturated conditions in the soil. This increases suction in the soils and therefore its strength and resistance to landslide.

b. Water is typically less able to infiltrate the ground on a vegetated slope compared to a non-vegetated slope. Factors such as the delay in water getting into the ground as it moves through vegetation and leaf litter on the ground can delay or reduce the degree of water infiltration through the surface.

c. There can be a binding effect of roots in the ground that provides some level of reinforcement to the soil.

46) The loss of or lack of vegetation from a slope can be a preparatory factor for landslide.

4.6 Anthropogenic change

47) The preparatory factors described above can all be influenced by changes made to the landscape by humans, termed anthropogenic change. For example:

a. Earthworks could be undertaken which makes a slope steeper or higher or increases the stress applied to a slope such as through the placement of fill at the top of a slope or on the face of the slope itself.

b. Development could be undertaken that obstructs groundwater flow, for example deep building foundations, basements or fill placed over a spring or culvert. This can cause water pressure to accumulate in the vicinity of the obstruction or cause groundwater flow paths to alter direction causing groundwater pressure to increase in parts of the subsurface that would not usually be prone to this.

c. The potential for excess water to infiltrate into the ground through human made structures such as leaking dams, pools, ponds or underground water bearing services (sewer, mains water, storm water).

d. The potential for changes to natural surface water flow paths through development, including roads and stormwater infrastructure can divert surface water to parts of the landscape such that they receive higher flows than usual and potentially higher water infiltration to the ground than usual.

e. Vegetation removal can contribute to increased pore water pressure within the ground.

48) Anthropogenic change to the landscape brought on by development can make the landscape more susceptible to landslide and therefore be a *preparatory* factor for landslide.

5 General Causal Factors for Landslide

49) In this section I discuss in general terms *causal* factors for landslide, noting that these factors are general and not specific to the McCrae landslide. Causal factors are also termed landslide triggers.

5.1 Pore pressure change

50) As discussed at Section 4.1, soil strength can change in response to changes in pore water pressure, whereby strength will typically reduce in response to an increase in moisture content or pore water pressure. In a partially saturated state, soil can maintain relatively high strength due to soil suctions. An increase in pore water pressure can lead to a tipping point at which soil strength is lost to the extent that a landslide is triggered. There are a number of means by which the pore pressure could increase in the ground. For example:

a. Intense rainfall causing water to rapidly infiltrate the ground. Water can infiltrate the ground more rapidly than usual where runoff is inhibited due to high flows, allowing water to accumulate or pond over ground it would not usually flow over.

b. Prolonged or antecedent rainfall whereby frequent rain events over an extended period, for example a La Niña climate cycle allow gradual increase in groundwater levels and/or build-up of pore pressure. Antecedent rainfall can also make the slope more susceptible to the effects of intense rainfall because the incremental increase in pore pressure needed to cause a landslide might be less.

c. Water introduced to the soil via leaking underground water bearing services. For example, the prime causal factor of the fatal 1997 Thredbo landslide was assessed to be a leaking water main[5] which introduced water into the soil above a ski lodge, causing an increase in pore water pressure and subsequent landslide.

d. Water introduced to the soil via leaking water holding structures such as tanks, pools, ponds and dams.

e. Natural changes to subsurface flow through aquifers. There can be natural fluctuations in pore water pressure caused by how water flows through the subsurface. Groundwater recharge, whereby groundwater infiltrates into the ground can occur many kilometres away from where the effects of that infiltration are realised through increased pore water pressure after a period of time.

f. Where a slope abuts a water body such as a lake, riverbank or reservoir, the pore pressure in the slope may be balanced by the water abutting it. A rapid draw down of water against the slope can lead to a high differential between the pore water pressure in the slope and external to the slope which can be sufficient to cause landslide.

5.2 Earthquake

51) There are two main mechanisms by which earthquake can be a causal factor for landslide:

a. Horizontal forces applied to the ground by an earthquake can cause a rapid, dynamic re-distribution of forces in the slope which can be sufficient to cause landslide.

b. Earthquake can cause a rapid increase in pore water pressure and potentially liquefy soil which can then cause a landslide in a similar way to that described at 5.1.

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5 Hand, D., Report of the inquest into the deaths arising from the Thredbo landslide, NSW State Coroner, 29 June 2000.

52) Landslides caused by earthquake are rare in Australia compared to more seismically active countries such as New Zealand or Papua New Guinea that lie on tectonic plate boundaries. Earthquake intensity is rarely sufficient in Australia to cause landslide.

5.3 Erosion and changing landscape

53) Steepening of slopes due to erosion can be a causal factor for landslide. This is a typical causal factor for landslides on coasts in response to a storm surge or extreme tide events whereby rapid erosion can steepen or undercut slopes triggering landslide. Riverine floods can induce a similar effect if rapid bank erosion occurs.

5.4 Anthropogenic change

54) Whilst anthropogenic change can be a preparatory factor for landslide as discussed at 4.6, it can also be a causal factor. In addition to the introduction of water into the ground through anthropogenic means such as leaking pipes as discussed at Section 5.1, anthropogenic change can induce landslide through several means as described below:

a. Where earthworks are undertaken to steepen slopes to the extent that collapse occurs.

b. Where surcharge loading is placed at the top or on the face of slopes thereby increasing the vertical load down on the slope additional to that induced by gravity to the extent that landslide occurs. This could be through the placement of earth fill, heavy machinery or other loading.

c. Where slopes are vibrated, for example through vibrating machinery or construction works.

6 McCrae Area Engineering Geological Model

55) Before discussing the preparatory and causal factors specific to the landslides on the McCrae escarpment, this section sets out an engineering geological model for the escarpment and its surroundings. The engineering geological model of the site helps to inform which causal and preparatory factors may have contributed to the landslides.

6.1 Regional Geology and Geomorphology

56) Published geological mapping undertaken by the Geological Survey of Victoria (GSV) indicates the McCrae area is underlain by three main geological units that outcrop at surface as per the Sorrento 1:63,360 geological map (GSV, 1967) shown in Figure 6.1. Geological units mapped within the vicinity of the site include:

a. R1: Holocene[6] age coastal deposits, comprising siliceous sand, shell beds.

b. R3: Holocene age raised coastal deposits, comprising siliceous and calcareous sand, shell beds, guano (Mud Islands).

c. Dg: Devonian[7] age granodiorite, referred to as Dromana Granite since 1988. The term granite is used in this statement to reference the Dromana Granite.

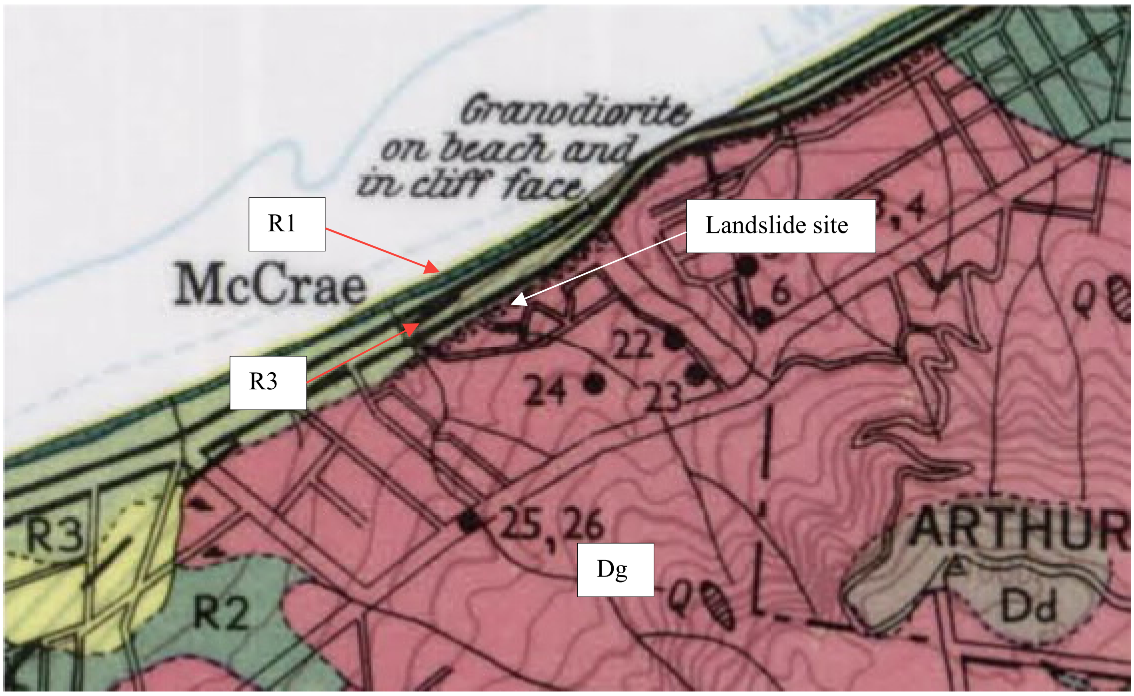

Figure 6.1 Extract from the Sorrento 1:63,360 geological map, with annotations.

6 Holocene refers current geological epoch, beginning approximately 11,700 years ago.
7 Devonian refers to a geological period of time between approximately 358 and 419 million years ago.

57) The published geological map also indicates the mapped location of the Selwyn Fault, a regional scale seismically active fault that extends from Bass Strait to Dandenong. The mapped location of this fault has been revised since publication of the Sorrento 1:63,360 map with the current trace of the fault inferred to follow the escarpment at the site (Figure 6.2). Notwithstanding this, the actual fault trace is more likely to be further to the north west towards Port Philip Bay because the escarpment would have eroded and regressed back through landslide processes.

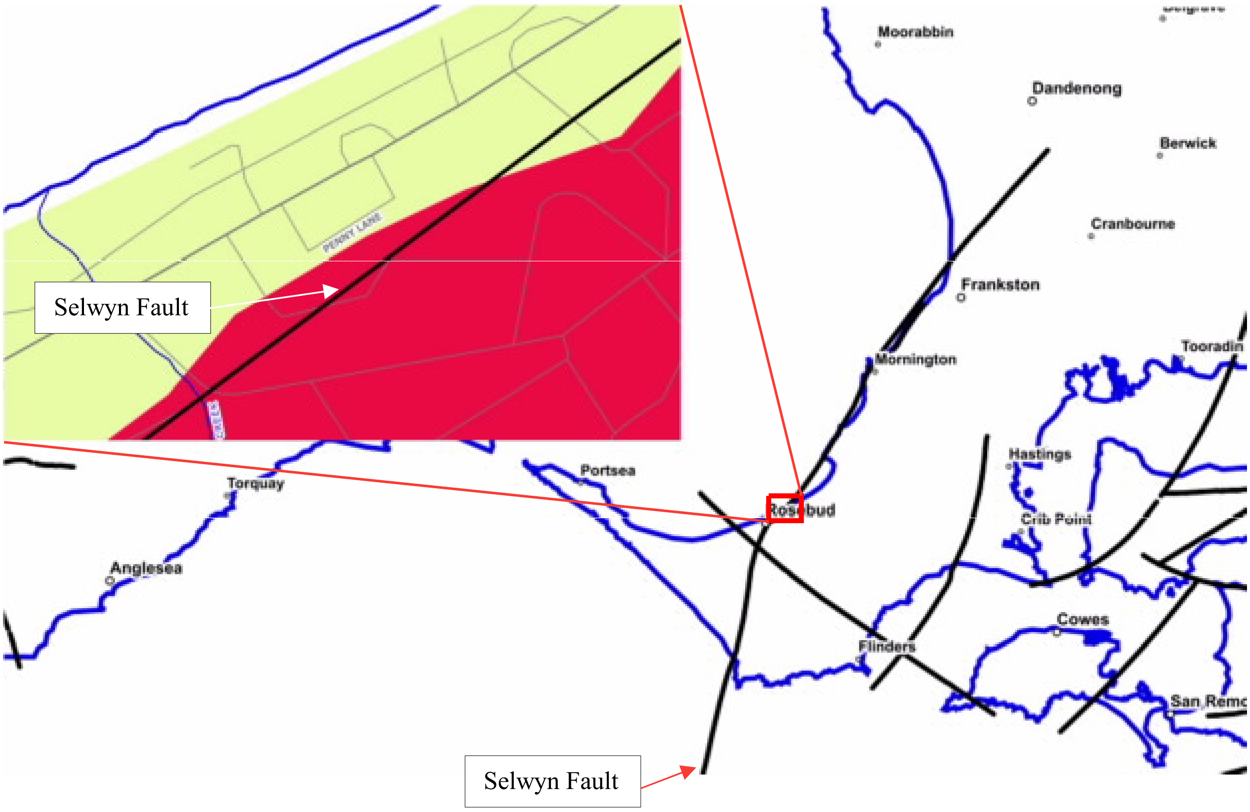

Figure 6.2 Extract from the Geological Survey of Victoria GeoVic portal showing the most recent published mapping of the Selwyn Fault relative to the site.

58) The intrusive granitic rocks form the regional topographic high of Arthurs Seat, steep hills rising to approximately 300 m in elevation 1.5 km from the coastline. These hills have formed because the relatively more resistant granitic rocks have been less prone to weathering processes over geological time compared to the surrounding sedimentary rocks, leaving them proud of the surrounding landscape.

59) Whilst less prone to weathering than the surrounding sedimentary rocks, the granitic rocks have still undergone weathering and erosion processes, resulting in a typically deep residual soil profile across the region. Residual soils are soils that derive from the alteration of rock minerals to clay minerals due to exposure to water and oxygen. An example of the weathering process of granitic rocks is shown in Figure 6.3.

60) As granitic rocks typically comprise quartz, feldspar and mica as the dominant minerals, the residual soils will typically comprise clayey sands, sandy clay or sandy silt, where sand is derived from the quartz component and

clay from the feldspar and mica component of the parent rock. With depth, gravels and cobbles or boulders of granite may be encountered.

Figure 6.3 Example profile within granitic rock showing transition from rock into residual soil (from Engineering Geology of Melbourne, Peck et. al. 1992).

61) As the granitic hills undergo chemical weathering, the flanks of the hills become prone to erosion and landslide, because soils cannot usually maintain as steep a slope compared to rock. The landslides that derive from granite can produce large scale debris flows comprising a mixture of granitic soils and corestones. The material that flows downslope in a debris flow will concentrate in and then deposit in channels (gulleys) once it loses its energy.

62) It is common in Victoria for debris flows to facilitate the buildup of colluvial deposits surrounding granitic hills such as Arthurs Seat. Colluvial deposits of this type comprise soil and rocks which have been transported by gravity during landslide events and in the process disaggregate and dilate. Larger, coarser rock travels less distance and is more commonly encountered closer to the landslide source, whereas finer material can travel further. Given colluvium is a transported soil derived from the parent rock or soil, it can be difficult to identify the contact

between colluvium and underlying residual soil. Identification is made through assessment of the structure within the soil, with colluvium usually a more chaotic, dilated material which may exhibit layering.

63) Through a sequence over geological time of debris flows, channel infill, carving of new channels and infill of those channels, a series of colluvium-filled gullies may form at the base of granite hills. The colluvium thickness can be highly variable across short distances, being thicker within backfilled channels and thinner towards the edge of or outside of the channels. This distribution of colluvium at the base of granite hills is common on the north and north west facing slopes of granites and granitic type rocks in Victoria including the Victorian alps and Yarra Ranges. A sketch showing the inferred landscape evolution in the McCrae area is shown in Figure 6.4.

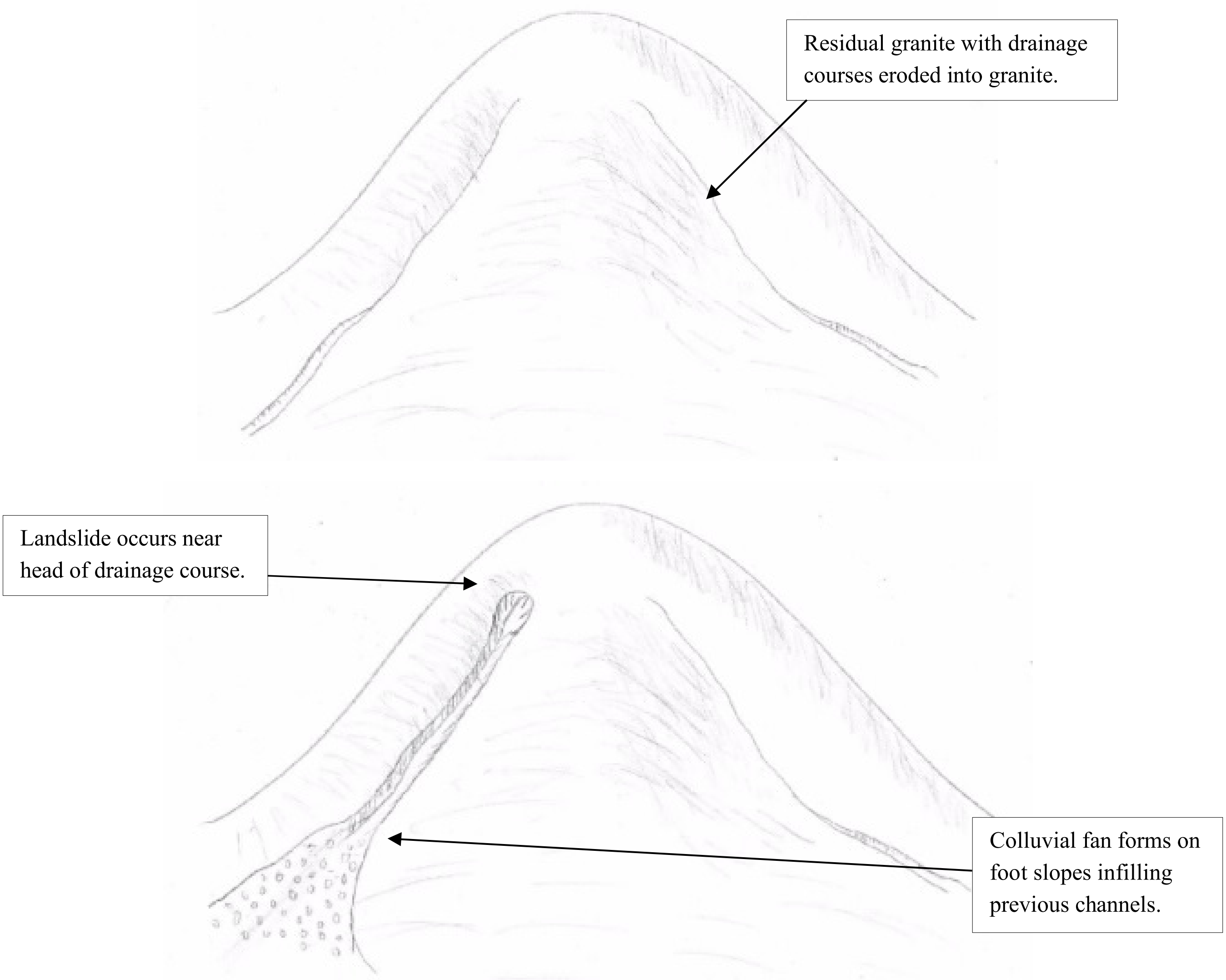

Figure 6.4 Evolutionary sketch showing landscape evolution

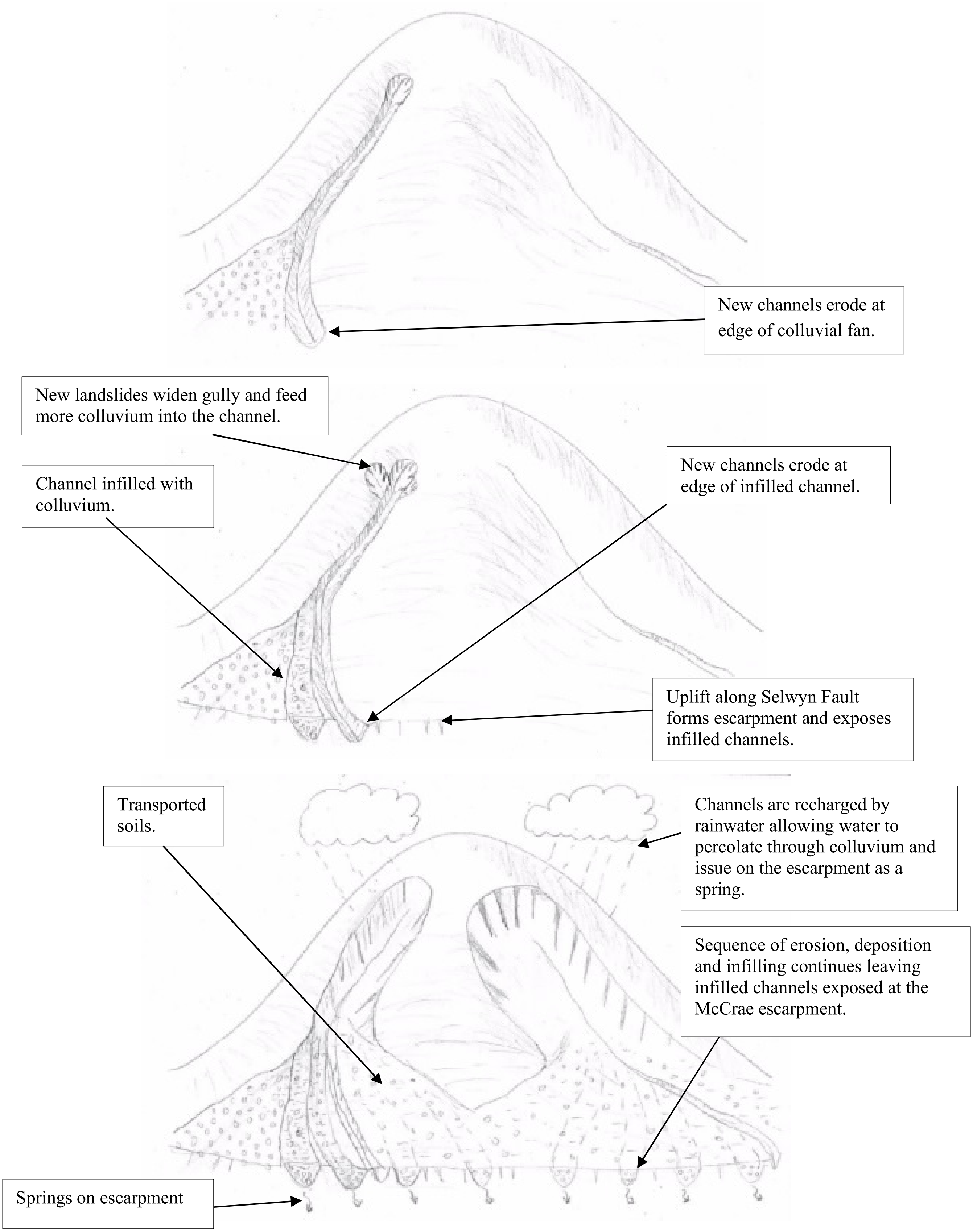

Figure 6.4 Evolutionary sketch showing landscape evolution

64) There are a series of present day, well-developed gullies extending from Arthurs Seat to the coastline at McCrae, some of which appear to have been piped and infilled (for example upslope of Margaret Street) based on comparison between older (circa 1950's) topographic maps and current maps, also see Figure 6.5. Others, however may have been infilled with colluvium over geological time. Figure 6.5 presents observations of the geomorphology through the McCrae area that help to inform the geomorphic development of the area.

65) Development of the steep McCrae escarpment observed at the site is the result of both uplift of the rocks to the east of the Selwyn Fault and ongoing coastal regression. These may offset earlier channels forming the series of hanging valleys observed along the escarpment as shown in Figure 6.4. These hanging valleys likely now coincide with the locations of springs as water is able to migrate more readily through the more permeable channels backfilled with colluvium compared to the less permeable underlying residual granite that defines the channels.

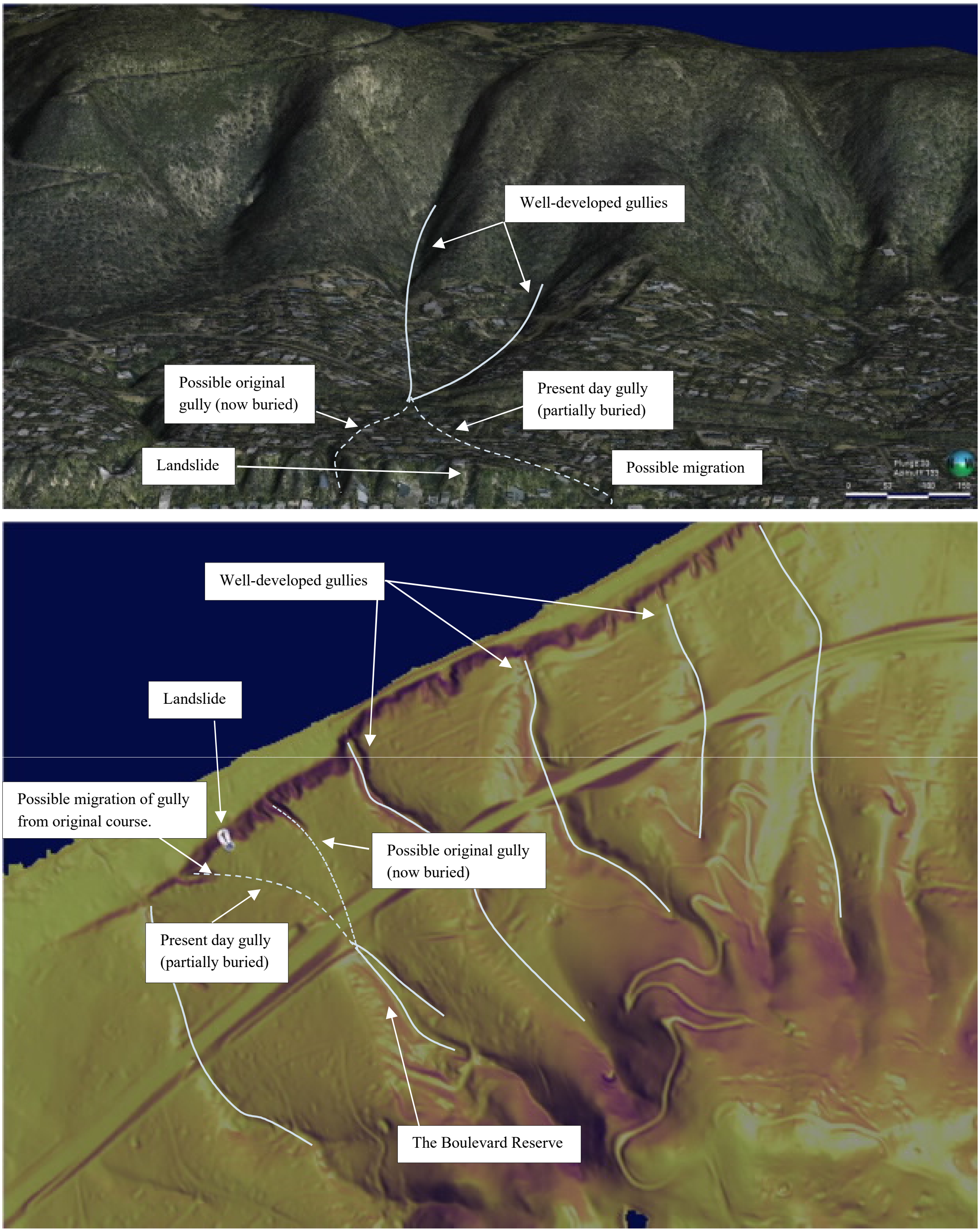

Figure 6.5 Observations of geomorphic features related to channels in the McCrae area (5m digital elevation model sourced from Geoscience Australia).

6.2 Recent Investigations

66) Whilst an understanding of the regional evolution of the ground is an important first step to developing an engineering geological model, localised information is needed to develop a model at a scale relevant to the landslide. Recent site investigations and observations have been utilised in the development of the EGM including:

a. PSM 2025 Site investigation including boreholes, groundwater and site observations provided in document MSC.5007.0004.0078.

b. Site observations from WSP's site visit on 23rd May 2025.

c. PSM McCrae Landslide – Stormwater and Sewer Investigation including boreholes and groundwater observations provided in MSC.5067.0001.0018.

67) Site investigations have generally encountered subsurface materials consistent with expectations based on the regional assessment as set out in Section 6.1, with granitic residual soils and weathered granite identified across the area encountered in all boreholes. Granitic residual soils were also observed at surface within the escarpment face. An example of granitic residual soil and extremely weathered rock encountered in boreholes is shown in Figure 6.6.

Figure 6.6 Core recovered from BH01 showing residual soils (white) and extremely weathered granite (red). Depth range 8 m to 12 m below ground surface.

68) Whilst not identified in the Sorrento 1:63,360 geological map, both the PSM (MSC.5007.0004.0078) boreholes and site observations identified colluvium as a geological material underlying the McCrae escarpment, including south of the Mornington Peninsula Freeway and the areas between the Mornington Peninsula Freeway and the McCrae escarpment. Colluvium is a transported soil derived from landslides. In this report, I refer to colluvial soils as transported soils noting that the transported soils include not just soils transported through landslide processes but also soils transported through aeolian (wind blown) processes. Key observations made of the colluvium include:

a. Colluvium was observed within the headscarp of the 14 January 2025 landslide during my site visit on 23 May 2025. Colluvium appeared to be channelised at the headscarp location, with gravel and cobbles observed at the base of the colluvium horizon. This colluvium horizon is shown in Figure 6.8 and is a feature consistent with expectations based on the regional geology.

b. Inferred colluvium was identified in the four boreholes drilled by PSM near the crest of the escarpment, on View Point Road and between View Point Road and the McCrae escarpment, with thicknesses of between 2.7 m and 5.05 m inferred in boreholes. An example of colluvium observed in BH04 of the PSM 2025 site investigation is provided in Figure 6.7.

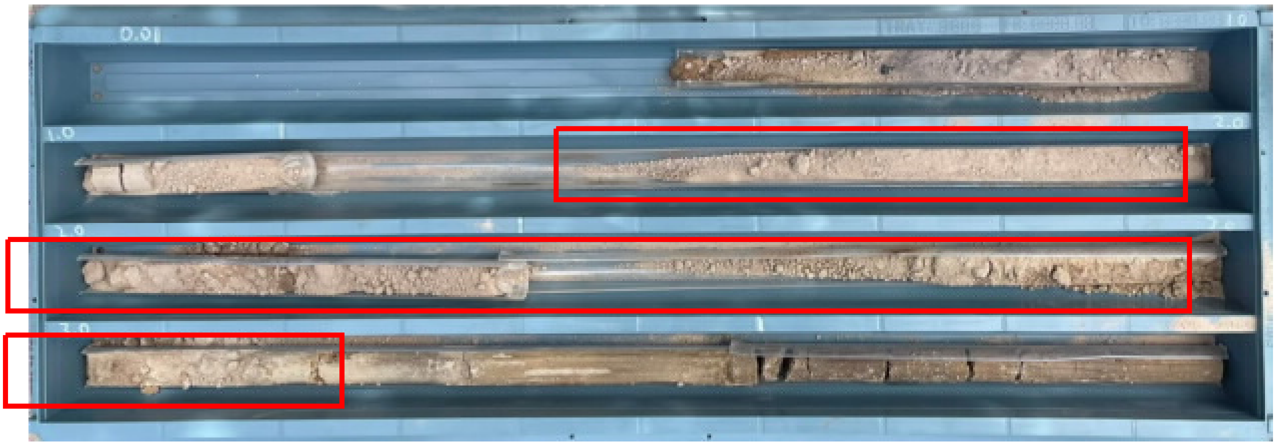

Figure 6.7 Colluvium (red) observed in BH04, overlying granitic residual soils.

c. Colluvium comprising sandy material and rounded cobbles and boulders was observed in the headscarp formed by the 14 January 2025 landslide and on the slopes to the west of the headscarp. Rounded grains, sorting and layering in these deposits are indicative of sediments that have been transported. In this case likely by debris flow or fluvial (carried in water flow) processes. Examples are shown in Figure 6.8, Figure 6.9 and Figure 6.10.

Figure 6.8 Sub-surface profile as identified within the landslide headscarp.

Figure 6.9 Examples of materials exposed on the escarpment

Figure 6.10 Examples of materials exposed in landslide headscarp

69) Transported soils were observed at other locations in the McCrae area in boreholes and excavations as described in the geological model set out at Section 6, including south of the Mornington Peninsula Freeway at Bayview Road and opposite The Boulevard Reserve as indicated in Figure 6.11. Colluvium was also observed in boreholes located between the landslide location and Bayview Road during the Stormwater and Sewer investigation conducted by PSM including BH14A, NDT13, NDT08, NDT06 and NDT05 (MSC.5067.0001.0018).

Figure 6.11 Transported soils exposed on Bayview Road opposite The Boulevard Reserve (SME.0001.0001.0120)

70) Fill materials have been identified in boreholes in the area surrounding the site, typically with thicknesses up to 1.5 m. There are also likely to be additional, deeper areas of fill present where retaining structures have been constructed on and near the McCrae escarpment and there is localised deeper fill that has been used to backfill trenches. Observations of fill are as follows:

a. Fill horizons were observed to be exposed within the headscarp of the 2025 landslide, with several generations of fill identified.

b. Figure 6.12 identifies areas where landscape modification including fill placement has occurred over the eight-year period between 2017 and 2025. This map is derived by calculating the difference in elevation between the ground surface as measured in 2017 and as measured in 2025. Colours indicate where soil has either been removed (cut) or emplaced (fill). An example of fill placed at 10-12 View Point Road, immediately adjacent to the landslide is shown in Figure 6.13. This fill is understood to have been placed between December 2020 and January 2024 as part of retaining wall construction at 10-12 View Point Road (RES.0001.0003.0002).

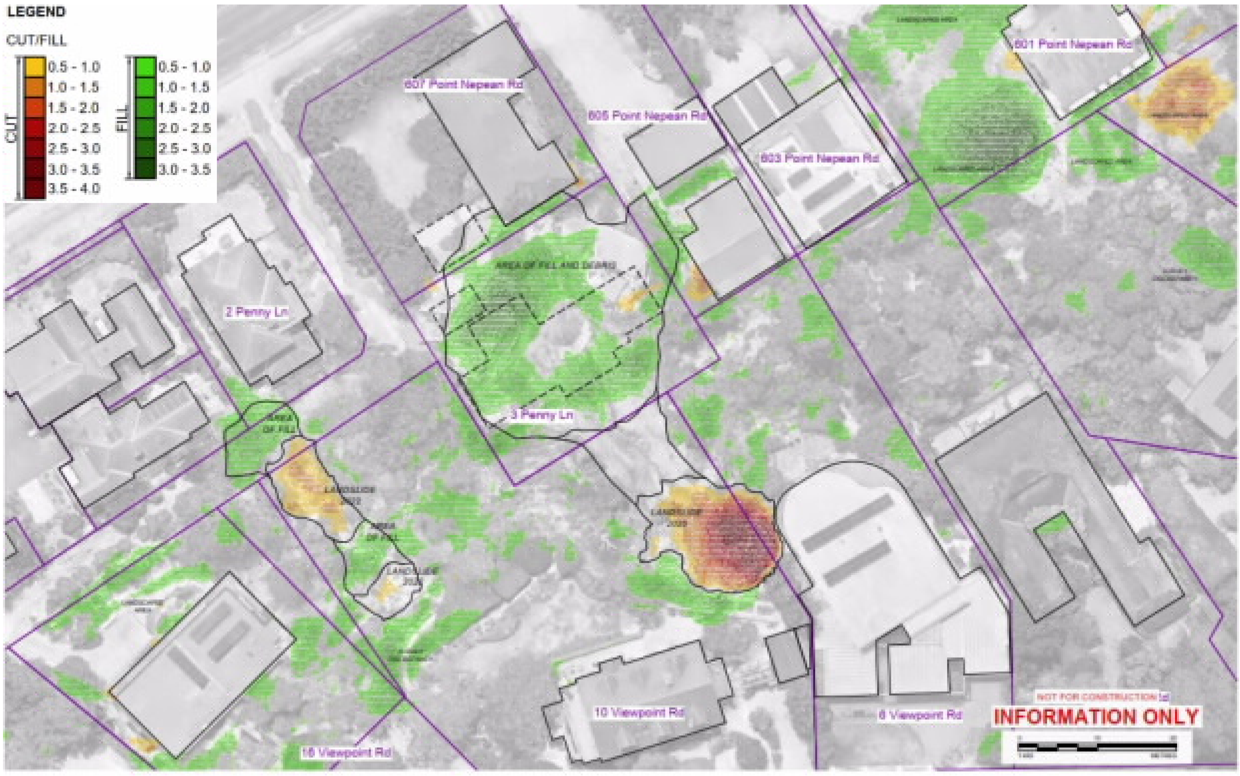

Figure 6.12 Landscape modifications made between 2017 and 2025 based on comparison of LiDAR.

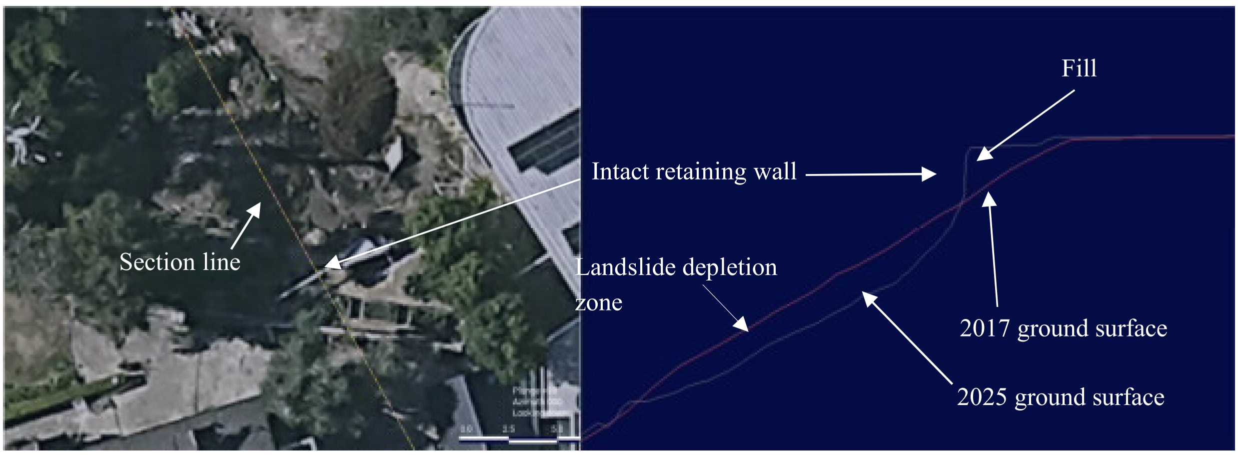

Figure 6.13 Example of fill placed after 2017.

c. Service trenches have been constructed across the McCrae area including stormwater, sewer and water mains which involved backfilling of trenches typically with compacted backfill material. This is discussed further in Section 7.5.2.

6.3 Engineering Geological Model

71) An engineering geological model (EGM) has been developed for the site to identify and describe the spatial relationship between the geological units observed.

72) Four geological units were identified that comprise the EGM. These units are summarised in Table 6.1.

Table 6.1 Geological units identified and included within the EGM.

Unit	Description	Occurrence
Fill	Highly variable, typically silty sand to sand. Multiple generations of fill, in particular near the McCrae escarpment. Backfilling of service trenches.	Observed from surface across the site with variable thickness, typically less than 1.5 m. Localised deep fill is expected behind retaining walls and within service trench backfill.
Transported Soils	Comprises colluvium (soils deposited through landslide processes) and aeolian (wind blown) sands. Clayey sand to sand with cobbles and gravel. Aeolian sands typically do not contain clays in notable proportions and the aeolian proportions are typically calcareous.	Aeolian sands are largely present at the base of the escarpment. May be observed in thin horizons or be absent at the top of the escarpment. Colluvium is observed as an apron around Arthurs Seat, with areas of increased thickness expected within both existing gullies and historic, now buried gullies/channels.
Residual Granitic Soils	Clayey sand to sandy clay. Clays are typically very stiff to hard and sands are typically dense to very dense.	Underlies transported soils across the site originating from the weathering of the basement rock, the Dromana Granite. Observed to be of variable thickness, up to 9.5 m thick in BH03 (MSC.5007.0004.0078)
Extremely Weathered Granite	Clayey sand to sandy clay with relic rock fabric observed. Clays are typically very stiff to hard and sands are typically dense to very dense.	Underlies residual soils across the site extents.

73) A series of cross sections and 3D renders are presented in Appendix C to illustrate the inferred spatial relationships between the subsurface materials expected to underlie the McCrae area.

74) The EGM is based on the best information available at the time the model was compiled. Given this limited data, the EGM is judged to show the relationship between units with moderate to high certainty whilst the extents and thickness of units is modelled with very high certainty at borehole locations, but low certainty away from boreholes. Further investigation information will assist with improving the certainty in the EGM.

75) All EGM's contain some uncertainty because it is not possible to observe all parts of the subsurface. Lower certainty applies to locations at which there is little or no investigation available to inform the EGM, for example where there are no investigative boreholes. Whilst there are parts of the EGM with low certainty because there is no investigation, when considered in conjunction with what is known about the geological evolution of the area, this

localised uncertainty does not preclude use of the EGM for the purpose it has been developed which is to assess the causes of the November 2022 and January 2025 landslides on the McCrae escarpment and to draw conclusions on the causes of those landslides as discussed in Sections 7 and 8.

6.4 Hydrogeological Conceptual Model

76) A hydrogeological conceptual model describes the hydrostratigraphic units where groundwater may be present, groundwater flow paths and groundwater quality. Hydrostratigraphic units are the geological materials described in terms of their influence on groundwater. The hydrostratigratic units in the site area are expected to be as described in Table 6.2, with physical characteristics as described in Table 6.1 and Figure 6.3. In the absence of site-specific measurements, typical properties are derived from published ranges for different geological materials (e.g. Domenico & Schwartz, 1990)[8]. Indications of aquifer properties from site observations are discussed in Section 7.3.

Table 6.2 Hydrostratigraphic units identified

Unit	Aquifer/aquitard	Typical properties
Fill	Local aquifer, restricted in area and continuity. May be unsaturated or hold perched groundwater at times.	Unconfined porous media. Hydraulic conductivity (K) may range from around 10^{-6} m/s to 10^{-3} m/s. Likely to be variable depending on composition and degree of compaction. Likely to be higher hydraulic conductivity in service trench backfill depending on type of backfill.
Transported Soils	Local aquifer, restricted in area and continuity. May be unsaturated or hold perched groundwater at times.	Unconfined porous media. K may range from around 10^{-5} m/s to 10^{-3} m/s. Likely to be variable depending on composition. Some parts possibly as high as 2×10^{-1} m/s based on dye trace between Borehole NDT01 and landslide escarpment.
Residual Granitic Soils and Extremely Weathered Granite	Aquitard, limiting the downward flow of groundwater.	Unconfined porous media. K may range from around 10^{-10} m/s to 10^{-7} m/s.
Moderately to Highly Weathered Granite	Aquifer. Likely to host the permanent regional water table.	Unconfined porous media transitioning to fractured rock with decreasing weathering. K may range from 10^{-6} m/s to 10^{-5} m/s.
Fresh granite	Aquitard/aquiclude preventing downward movement of groundwater.	Impermeable basement rock with absent or closed fractures. Very low K.

77) Measurements in groundwater monitoring wells and piezometers installed around the site are mostly inferred to represent the perched fill/colluvial aquifer (BH01A, VWP1A, BH03A, VWP3C, BH04A, VWP5A, NDT01,

[8] Domenico, P.A. and F.W. Schwartz, 1990. Physical and Chemical Hydrogeology, John Wiley & Sons, New York, 824 p.

VWP2D) or weathered granite aquifer (VWP1B, VWP1C, VWP2A, VWP2B, VWP2C, VWP3A, VWP3B, BH04). (MSC.5067.0001.0018). The separation in groundwater elevations between shallow and deep piezometers (e.g. Figure 8.6) indicates perched shallow groundwater with an underlying unsaturated zone above the deeper regional groundwater.

78) Due to the topographic relief, groundwater flow in the site area is expected to be generally to the north-west, towards Port Phillip Bay.

79) Groundwater recharge would normally be from rainfall infiltration, with variable contributions from anthropogenic sources such as leaking water, sewer or stormwater services, irrigation and septic tanks (where applicable). Recharge to the weathered granite aquifer discharge would primarily be in elevated areas to the south-east where the clayey weathered granite materials have been removed by erosion. There would be a component of downward migration of groundwater from the fill and colluvium to the weathered granite aquifer, with the rate limited by the low permeability clay-rich weathered material.

80) Regional groundwater discharge would primarily be to Port Phillip Bay, but also to springs and surface water streams. Springs would generally be from shallow perched aquifers where there is a subsurface barrier to flow or a local topographic low point such as a channel or scarp. Springs may not be permanently flowing, varying with the saturation and water levels in the perched aquifers.

81) Regional groundwater is assessed as having moderate salinity, with total dissolved solids (TDS) between 1,000 mg/L and 3,500 mg/L. Perched groundwater is likely to be fresher due to more recent and direct recharge.

82) When considering groundwater travel time from point to point it must be remembered that subsurface flow paths are not direct, with water travelling through pore spaces and around lower permeability particles and zones. There is also interaction with subsurface materials, such as absorption, dissolution and surface tension effects, physical evaporation and transpiration by vegetation. Therefore, fluid released at one point will travel at different rates, spread out and arrive down-gradient spread over a wide time interval. The velocity of a particle travelling through the aquifer, referred to as specific discharge, is higher than the linear velocity measured from point to point at the ground surface. Travel time can refer to the fastest arrival, the peak flow rate arrival or the time for the flow to cease.

7 McCrae Landslide Preparatory Factors

7.1 Geology and Soil Properties

83) The EGM helps to provide an indication of the rocks and soils comprising the slopes of the McCrae escarpment and in the vicinity of the escarpment on which the January 2025 landslides occurred. However, the susceptibility of those soils to landslide depends on their composition and behaviour in response to changes such as changes in pore water pressure. The following evidence is available to assess the composition of the soils comprising the escarpment on which the 2025 landslide occurred:

a. Boreholes undertaken near the head of the escarpment by PSM and included in document MSC.5007.0004.0078 include a description of the soil profile immediately upslope of the January 2025 landslides.

b. Observation of the soils exposed in the escarpment undertaken by me on 25 May 2025.

c. Photos of the soils exposed in the escarpment and presented in various documents including the witness statement of Gerrard Borghesi (RES.0001.0003.0002) and PSM risk to life assessment (MSC.5047.0001.0001).

84) There are three subsurface materials underlying the site of the January 2025 landslides which due to their geotechnical properties are susceptible to landslide: residual granitic soils, transported soils and fill. The composition and the response of these soils to changes caused by wetting is subsequently discussed.

7.1.1 Residual Granitic Soils

85) The residual granitic soils are derived from in situ weathering of granite whereby the granite rock has completely weathered to a material with soil properties. Based on particle size distribution testing undertaken in residual soils and set out in Appendix E of reference MSC.5007.0004.0078 and reproduced in Figure 7.1, the residual soils are sandy clays or silts, containing 45% to 60% fines (clay or silt sized material). Materials with this particle size are able to develop and preserve soil suctions which can give them strength. This effect is evident given the subvertical headscarp that has formed and remained in place as a result of the 14 January 2025 landslide and noting that the headscarp is well above the water table. Based on the PSM groundwater monitoring in Borehole BH01 (PSM.5002.0001.0002) the water table is 25 m to 26.5 m below the ground surface (VWP1C installed at 29 m).

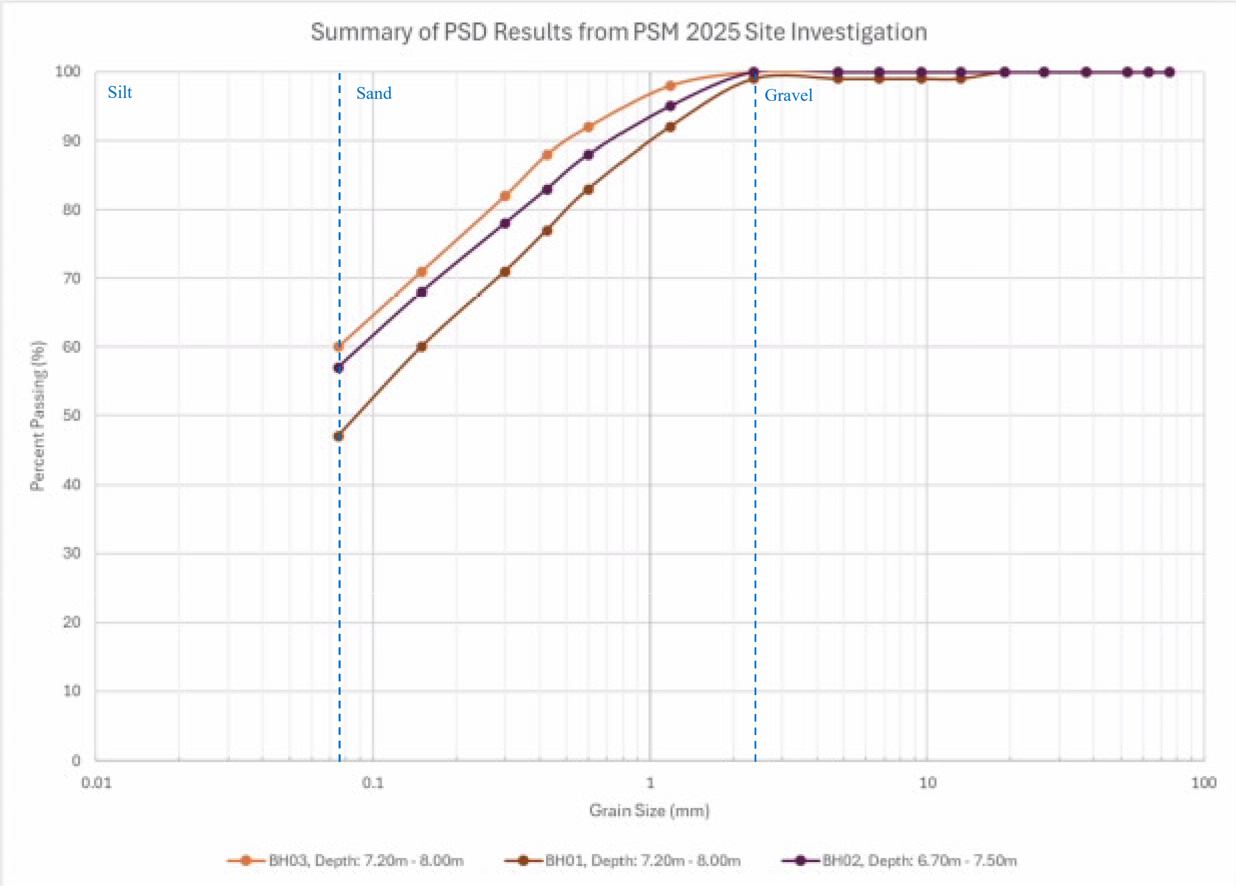

Figure 7.1 Particle size distribution in residual granite soils based on laboratory results presented in reference PSM factual report, MSC.5007.0004.0078.

86) No testing of the residual granite has been undertaken to measure the suction potential, however an indication can be gained based on the particle size. Figure 7.2 presents a chart showing soil suction versus moisture content for typical soil types including clay, silt and sand. The residual granite is mostly characterised as sandy silt or clay. Based on these classifications and on the reported moisture content (converted to volumetric water content using assumed bulk density of 2.2 g/cm^3), an annotation has been provided on Figure 7.4 to indicate the range of matric suction that might develop in the residual granitic soils underlying the McCrae escarpment. Although this is an approximate approach adopted in lieu of testing, it is sufficient to provide a very high degree of certainty that the residual soils underlying the McCrae escarpment can generally support high suction and because of that can preserve strength through the effects of suction stresses (until the soil wets up).

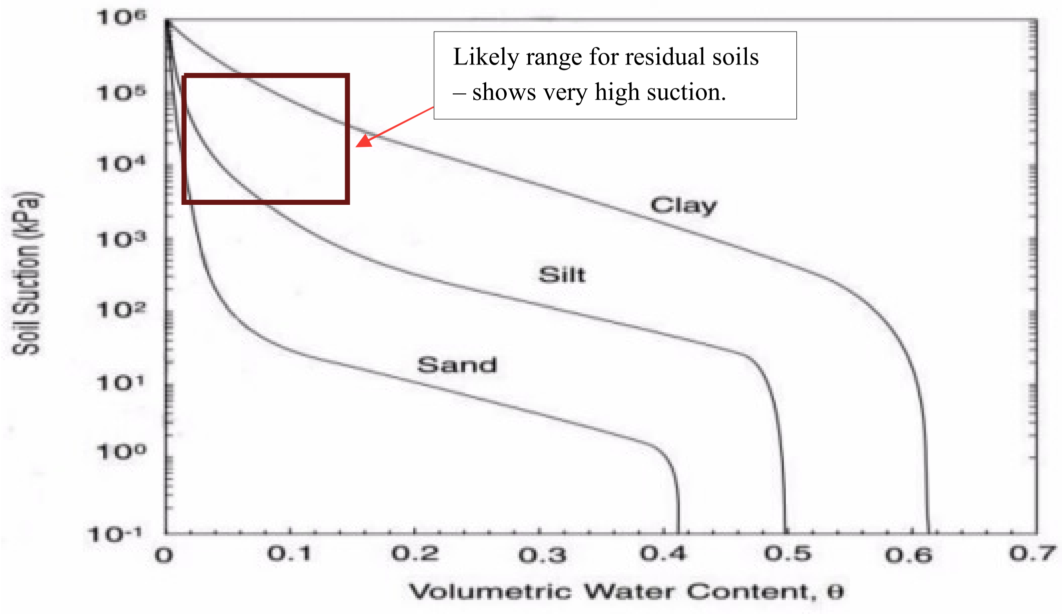

Figure 7.2 Typical soil water characteristic curve for various soil types annotated to show expected range of soil suction based on particle size distribution measurement for residual soils included in MSC.5007.0004.0078.

87) Also, with reference to Figure 7.2, as water content increases in the soil, suction is lost and so to is soil strength.

88) With a high degree of certainty, the residual granitic soils are able to preserve high suctions, which gives them relatively high soil strength and allows them to form steep slopes. The presence of these soils is a preparatory factor for landslide because they can rapidly lose suction upon an increase in water content and pore water pressure and therefore lose strength. If sufficient strength is lost the soil can develop into a landslide.

7.1.2 Transported Soils

89) The transported soils are comprised of a mixture of soils transported through landslide processes (colluvium) and soils transported by wind (aeolian). Particle size distribution testing within the transported soils indicate them to be more granular than the residual soils, as shown in Figure 7.3, containing between 25% and 45% fines. They are typically classified as clayey or silty sand.

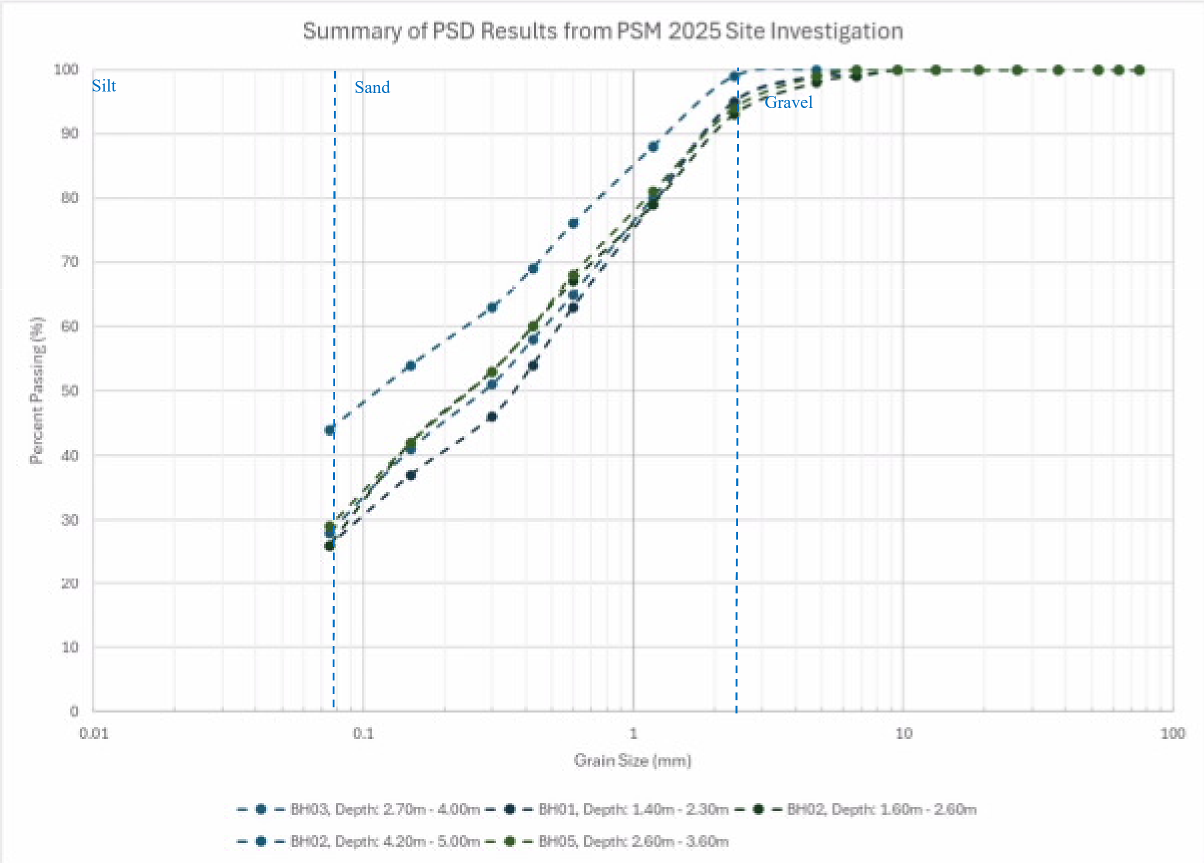

Figure 7.3 Particle size distribution in transported soils based on laboratory results presented in PSM factual report, reference MSC.5007.0004.0078.

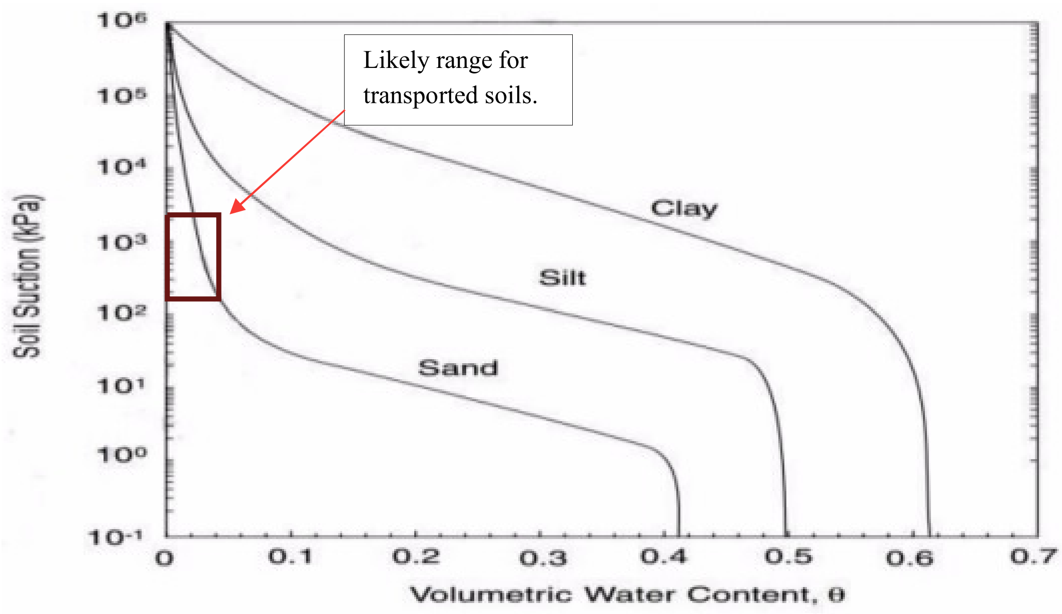

Figure 7.4 Typical soil water characteristic curve for various soil types[9] annotated to show expected range based on particle size distribution measurement for transported soils included in MSC.5007.0004.0078.

90) Based on observations made of exposures in the transported soils including in the headscarp of the 2025 landslide, the transported soils contain some cobbles and boulders of granite (Figure 6.10), which cannot be sampled from a borehole and tested to derive a particle size distribution curve. The transported soils may therefore be biased to finer materials and the in situ materials may be more granular than is indicated in Figure 7.4. Because the particles comprising the soils are coarser, these materials cannot support suction stresses as high as those in the residual granite, and the change in moisture content required to lose suction and therefore strength in this material is relatively lower.

91) Because the transported soils are coarser than the residual granite, their hydraulic conductivity is expected to be much higher meaning that water can flow through this material more readily than it can flow through the residual granitic soils. This is further discussed in Section 7.3.

92) The presence of the transported soils are a preparatory factor for landslide because like the residual granite, whilst they can maintain suctions allowing them to form steep slopes, that suction can be rapidly lost on wetting resulting in landslides. Furthermore, the contrast in hydraulic conductivity between the coarser grained transported soils and the underlying residual granite provides a pathway for groundwater flow as discussed in Section 7.3.

7.1.3 Fill

93) Fill materials have been placed to varying thicknesses over the transported soils and are exposed in the headscarp formed by the 14 January 2025 landslide as shown in Figure 7.5. Multiple layers of fill appear to have been deposited near the headscarp, which based on their distribution appear to have infilled a natural gully.

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[9] Mekkiyah, H., Fattah, M.Y., (2020) The soil water characteristic curve for Non-cohesive soils, Solid State Technology, October 2020.

a. There is an organic material 200 mm to 300 mm thick at the base of the gully which immediately overlies the transported soils. The organic material appears to contain waste plastic suggesting the fill overlying it is of relatively young age (e.g. fill is more likely to have been placed in the last 50 years rather than the last 100 years). The organic material may be natural, although this cannot be determined from visual observation alone and could represent organic material that has accumulated in a minor water course.

b. A lower fill comprising what appears to be silty sand based on visual assessment that is likely to be locally derived, possibly from the transported soils or residual granite.

c. An upper fill comprising orange clayey sand about 0.4 m thick. A layer of geofabric separates the upper and lower fill.

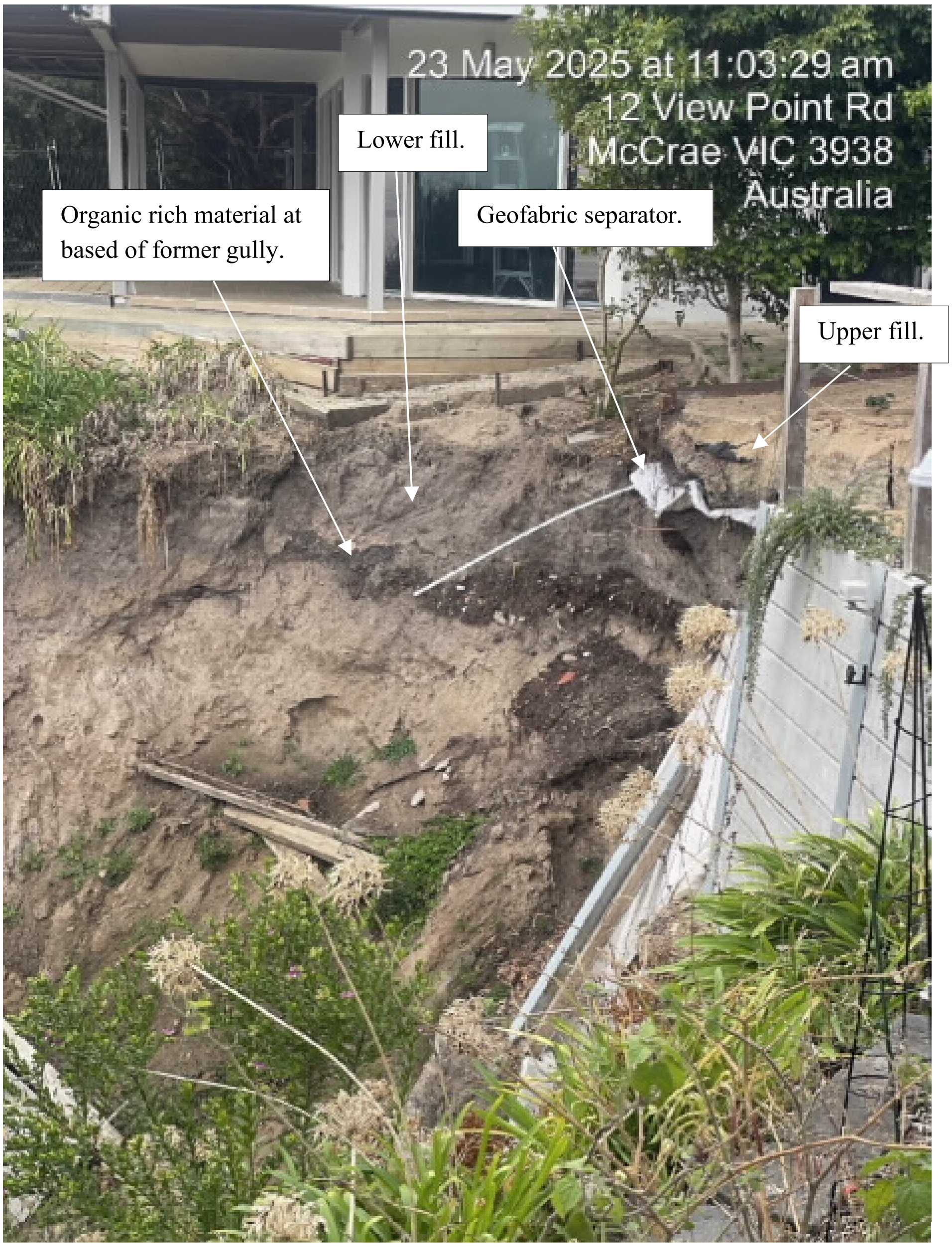

Figure 7.5 Fill materials exposed in the headscarp formed by the 14 January 2025 landslide.

94) The fill materials are comprised of predominantly silty or clayey sands and like the underlying natural materials can preserve soil suctions and stand at steep angles as can be seen in Figure 7.5. Upon wetting, a rapid loss of strength can ensue leading to the landslide. This makes the presence of the fill a preparatory factor for landslide. Preparatory factors for landslide relating to the placement of the fill at the crest of the McCrae escarpment are also discussed with respect to anthropogenic factors at Section 7.5.

7.2 Slope angle and terrain

95) The characteristics of the soil or rock type alone do not make the McCrae area susceptible to landslide. These materials must underlie a slope that is steep enough such that if soil strength is reduced, the soil is able to move downslope under the action of gravity forming a landslide.

96) Based on survey, the angle of the McCrae escarpment, including at the locations of the November 2022 and January 2025 landslides is in the order of 35° to 40°, which is demonstrated by the fact that soil displaced by the November 2022 and January 2025 landslides was able to move downslope in response to a loss of strength caused by water. For a silty sand or sandy silt material in which suction stresses are lost due to wetting, this would usually be a sufficiently steep slope angle to initiate landsliding. A rough estimation can be made of the degree of saturation that could be required in the residual soils to induce landsliding assuming a 40° slope, using an equation after Lu and Godt (2008)[10]:

$$F = \frac{\tan \emptyset'}{\tan \beta} + \frac{2c'}{\gamma H_{ss} \sin 2\beta} - \frac{\sigma^s}{\gamma H_{ss}} (\tan \beta + \cot \beta) \tan \emptyset' \qquad (1)$$

Where:

- F is the factor of safety, assumed to be 1 at the point of landslide.
- $\emptyset'$ is the effective friction angle in degrees (°), although there is no testing, a typical value for sandy silt is about 28° (lab testing would help to refine this estimate).
- c' is the effective cohesion, assumed to be 5 kPa based on the silt and clay content (lab testing would help refine this estimate).
- β is the slope angle in degrees (°) as measured from the horizontal, assumed to be 40° at the site of the landslide.
- H_{ss} is the depth to the sliding plane from the ground surface, assumed to be 4 m based on the height of the landslide headscarp (see Figure 7.10).
- σ^s is the suction stress which is related to the volumetric water content as indicated in Figure 7.2.
- γ is the soil unit weight, assumed to be 2.2 t/m^3, typical for residual granite.

97) Solving equation (1) for σ^s, and assuming the inputs set out above, the suction stress of the residual granite at the point of landsliding would be in the order of 800 kPa. With reference to Figure 7.2, a reduction in suction stress to 800 kPa, might require only an increase in volumetric moisture content of say 10% up to 30%. Albeit based on assumptions, this provides an indication that a nominal increase in water content within the soils, combined with the steep slope angles could be sufficient to trigger landslide.

98) The slope angle in conjunction with the soil type are preparatory factors for landslides on the McCrae escarpment because a nominal increase in soil water content on a slope as steep as that which forms the McCrae escarpment can trigger landslide.

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10 Lu, N., Godt, J. (2008), Infinite slope stability under steady unsaturated seepage conditions, water resources research, Vol 44 (11) W11404.

7.3 Hydrogeology

99) The hydrogeological characteristics within the McCrae area are important because they relate to the propensity for water to move through the subsurface and to provide a pathway for water to infiltrate the soils underlying the escarpment, reduce suction stresses and to cause a landslide.

100) There is evidence for subsurface pathways along which water flows in the form of springs that were noted in 1862 prior to residential development and are included at Appendix A of Reference (MSC.5047.0001.0001) and reproduced with annotations in Figure 7.6.

101) Figure B1 in Appendix C provides an indication of potential flowpaths. Figure 7.7 presents an extract from that figure to illustrate potential natural flowpaths and Figure 7.8 shows where the section plots at a regional scale for context.

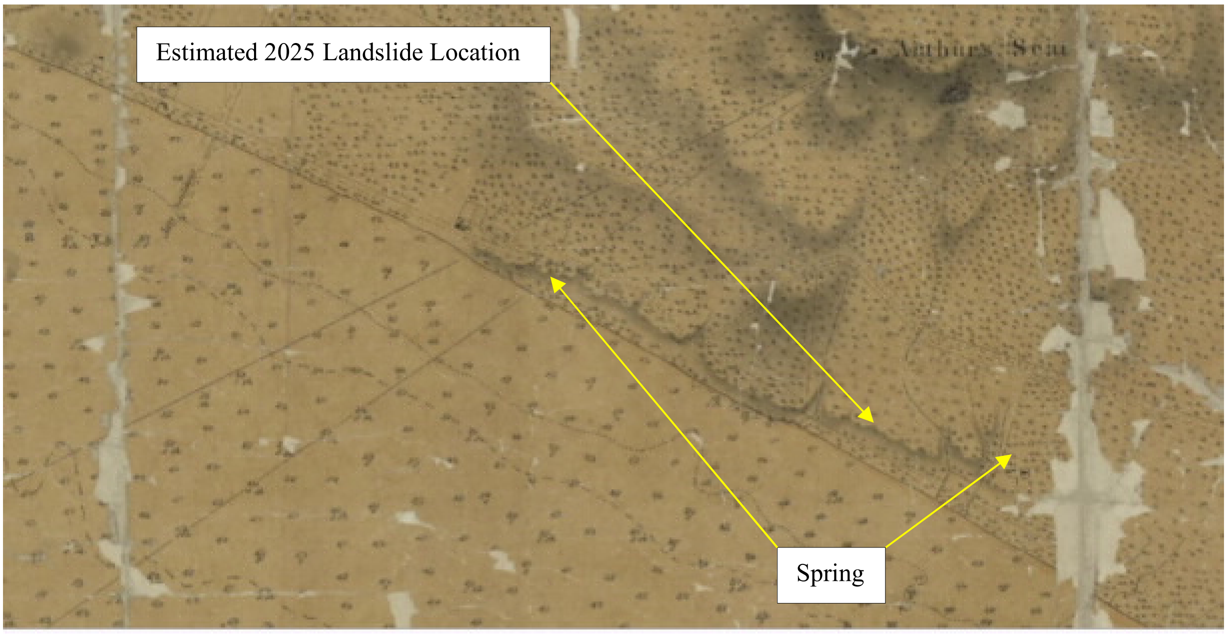

Figure 7.6 Evidence for springs based on 1862 coastline mapping of Port Phillip Bay.

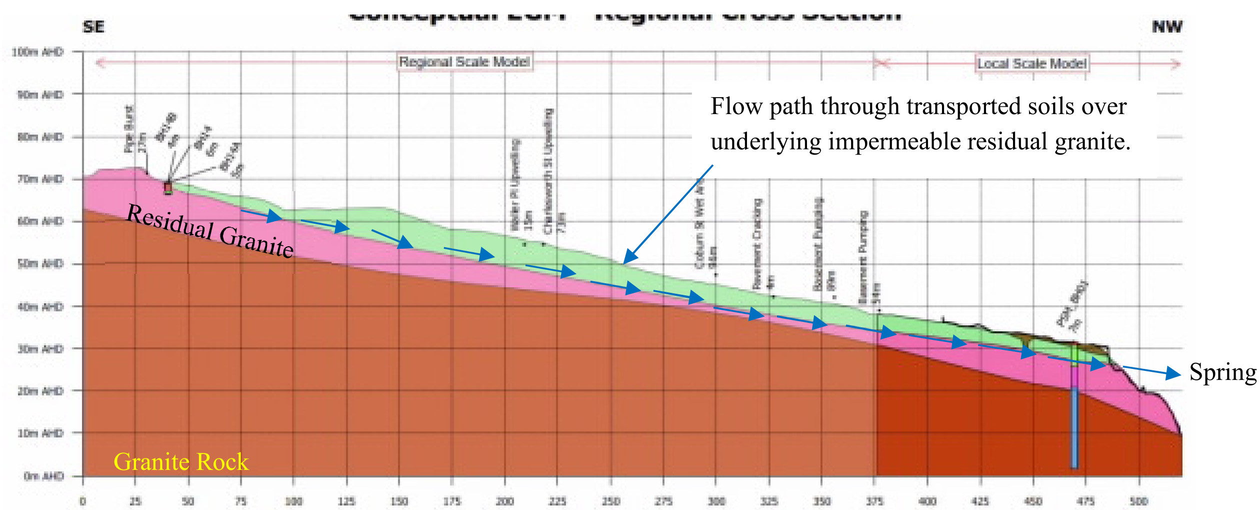

Figure 7.7 Conceptual hydrogeological sketch. Showing natural flowpaths between the foot of Arthurs Seat at The Boulevard and the McCrae Escarpment.

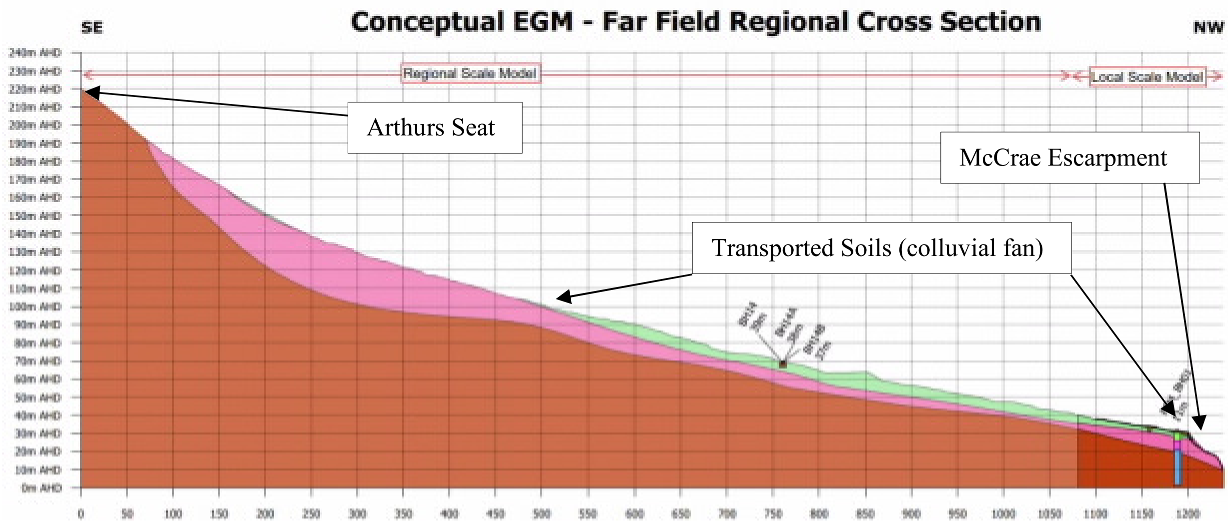

Figure 7.8 Conceptual hydrogeological sketch showing colluvial fan deposits at the foot of Arthurs Seat.

102) Seepage was observed issuing from the headscarp formed by the 14 January 2025 landslide at the base of an infilled channel through granular colluvial material containing cobbles and boulders. PSM describe a dye trace test undertaken on 10 February 2025 which involved injecting fluorescent green dye into Borehole NDT01 at 11:54 am (reference: PSM.5000.0004.4640). The dye was observed to be issuing from the headscarp near the contact between granular colluvium and residual granite at 1:28 PM meaning dye migrated through the subsurface between Borehole NDT01 and the landslide headscarp, a distance of about 22 m in 94 minutes. There are no known service trenches or anthropogenic pathways between borehole NDT01 and the point at which it was issuing from the escarpment suggesting flow through natural materials, likely the base of a colluvium filled channel between these points.

103) An estimate of the hydraulic conductivity of the transported (colluvial) soils through which the dye flowed can be made based on the time taken for the dye to pass between Borehole NDT01 and issue at the escarpment. The relationship between travel time and hydraulic conductivity is as follows, derived from Darcy's Law:

$$v_l = K.\frac{dh}{dl} \div n$$

Where v_l = linear velocity

K = hydraulic conductivity

$\frac{dh}{dl}$ = hydraulic gradient, and

n = porosity.

An estimated travel of 22 m in 94 minutes, gives a velocity of 0.004 m/s. With hydraulic gradient of 0.1 (2.3 m drop over 22 m) and assumed porosity of 20%, indicative K is 0.2 m/s (2 x 10^{-1} m/s). This is indicative of highly permeable ground.

104) Saturated soil has lower resistance to groundwater flow than unsaturated soil, as water must first overcome surface tension in unsaturated pore spaces prior to creating a flow pathway. Naturally occurring perched groundwater would provide this condition, so introduction of additional water may move more easily than in previously dry ground. Although groundwater monitoring locations were not present prior to the landslide to verify prior water table levels, historical records of springs suggests that shallow groundwater is naturally present, at least at some times.

105) The fines material within the colluvial soil is silty and dispersive meaning it can be eroded by flowing water. With continued flow through these dispersive soils, the hydraulic conductivity might be expected to increase over time with ongoing subsurface flow.

106) With very high certainty there are channels incised into the surface of the residual granitic soils that are infilled with transported soils (colluvium). These can act as subsurface flow paths for water that infiltrates into the subsurface on the flanks of Arthurs Seat. This is the mechanism by which natural springs have formed on the McCrae escarpment and these subsurface flow paths could act to convey water infiltrated from non-natural sources.

7.4 Vegetation

107) Vegetation has been progressively removed from the McCrae escarpment in the years preceding the 2022 and 2025 landslides as illustrated in Figure 7.9.

Figure 7.9 Comparative aerial photos showing vegetation removal on and around the McCrae escarpment in the vicinity of the January 2025 landslides between 2016 and 2024.

108) It is uncertain as to whether the roots of the vegetation would extend to sufficient depth such that they would draw water from towards the base of the transported soils. However, in general the removal of vegetation increases landslide susceptibility for the reasons set out in Section 4.5. The removal or lack of vegetation is a

preparatory factor for landslide, although the role of vegetation in making the slope around the January 2025 landslides more susceptible to landslide has low certainty and was probably minor.

7.5 Anthropogenic change

109) There have been works undertaken in the McCrae area that are likely to have increased the susceptibility of the area on and around the McCrae escarpment to landslide and are therefore nominated here as preparatory factors. These are discussed here separately under the categories of earthworks and services.

7.5.1 Earthworks

110) Section 4.6 sets out how changes made to the landscape through earthworks can increase susceptibility to landslide and so are preparatory factors for landslide and Figure 6.12 presents a comparison between the November 2017 LiDAR surface (PSM.5000.0002.9093) and the 2025 survey (PSM.5000.0003.4055), both of which were provided as part of an information pack provided by PSM.

111) Whilst the zones of depletion and accumulation associated with the November 2022 and January 2025 landslides are clear in Figure 6.12, there are several locations near the crest of the escarpment, including near the headscarp formed by the 14 January 2025 landslide where new fill appears to have been placed between 2017 and 2024. Based on the comparison between 2017 and 2025, the maximum thickness of fill placed near where the January 2025 landslide occurred is about 2.4 m as indicated by the cross section presented in Figure 7.10. This material is inferred to have been placed between 2022 and 2024 as part of works to build retaining walls at 10-12 View Point Road (RES.0001.0003.0002).

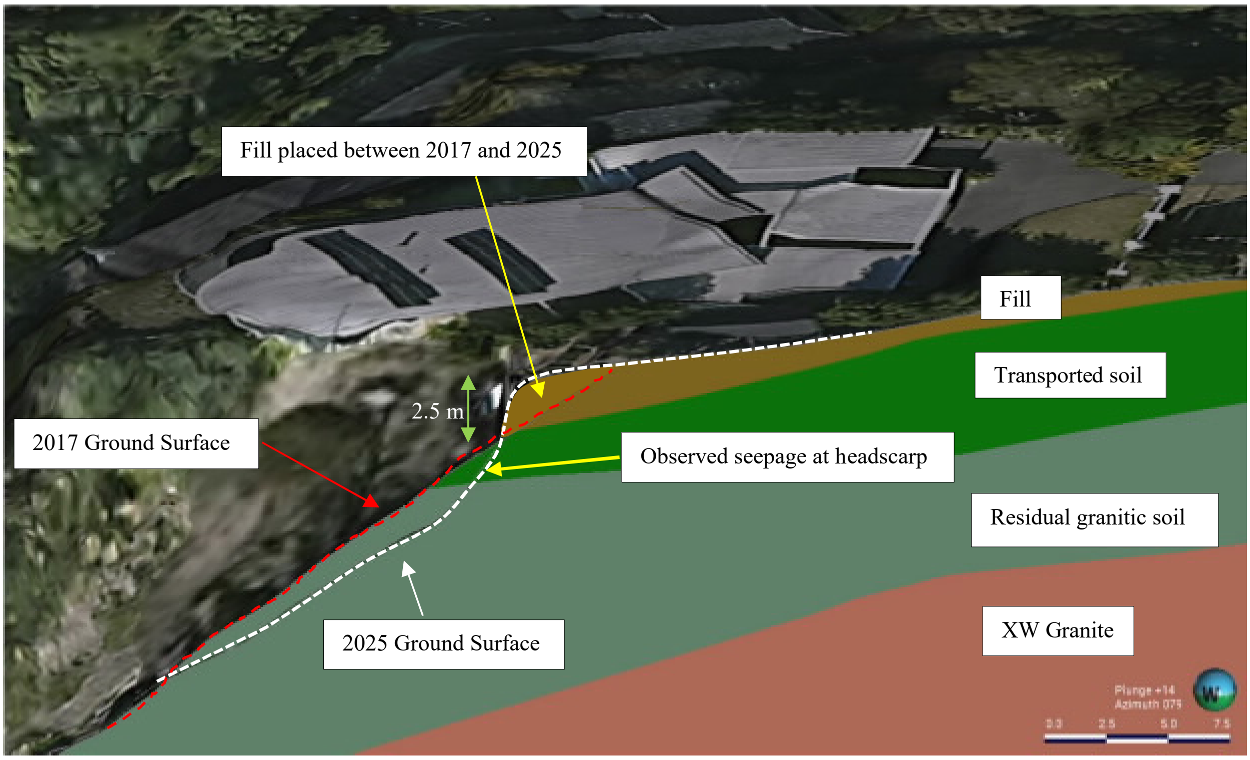

Figure 7.10 Cross sections through headscarp of January 2025 landslides showing comparison between 2017 and 2025 ground surface and interpreted subsurface profile.

112) Comparison between the 2017 and 2025 ground surfaces allows an estimate of the proportion of landslide debris derived from natural materials and from the soils retained behind the retaining wall (Figure 7.11). This comparison indicates that less than 5% of the landslide debris is derived from fill. This estimate is calculated with a low to moderate confidence given the 2017 ground surface may not have been reflective of the actual ground surface immediately preceding the landslide.

Figure 7.11 Comparison of 2017 and 2025 ground surface showing proportion of retaining wall and fill evacuated during the landslide.

113) Earthworks are a preparatory factor for landslides in the McCrae area because fill has been placed at and over the crest of the escarpment therefore applying a surcharge load to the escarpment which reduces stability. Furthermore, the fill increases the volume of material that can detach in the event of a landslide noting that some of the fill that was placed over the escarpment at 10 – 12 View Point Road (Figure 7.10) detached and contributed to the volume of material that impacted and eventually caused the collapse of the house at 3 Penny Lane. Without the fill there, the volume of soil that could have been mobilised and therefore impacted the house at 3 Penny Lane would have been less albeit marginally less, around 5%. The surcharge load applied by the fill reduced the stability of the underlying slope making the escarpment at that location more prone to collapse in response to the wetting that triggered the landslide. Whilst the significance of the contribution of fill as a preparatory factor for landslide is difficult to assess, it is inferred to be low because the points of initiation of the January 2025 landslides were below the base of the retaining wall, causing the retaining wall to be undermined and because the volume of soil retained by the wall and which therefore was surcharging the slope was relatively small (less than 5%) compared to the total volume of soil detached in the 14 January 2025 landslide.

7.5.2 Service Trenches

114) There are service trenches within the McCrae area including underlying the streets upslope of the escarpment that host:

a. Water mains comprised of asbestos cement installed predominately in the 1950's and 1960's (SME.0001.0001.0147).

b. Sewers comprised of vitreous clay pipe installed in 1981 (SME.0001.0001.0147).

c. Stormwater comprised mainly of concrete pipe and installed at various times (dates of installation range between 1971 and 2023 based on SME.0001.0001.0309) as part of stormwater upgrade works in View Point Road. Some stormwater pipes have been placed as part of infilling natural water courses, including the natural upstream extension to the south east of what is now the Margaret Street drain.

d. Other non-water bearing trenches including telecommunications and gas.

115) A plan showing the locations of water bearing services including their invert elevations in the vicinity of the November 2022 and January 2025 landslides is shown in Figure 7.12 and Figure 7.13.

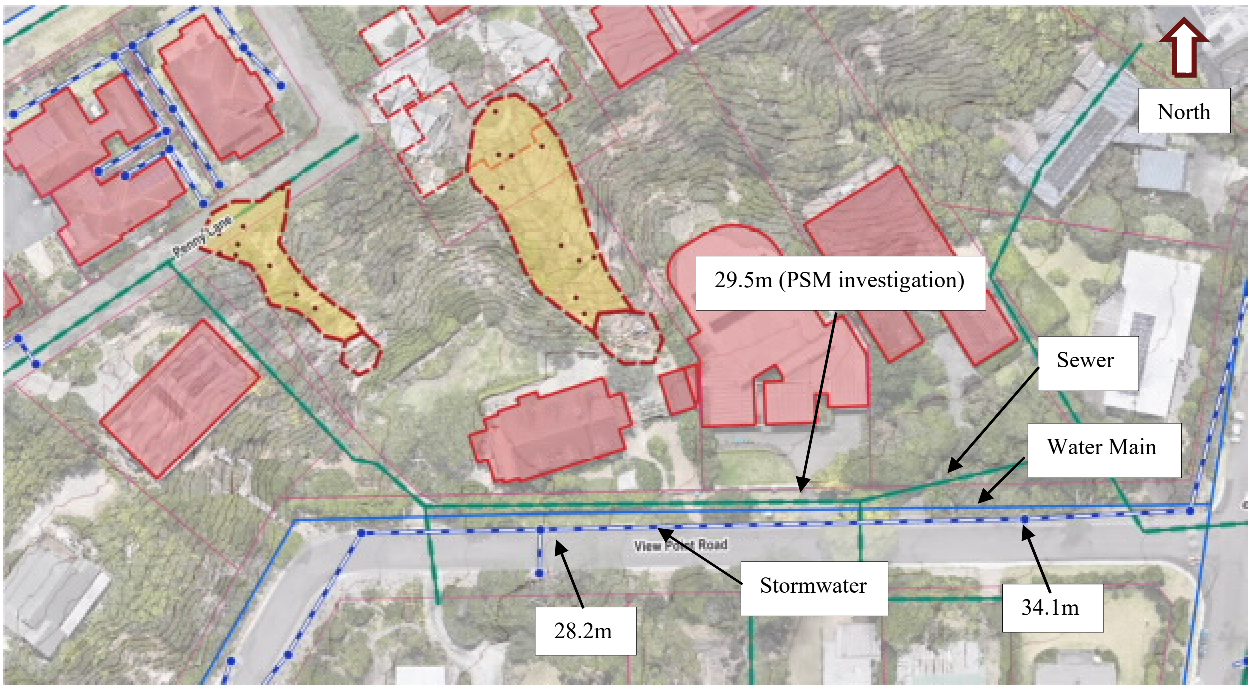

Figure 7.12 Service trenches for water infrastructure in the vicinity of the McCrae Landslide. Numbers indicate sewer invert elevations in meters AHD (elevation relative to Australian Height Datum).

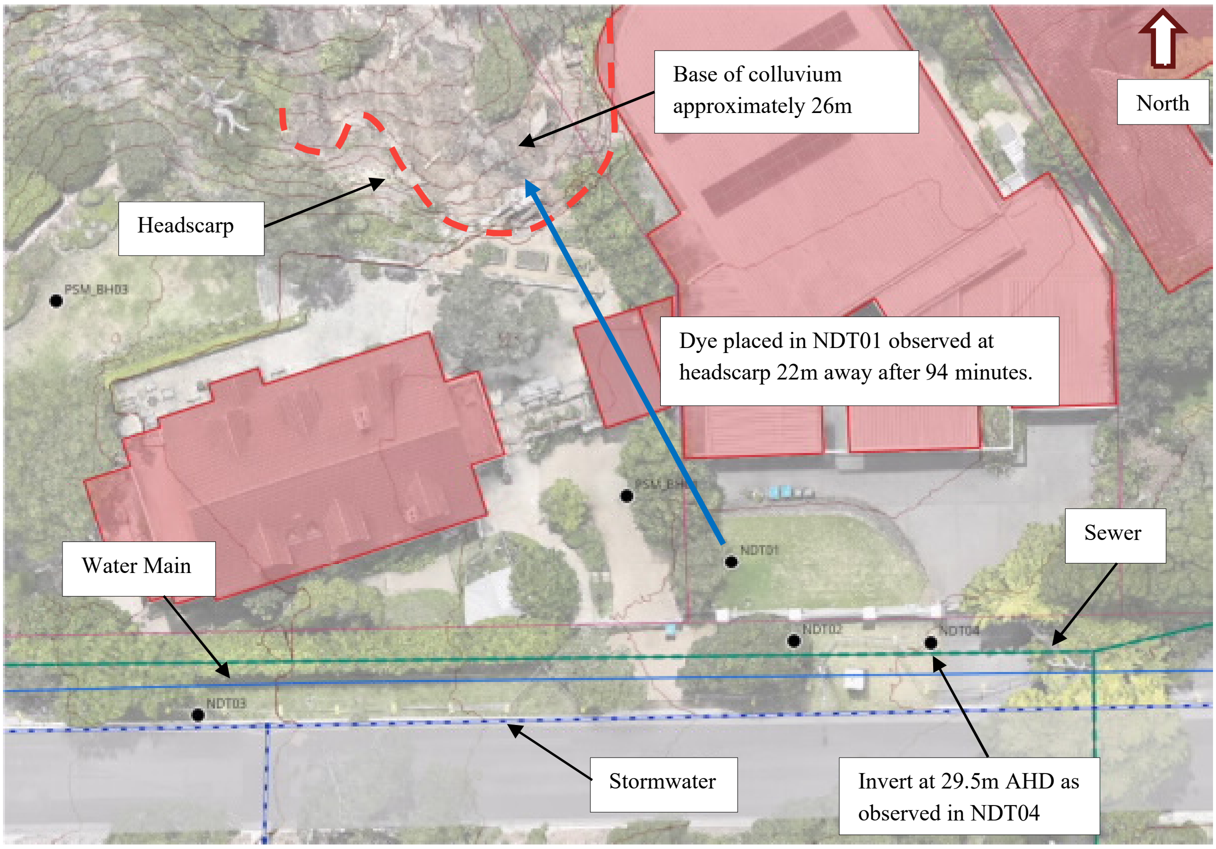

Figure 7.13 Inset of Figure 7.12 showing service trenches for water infrastructure in the vicinity of the McCrae Landslide

116) Figure 7.14 shows the services in an isometric image relative to the landslide headscarp. Note that two sewer pipe elevations are shown. One was indicated by borehole NDT04 drilled as part of the PSM investigation into trenches (ref: MSC.5067.0001.0018) and the other as indicated on sewer plans provided in ref: SME.0001.0001.0148. There is approximately a 3 m vertical difference between these elevations. Given the direct observations made in the PSM borehole, the higher elevation is assumed to be correct. Note that for both alignments the sewers are within the colluvial soils at the point where they are closest to the location of the January 2025 landslides.

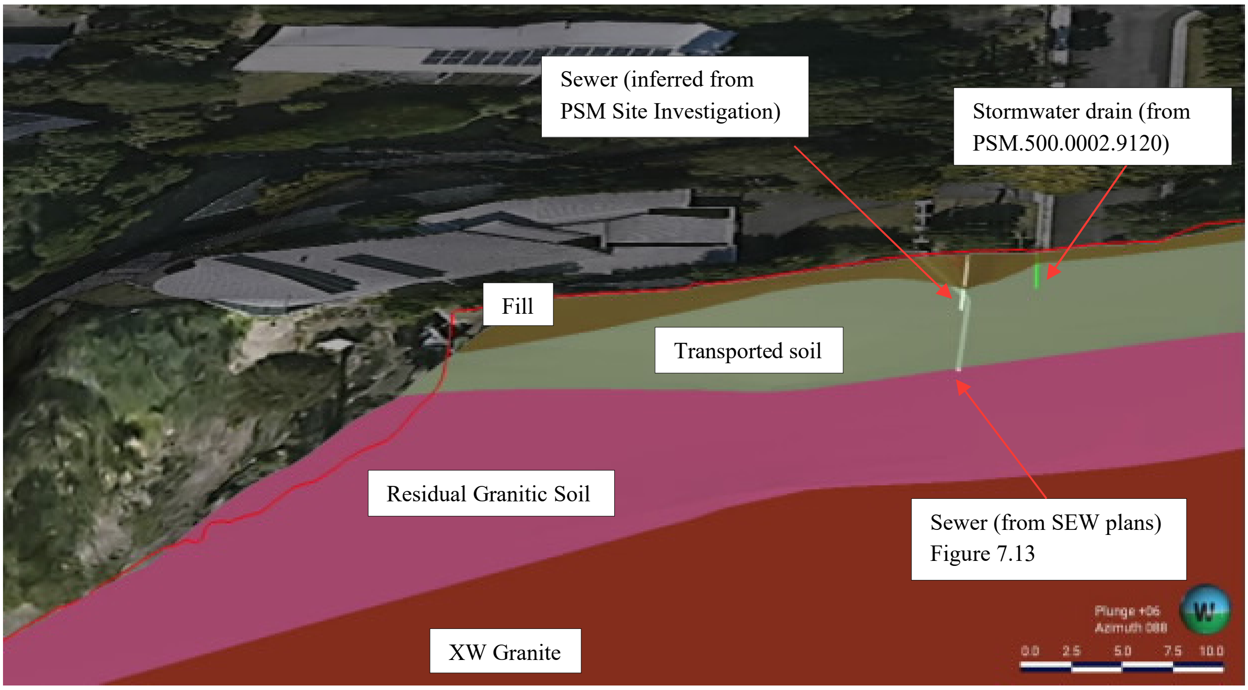

Figure 7.14 Isometric image of sewer and stormwater drain along View Point Road in relation to the modelled geological units. Note there is an approximately 3 m discrepancy between the sewer invert levels indicated on the SEW plans and the depths inferred through observations in the 2025 PSM site investigation.

117) The type of backfill in some of the trenches is known through photographs taken as part of works to expose services and to repair leaks or water damage. Indications of service trench backfill include:

a. Works to expose a sewer on 24 January 2025 at the corner of Charlesworth Street and Waller Place exposed vitreous clay pipe on a bed of gravel. We note that based on our experience this form of sewer construction is typical for the time it was installed in 1981. The width of the trench is not known, however based on objects within the image in Figure 7.15, gravel appears to extend 200 mm to 300 mm either side of the pipe. The sewer depth is up to 4 m in View Point Road (based on service plans, less based on the PSM boreholes), and it is likely a trench of this depth could have been wider.

Figure 7.15 Vitreous clay sewer on gravel bed (reference SME.0001.0001.0018)

b. Works to expose a water main near 26 Coburn Avenue which burst in November 2022 indicate trenches are backfilled with a mixture of fine grained and granular material (SME.0001.0001.0149) as shown in Figure 7.16.

Figure 7.16 Water main trench

c. Details on how stormwater trenches were backfilled have not been sourced. However, photos from the works to upgrade the stormwater pipes in 2023 in View Point Road suggest backfill with soil arising from the excavation.

Figure 7.17 Stormwater trench backfill (RES.0001.0003.0001).

118) In addition to service trenches, road materials underlying the road surface are likely comprised of granular materials. If water exfiltrates to the road surface, it can travel out through the pavement subgrade and affect a broader portion of the road than just the area local to the pipe.

119) Service trenches are preparatory factors for landslide in the McCrae area because they are backfilled at least in part with permeable backfill. In particular sewer trenches which are comprised of vitreous clay pipes supported on a gravel bed. This can allow the trenches to convey water more rapidly than the surrounding soils and to carry that water to parts of the subsurface that it would not be conveyed to naturally. The pipes themselves can perform the same function if they are ruptured, noting with reference to Figure 8.14, there have been numerous pipe bursts in the area along with stormwater leaks as shown in Figure 8.22. The construction of service trenches in terrain susceptible to landslide can increase landslide susceptibility and the likelihood of landslide occurrence.

7.6 Planning Controls

120) There are no formal planning controls, for example an EMO applicable to the McCrae escarpment, although planning controls for landslide were introduced progressively to the Mornington Peninsula area from the 1970s (MSC.9000.0001.0002_0001). These did not cover the McCrae escarpment. The reason for this is unclear as I have not been provided with documentation setting out the basis for the EMO mapping introduced in 2010. However, it seems that the 2010 EMO may have been based on prior studies undertaken in discrete areas with known landslide issues rather than a whole of shire study.

121) A subsequent 2012 report by Lane Piper (ref: MSC.5001.0001.6105) did assess landslide susceptibility at a shire wide scale and identifies the McCrae escarpment as being susceptible to landslide. That report is based on the use of a digital elevation model derived from airborne LiDAR, which in general better allows areas susceptible to landslide to be identified than the techniques used to inform the extent of the EMO prior to 2010. This is because LiDAR better allows past landslides to be identified in the landscape and for the slope angles to be measured and type of geology estimated.

122) The McCrae escarpment has been included in the susceptibility mapping in the 2012 Lane Piper report as having a high susceptibility to landslide. This characterisation has been made on the basis that the McCrae escarpment has two key preparatory factors for landslide, being that it is underlain by Devonian Granite and has a slope angle steeper than 50% (approximately 27°). The slope angle of the McCrae escarpment is about 40° and therefore well above the threshold nominated in the 2012 Lane Piper report to be considered highly susceptible to landslide. An extract from the 2012 Lane Piper report is presented in Figure 7.18. The red dots show areas susceptible to landslide based on measuring average slope angle across an 8 m by 8 m grid. Notably, the high susceptibility grids appear to align with the crest and toe of the escarpment as identified from air photos. The susceptibility map does not appear to explicitly include landslide runout (areas below the escarpment that might be relatively flat but that could be impacted by debris arising from a landslide), nor landslide regression (areas upslope of the escarpment that might be relatively flat but that could be undermined due to a landslide on the escarpment).

Figure 7.18 Extract from Lane Piper 2012 report showing assessed landslide susceptibility on the McCrae escarpment, with my annotations added.

123) The extent of the EMO is based on a delineation of areas susceptible to landslide based on the identification of areas where preparatory factors for landslide have been identified. The 2012 Lane Piper report identifies the McCrae escarpment as being susceptible to landslide and based on my assessment of preparatory factors for landslide I agree that the escarpment is susceptible to landslide and that there is a basis for its inclusion within the Mornington Peninsula Shire EMO.

124) One of the objectives of the planning controls that accompany the EMO is not to introduce new development that could make the slope more susceptible to landslide. Works that have been undertaken on and around the McCrae escarpment that might have otherwise been prevented or moderated through the use of planning controls include:

a. Earthworks, including the placement of fill at the crest of the escarpment.

b. The construction of retaining walls on and near the escarpment.

c. The removal of vegetation.

d. The construction of water bearing services without special controls against leakage and conveyance or ponding of water along trenches, for example trench stops, piping with high resistance to ground movement and leaks to reduce the potential for services to lead to water infiltration in the vicinity of the escarpment.

125) With moderate confidence, I consider the absence of planning controls has led to an increase in the susceptibility of the McCrae Escarpment to landslide.

126) Another objective of the EMO is to reduce the risk from landslide. This can include planning to reduce the consequences from landslide if one were to occur and could include measures such as:

a. Providing a buffer at the crest of the slope such that dwellings or other development is sufficiently set back from the escarpment such that it is unlikely to be impacted if a landslide occurs on the escarpment.

b. Providing a similar offset at the toe of the slope such that debris that travels down the escarpment does not reach houses.

c. Reducing the density of housing such that there are fewer people and dwellings exposed to potential landslide.

127) In addition to increasing landslide susceptibility, the absence of planning controls is also likely to have increased the landslide risk by allowing development to occur in areas that could be impacted by landslide.

8 McCrae Landslide Causal Factors

8.1 Direct Cause

128) In assessing the direct cause of the January 2025 landslides, consideration has been given to potential causal factors as set out in Section 5, including earthquake, pore pressure change, erosion and anthropogenic change. Each is discussed in the following sections.

129) The preparatory factors identified in Section 7 make the McCrae escarpment susceptible to landslide upon wetting of the soils underlying the escarpment. After consideration of plausible causal factors as set out in Section 5 and discussed subsequently I have concluded with very high certainty, that the direct cause or trigger of the January 2025 landslide at McCrae was an increase in pore water pressure within the soils underlying the McCrae escarpment which caused a loss of suction stress and therefore strength within the soil. For an increase in pore pressure to occur, there must be water infiltration into the ground and a pathway by which that water can migrate through the ground to the soil underlying the escarpment.

130) The following also explores the mechanisms by which water could have infiltrated into the ground and migrated to the escarpment at the locations of the November 2022 and January 2025 landslides. Consideration has been given to different water sources including rainfall, leakage from water services and domestic water sources such as irrigation. Multiple pathways for water to migrate from its source to the escarpment have also been assessed including through natural subsurface soils, stormwater pipes and sewer trenches. I have concluded that the most plausible source of water that lead to the increase in pore pressure at the escarpment to be water main leakage. Furthermore, that there are multiple pathways that could have conveyed water from the water main leak to the escarpment, and it is uncertain as to which pathway or pathways conveyed the water.

131) Discussion is also provided on whether there are actions that could have been taken between the initial landslide on 5 and 14 January to reduce the impact of causal factors and to then reduce the potential for the further landslide that occurred on 14 January.

8.2 Earthquake

132) There is no evidence of earthquake around the time of the November 2022 nor January 2025 landslides. The Geoscience Australia Earthquakes@GA[11] database indicates no earthquakes within Victoria between 1 and 30 November 2022 nor between 1 and 15 January 2025. With very high confidence, earthquake did not trigger the landslides.

8.3 Erosion

133) There is no evidence of significant natural erosion having affected the McCrae Escarpment at the locations of the November 2022 nor 5 January 2025 landslide. I have very high confidence that erosion immediately prior to the landslide was not a cause of the 5 January 2025 landslide. Due to a lack of evidence I have less confidence (moderate) that erosion was a cause of the November 2022 landslide.

134) Following the 5 January 2025 landslide, there was a steep headscarp formed on the escarpment as indicated in Figure 8.1. This steepening of the slope made it more susceptible to further landslides, and so the occurrence

[11] https://earthquakes.ga.gov.au/

of the 5 January 2025 landslide can be considered a plausible causal factor for the 14 January landslide. The process of subsequent landslides occurring following an initial landslide is called landslide regression. Notwithstanding this, as can be seen in Figure 1.2 and Figure 8.1, the zone of depletion at this stage was small relative to the overall slope. The causal contribution of this steepening to the 14 January 2025 landslide was minor relative to the influence of water, noting that the 5 January 2025 landside was estimated to have involved about 15 m^3 to 25 m^3 of soil detachment and the 14 January landslide around 300 m^3 of soil detachment (MSC.5047.0001.0001). I have high confidence in this conclusion.

Figure 8.1 Headscarp following 5 January landslide.

8.4 Anthropogenic change

135) Anthropogenic change has been discussed in relation to being a preparatory factor for the January 2025 landslides in Section 7.5. Where a change to the loading on a slope occurs immediately prior to a landslide, this change could be a causal factor. For example, if fill was placed at the crest of the slope or excavation was undertaken at the toe.

136) There is no evidence or anthropogenic change, for example the application of a surcharge load immediately prior to the November 2022 landslide. However, given the lack of evidence I have moderate confidence that anthropogenic change was not a causal factor for the November 2022 landslide.

137) There is no evidence to suggest anthropogenic change to the escarpment through either earthworks activities or the addition of surcharge loading within a reasonable time period preceding the January 2025 landslides, noting that construction of the retaining walls at 10-12 View Point Road was complete at least 10 months prior to occurrence of the January 2025 landslides. Aerial imagery shown in Figure 8.2 supports this suggesting that surcharge loading on top of the escarpment had been relatively unchanged since around February 2024, and meaning that the addition of surcharge load at the time of the landslide was not the trigger for the January 2025 landslides.

138) Given there had been no recent change to the surcharge loading or shape of the escarpment, the cause or trigger of the January 2025 landslides, with very high certainty was not anthropogenic change at or immediately prior to the landslide.

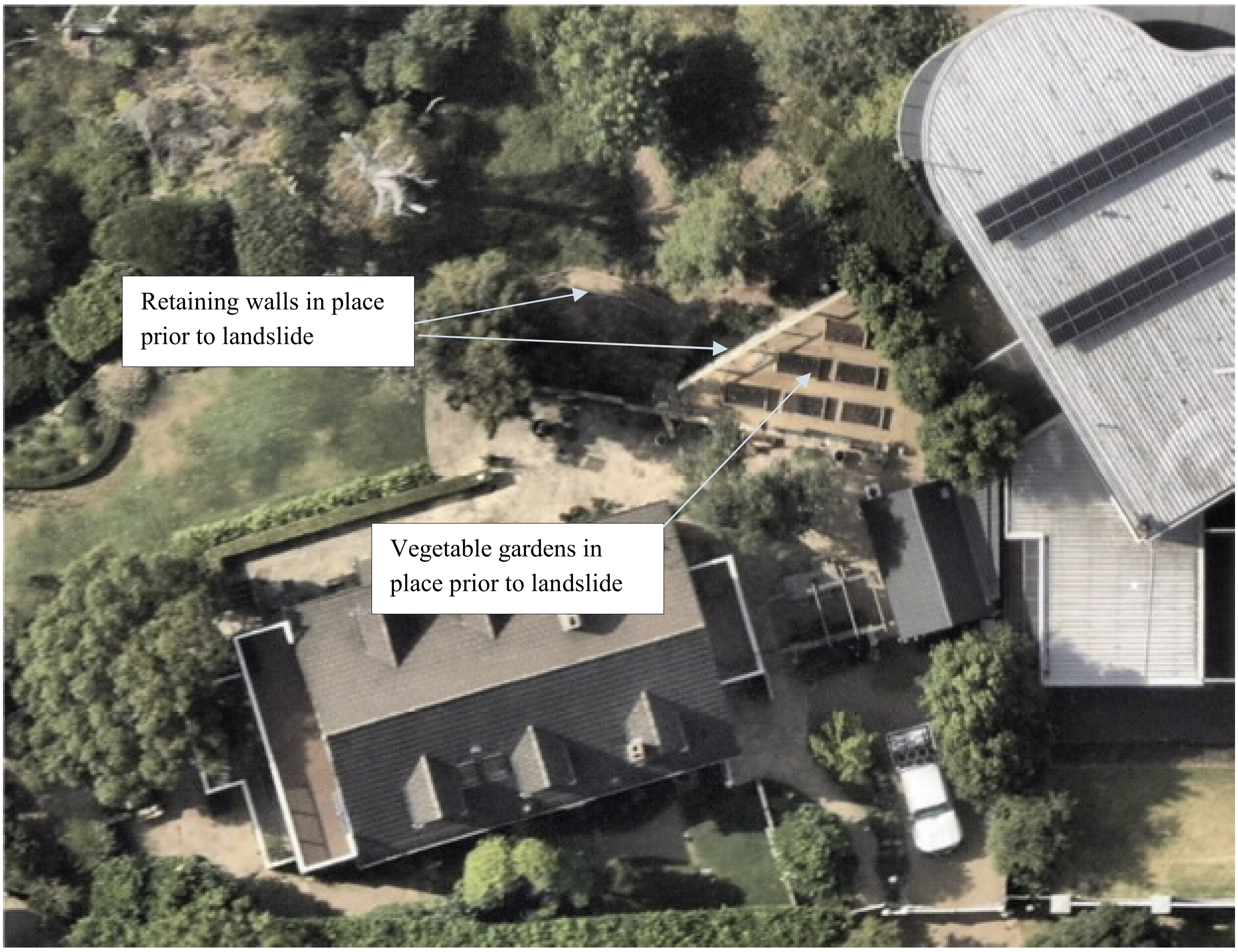

Figure 8.2 Aerial image of the site from Nearmap dated February 15 2024.

8.5 Rainfall

139) A graph showing monthly rainfall totals between January 2020 and May 2025 is shown in Figure 8.3. This shows that antecedent rainfall (cumulative rainfall) in the months leading up to the January 2025 landslides was reasonably typical, and less than the historical monthly median rainfall.

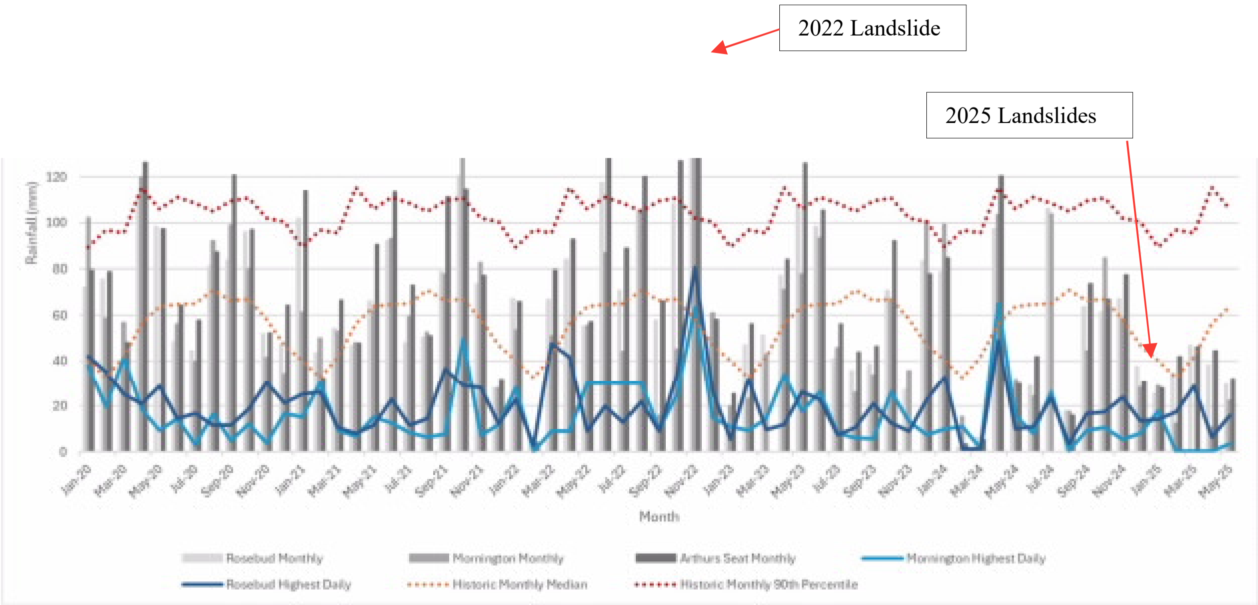

Figure 8.3 Monthly Rainfall Totals 2020 to 2025 for Rosebud 86213, Mornington 86079 (Bureau of Meteorology) and Arthurs Seat 586202 (Melbourne Water).

140) A plot showing daily rainfall totals between 1 December 2024 and 20 January 2025 is shown in Figure 8.4. This plot shows that there were no extreme rainfall events in the lead up to the January 2025 landslides. In contrast, daily rainfall preceding the November 2022 landslide is shown in Figure 8.5.

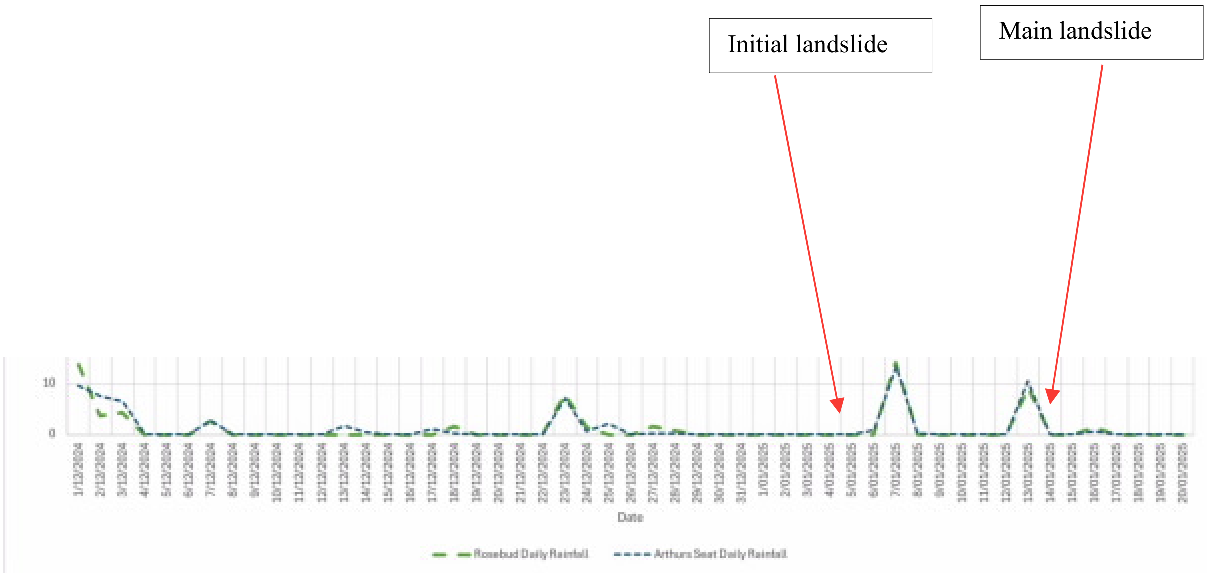

Figure 8.4 Daily rainfall totals December 2024 to January 2025 for Rosebud (Bureau of Meteorology) and Arthurs Seat (Melbourne Water). Mornington data has been omitted from this figure due to inconsistent reporting of daily rainfall totals resulting in cumulative totals being reported.

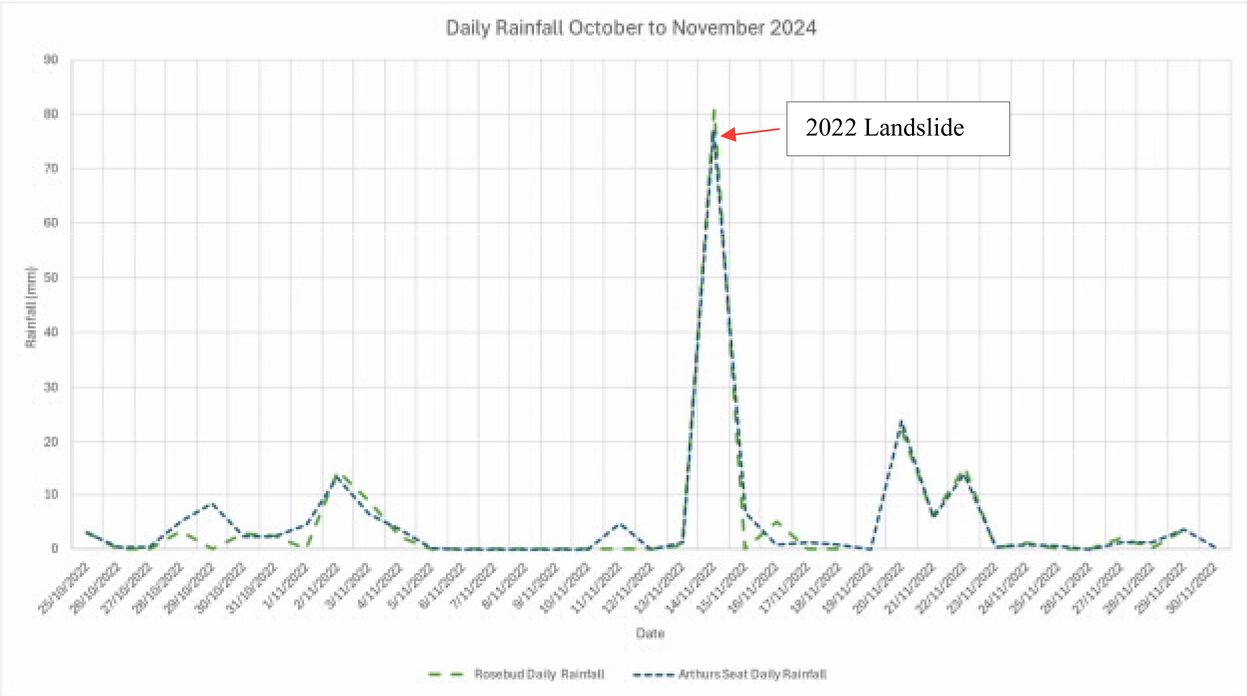

Figure 8.5 Daily Rainfall Totals October 2022 to November 2022 for Rosebud (Bureau of Meteorology) and Arthurs Seat (Melbourne Water).

141) The anomalously high rainfall on the day preceding the 15 November 2022 landslide gives cause to suspect rainfall as one of the sources of water that infiltrated into the ground and migrated to the escarpment causing the 2022 landslide, although the pathway along which water migrated is not certain. Infiltration was observed through the kerb on View Point Road (RES.0001.0003.0002) prior to 2022. It is also noted that there had been water main leaks observed in the road out the front of 23 Coburn Avenue about 23 m upslope of the November 2022 landslide (SEW.0001.0001.0142). This leak was observed and identified on the day before the landslide and the volume of leakage was up to 0.9 ML over 13 hours (SEW.0001.0001.5773). Some of this water exfiltrated at the road surface near the leak, and some must have infiltrated the ground because the point of water exfiltration at the ground surface was about 5 m away from the burst location and the sinkhole had opened in the private property at 23 Coburn Avenue.

142) Whilst the water main leakage on 15 November 2022 may not have been direct the trigger of the landslide on the following day and due to insufficient evidence on which to base it, I am unable to provide an opinion on the proportion of water from the burst compared to the proportion from rainfall that might have contributed to the 2022 landslide. It is possible that the burst caused wetting of the ground and helped to form subsurface pathways, making the ground at the escarpment more susceptible to landslide upon the subsequent extreme rainfall event, noting that since the inferred rainfall induced events of the 1950's there had not been other rainfall induced landslides on the escarpment. Subsurface pathways are discussed further in Section 8.7.2.

143) By contrast there does not appear to be any anomalously high rainfall preceding the January 2025 landslides and hence a much lower likelihood that rainfall was a contributing source of water. Noting that there are natural springs in the area and natural subsurface flow paths through infilled colluvial channels between the granite of Arthurs Seat and the McCrae escarpment, it is unreasonable to discount recharge into the ground by rainfall as contributing at least in part to the subsurface water pressures within the McCrae Escarpment. However, based on the available rainfall records it seems unlikely that recharge by rainfall contributed in a significant way to the pore pressure increase that triggered the January 2025 landslides.

144) Further supporting evidence is provided by considering the results of groundwater monitoring installed after the January 2025 landslides and the response of groundwater pressures to rainfall that occurred after their installation. Figure 8.6 presents the pore pressure response in Borehole BH1, located on the driveway of 10-12 View Point Road within natural ground. The shallowest instrument, VWP1A at a depth of 5.5 m shows a decrease in pore water pressure from 21 February 2025 through to 18 March 2025 then records negligible pressure. There is little to no evidence for correlation with rainfall. Introducing a lag of 2 weeks as shown in Figure 8.7 to account for time between the rainfall and then infiltration and travel to the Borehole BH1 near the landslide location improves correlation although the correlation remains relatively weak.

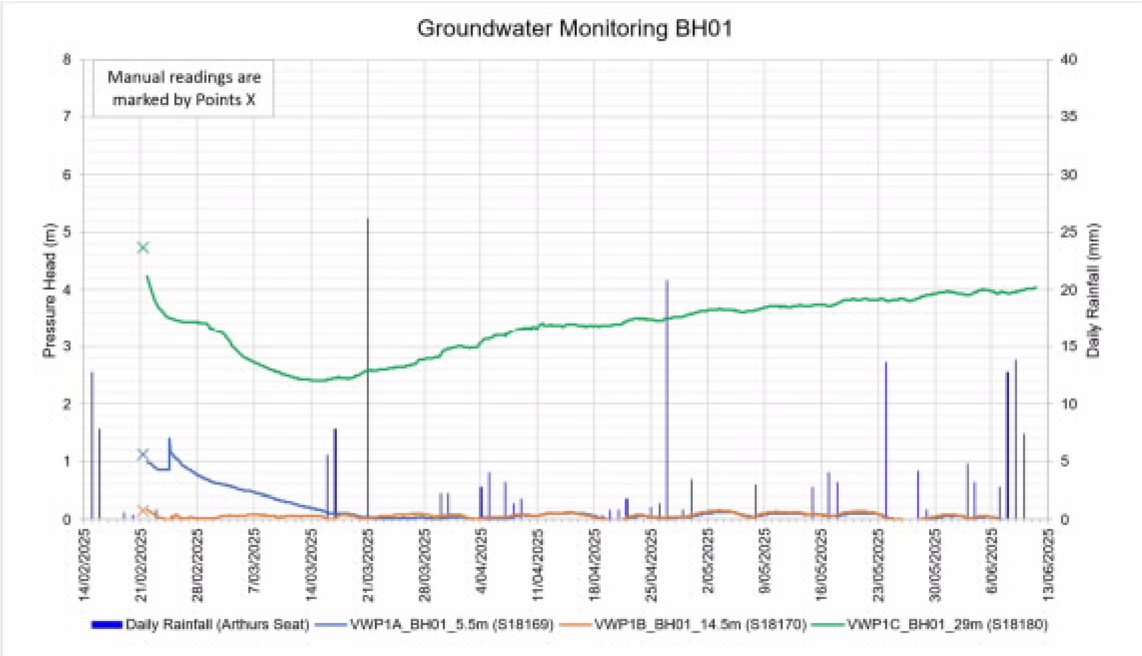

Figure 8.6 Groundwater monitoring in BH01, installed in natural ground underlying driveway of 10-12 View Point Road (PSM.5002.0001.0001)

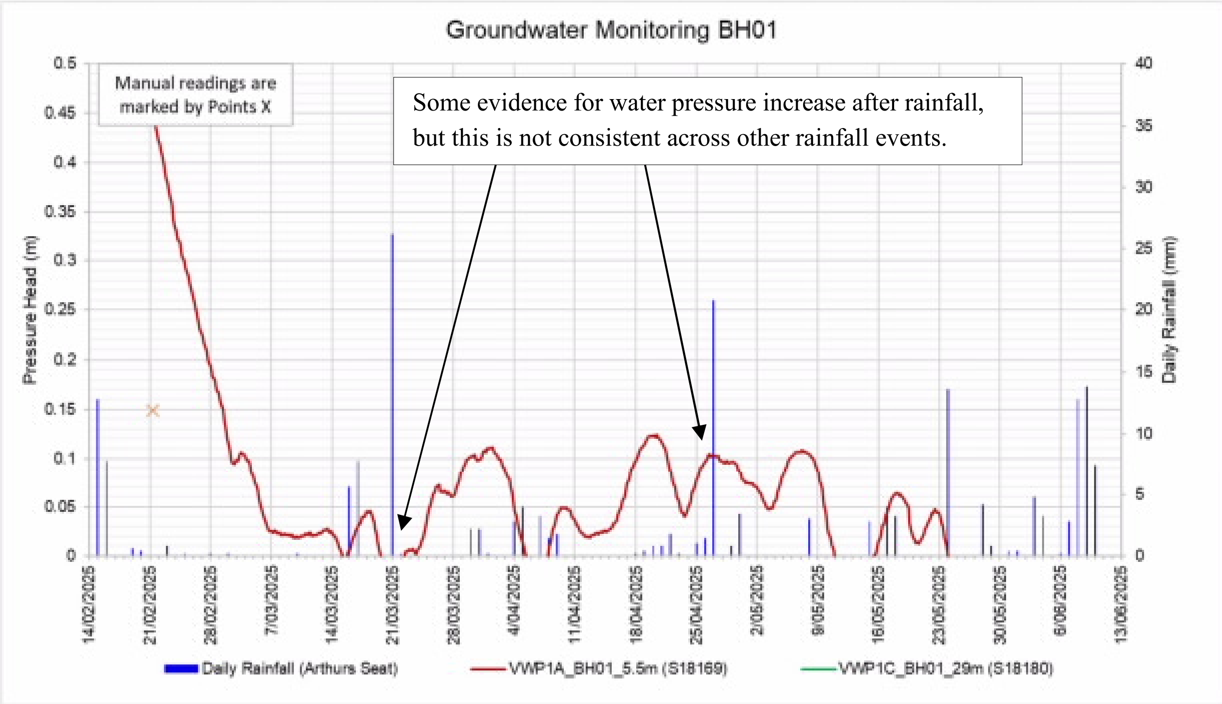

Figure 8.7 Groundwater monitoring in Borehole BH01, installed in the driveway of 10-12 View Point Road, adapted from (PSM.5002.0001.0001). Vibrating wire response shifted by 2 weeks to assess correlation with rainfall given a 2 week lag between rainfall and pressure response.

145) A plot of pore pressure measured using a vibrating wire piezometer installed in borehole NDT04 at the base of a sewer trench within View Point Road at 10 – 12 View Point Road is shown in Figure 8.8, and indicates a weak correlation with rainfall. The spikes in rainfall do not correspond to the points where pore pressure begins to increase. However, if there is assumed to be a lag of about 1 week between rainfall and measured pore pressure response, a better but still relatively weak correlation is observed.

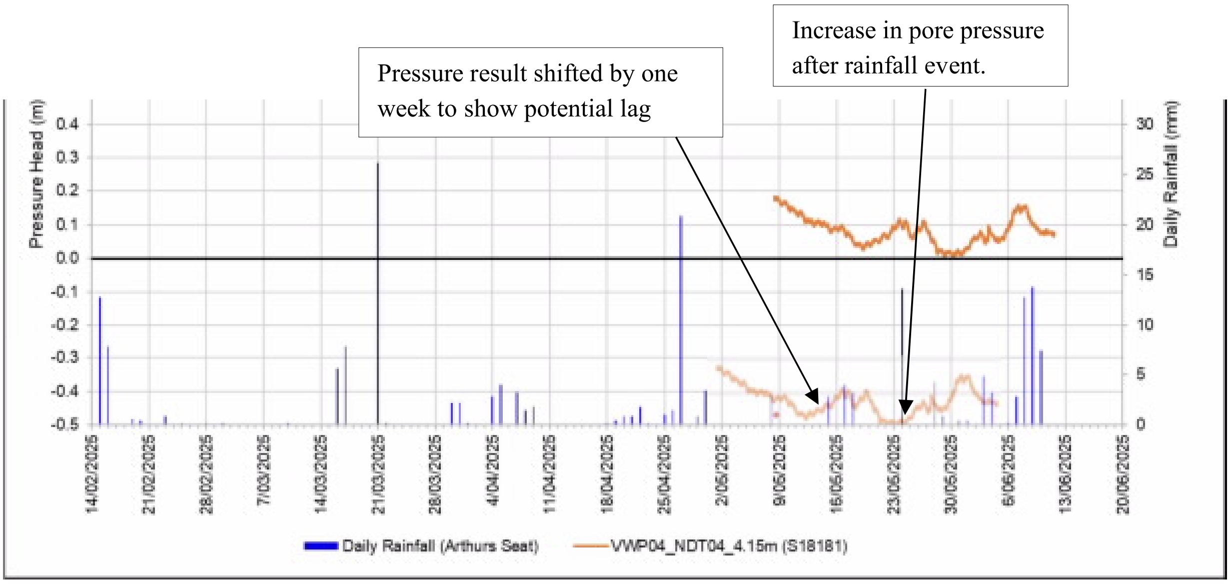

Figure 8.8 Groundwater monitoring in NDT04, installed in sewer trench (PSM.5002.0001.0002) added annotations.

146) The available evidence indicates there to be some correlation between rainfall and groundwater pressure near the headscarp formed by the January 2025 landslide. However, this correlation is weak, and requires assuming a lag between the rainfall and the measured pore pressure (allowing time for infiltration and travel of water to the landslide location via subsurface flow paths). Furthermore, there were no significant rainfall events in the lead up to the January 2025 landslides of similar magnitude to the rainfall events that had triggered landslides in the past, including the November 2022 landslide. I have moderate confidence that rainfall made a significant contribution to the water that caused the November 2022 landslide and similarly moderate confidence that rainfall did not significantly contribute to the water that caused the January 2025 landslides.

8.6 Domestic Water Use

147) Site observations undertaken on 23 May 2025 identified garden irrigation surrounding the escarpment at 10-12 View Point Road (Figure 8.9), including small diameter irrigation pipes and sprinklers typical of a domestic garden irrigation system.

Figure 8.9 Evidence of irrigation on and around the escarpment at 10-12 View Point Road.

148) Records of domestic water usage for properties in View Point Road is available from November 2021 through to November 2024 (readings were not obtained from subsequent quarters due to the implementation of the exclusion zone around the landslide) which identifies a number of properties surrounding the location of the January 2025 landslides as being high water users in comparison to the neighbourhood average. In particular, 10-12 View Point Road has the highest water usage, with 4 View Point Road having similar but slightly lower usage. Data for the quarter corresponding to the 2025 landslide is not available.

149) Figure 8.10 shows the quarterly private water usage for the three properties immediately above the landslide; 10-12 View Point Road, 6-8 View Point Road and 4 View Point Road. It has been noted that a leaking pipe in Q3 2022 caused abnormally high readings for that quarter. Whilst water use at 10-12 View Point Road and 4 View Point Road is higher than typical for the area, usage over time has remained relatively consistent with no step change in water consumption since 2021.

150) Figure 8.11 shows the approximate average daily water usage for the three properties assuming an average of 92 days per quarter. When the approximated daily usage is compared to the estimated daily output volume during the course of a South East Water pipe burst event 450 m away from the landslide (discussed in further detail in 8.7) throughout November and December 2024, orders of magnitude difference in rate and volume of leakage is observed. Whilst data on domestic water use is unavailable at the time of the January 2025 landslides, private water usage at each property is about 0.3% of the daily burst output during the late stages of the pipe burst event (4,500/day domestic water use vs 1.3 ML/day from the pipe burst).

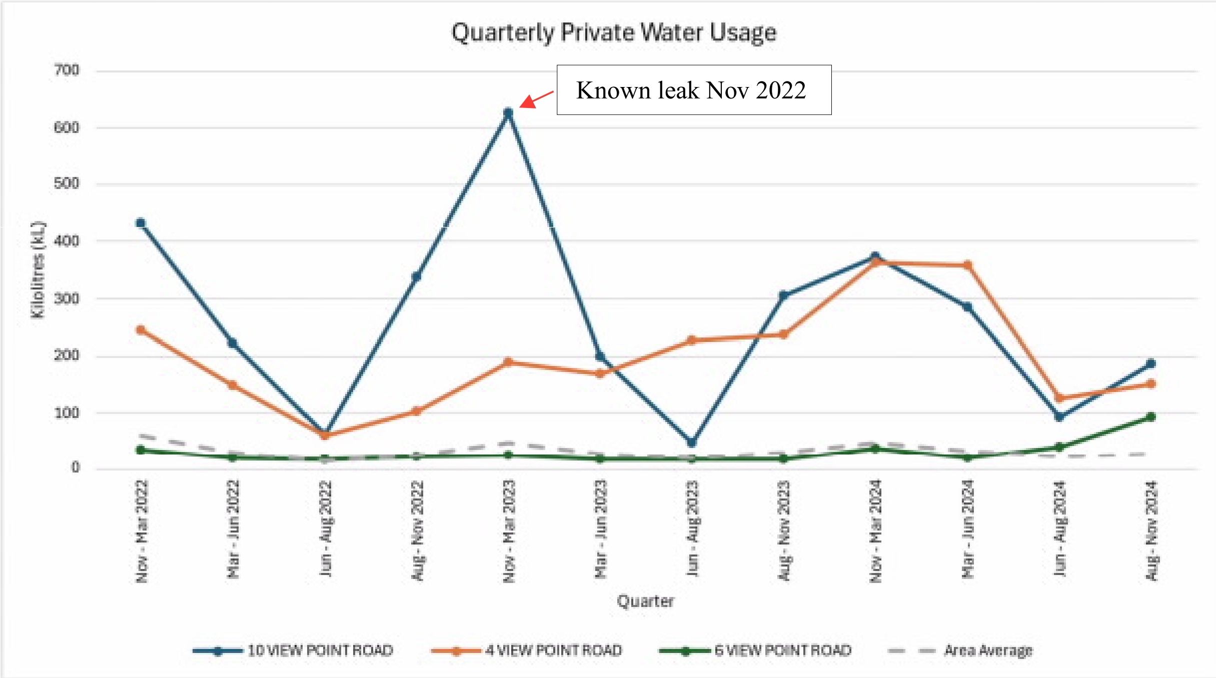

Figure 8.10 Quarterly private water usage, generated form data provided in SME.0001.0001.0083.

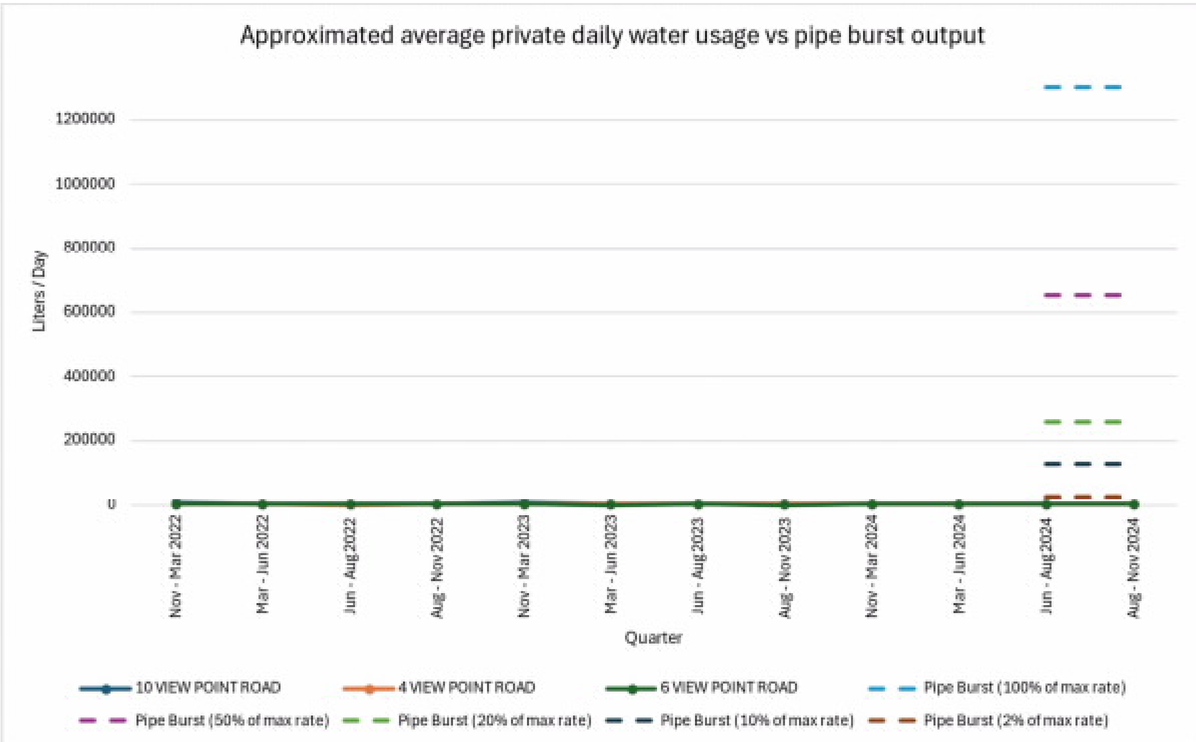

Figure 8.11 Approximated average daily private water usage, based on an average of 92 days per quarter. Estimated output form pipe burst in late December 2024 indicated.

151) The water usage at 10-12 View Point Road was abnormally high around the time of the November 2022 landslide due to a leak as indicated on Figure 8.10. However, the daily rate of water delivery of approximately 6,600 L/day (based on averaging 600kL across 3 months) is very low in proportion to the water that could have been delivered by rainfall and a water main burst on the day preceding the landslide. Although the water

leak if inferred to have been caused by the landslide severing an irrigation system, the exact stage of the landslide process at which the irrigation was severed and whether it leaked into the soil in the early stages of the landslide and therefore had a contribution is uncertain. I am unable to dismiss domestic water use as a causal factor of the November 2022 landslide.

152) The water usage at 10-12 View Point Road for the latest quarter of 2024 is about 4000 to 5000 L/day based on the data shown in Figure 8.10 which averages to around 0.05 L/sec. Noting this is total household water consumption, and that the area of the January 2025 landslides represents only a small portion of total irrigated area at 10-12 View Point Road. The average rate at which an irrigation system could have applied water to that area of the landslide would be less than this. On 6 January, PSM measured 0.1 Litres/sec to 0.2 l/sec issuing from the 14 January 2025 landslide headscarp and measured at the boundary between 3 Penny Lane and 10-12 View Point Road (5000.0004.4640). The rate that water was issuing from the landslide headscarp is at least 10 times greater than what could have been supplied by the irrigation system given the data cited above. Whilst this is an approximate comparison and takes no account of factors such as water absorption that could occur into the soil over time, it indicates potential inconsistency between the water observed issuing from the soils at the escarpment and what could have been provided by the portion of the irrigation system near the landslide at 10-12 View Point Road.

153) Irrigation systems observed at 10-12 View Point Road were predominately surface level watering systems supplying water to the surface of gardens. If water infiltration associated with excess irrigation was a significant contribution to the January 2025 landslides, it would be expected that following the 14 January 2025 landslide, the soils would be saturated from the ground surface down to the base of the landslide headscarp (the flow path between the surface and the base of the landslide headscarp would be wet). This is not what was observed in both the January 5 landslide (Figure 8.12) and January 14 landslide (Figure 8.13) and there is no evidence for connectivity between the irrigation system and the point at which water was observed to be seeping from the escarpment.

154) The pore pressure measurements in Borehole BH01 depicted in Figure 8.7 shows pore pressure dissipation from February 2025 to March 2025 over which time no further instability was observed. This borehole is located up gradient of the irrigation system and so dissipation of pore pressure measured in the Borehole BH01 is not consistent with the cessation of irrigation around January 2025. Furthermore, water was observed to flow from the toe of the headscarp formed by the January 2025 landslide during the May 2025 site visit, 5 months after the irrigation ceased which cannot be explained given the cessation of irrigation in January 2025 and the 5 months that had lapsed since.

155) Evidence suggests that domestic irrigation is unlikely to be a causal factor of the January 2025 landslides because it could not provide enough water, the usage was not unusual based on historic comparison and because there is no flow path vertically down consistent with where water was observed to issue from the escarpment. Given there is no evidence of increased surface water usage compared to historic norms, and no observation of surface water infiltrating vertically down to the landslide failure plane it suggests with high confidence that the excess water observed within and issuing from the escarpment in January 2025 is not related to irrigation in the vicinity of the landslide and that domestic water use did not make a significant contribution to the water that caused the January 2025 landslides.

Figure 8.12 Photo of headscarp following 5 January 2025 landslide with areas of dry and wet ground annotated. PSM.50000.0001.0114, photo dated 6 January 2025.

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Figure 8.13 Photo of headscarp following January 14 landslide with areas of dry and wet ground annotated. PSM.5000.0001.0290, photo dated 15th January 2026.

8.7 SEW pipe leakage

8.7.1 Pipe Burst Event

156) An alternative source of water that would likely have infiltrated into the ground and then migrated along a pathway to the location of the 2025 landslide is a leaking underground service. Based on South East Water plans as shown in Figure 8.14, there appears to be a greater frequency of leaking water mains in the McCrae area compared to surrounding areas.

157) With low certainty, the increased rate of pipe leakage in the McCrae area is related subsurface flow paths through the area. Because the soils are dispersive, and if trenches have been backfilled with native soils, fines in the soils can also migrate, allowing water to flow along trenches and form voids around the pipes. Asbestos cement pipes are brittle and can be prone to cracking and leakage if voids are able to form in the backfill around the pipes, noting this was a key causal factor of the 1997 Thredbo Landslide. Alternatively, incidents noted as leaks could be related to water exfiltration at the surface with the source of water infiltration being up-gradient of the location at which water was observed at the surface.

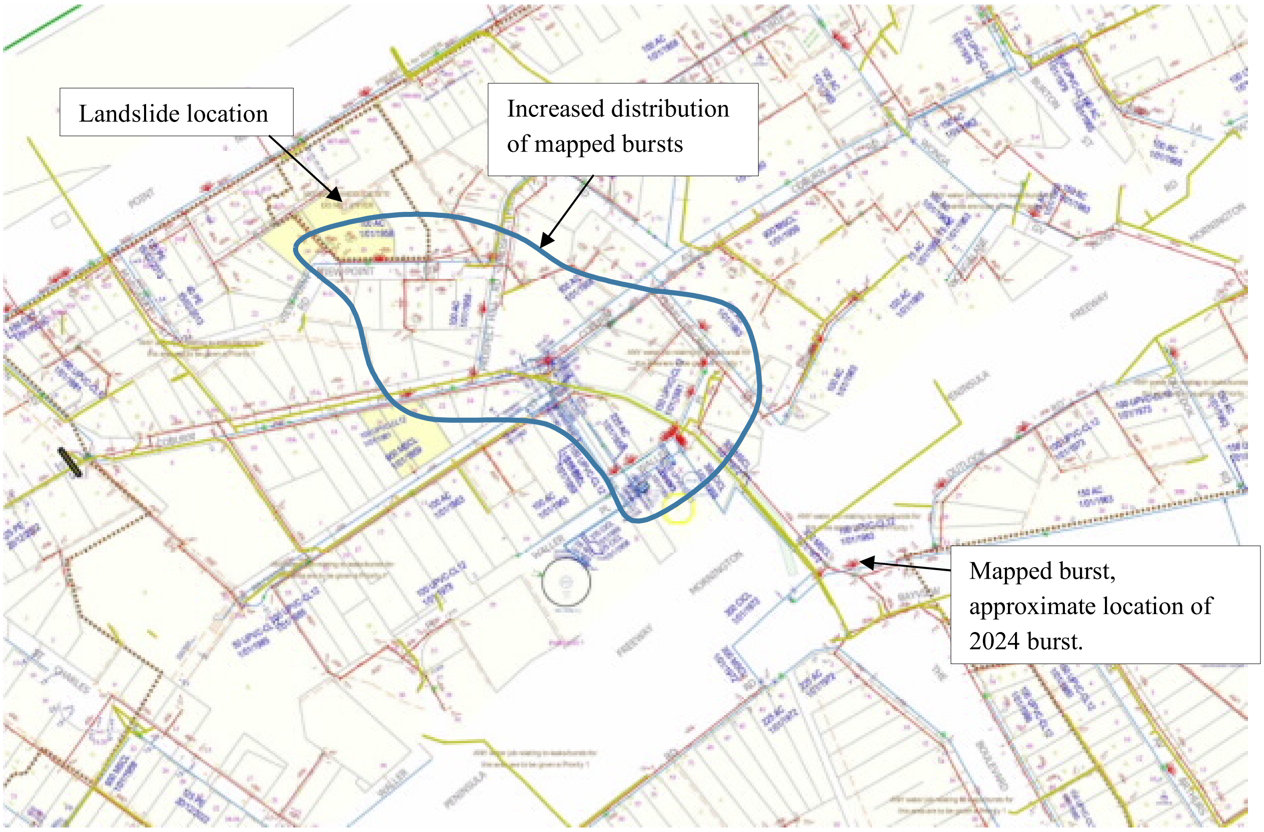

Figure 8.14 South East water plan showing frequency of water leaks within water mains in the McCrae area (SME.0001.0001.0148) with my annotations.

158) As described in the witness statement of Jonathan Crook and the accompanying report (SEW.0001.0001.0746), a leak occurred in a 150 mm water main near the intersection of Outlook Drive and Bayview Crescent (south of the Mornington Peninsula Freeway) with leakage occurring between approximately 5 October 2024 and 31 December 2024 and resulting in total water losses estimated at between 34 ML and 39 ML, but with the rate of leakage increasing over that time and exceeding 1ML/day over the week preceding repair of the pipe on 31 December 2024. A chart showing the interpreted water balance in the McCrae area is included in (SEW.0001.0001.0746). I understand there is some uncertainty associated with this estimate. Also, I assume that the y axis in this figure represents L/day, not total L.

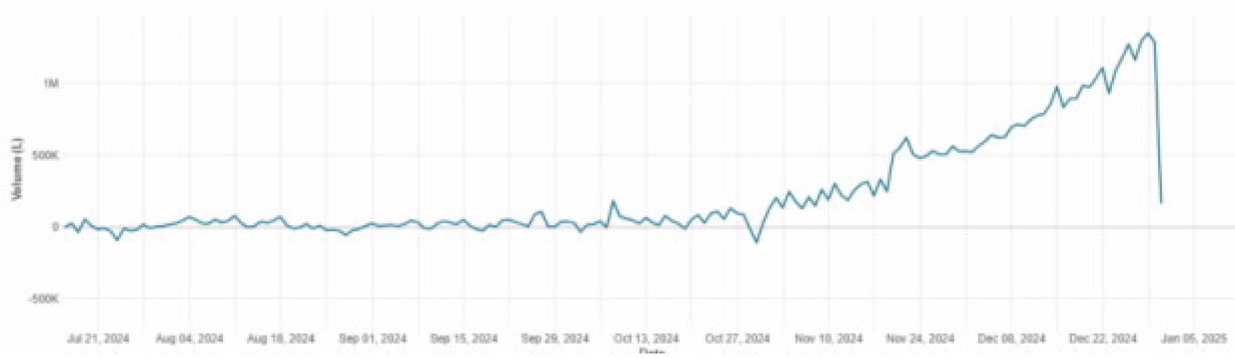

Figure 8.15 Adjusted water balance in McCrae area, July to December 2024 (from SEW.0001.0001.0746).

159) There is some uncertainty as to where the water that leaked from the pipe went. Observations made at the site of the leak indicate that at least some of the water bubbled up to the surface and flowed into the stormwater system via entry pits between the leak and the Mornington Peninsula Freeway. However, the earliest observation of excessive water in the stormwater pipes is reported in mid-December at Waller Place (witness statement of Brett Cooper, RES.0004.0002.0008). Water infiltration into the ground would be expected initially upon the occurrence of the leak and water would continue to infiltrate until the pores are saturated and the pressure required for water to infiltrate the ground is greater than what is required for water to migrate upwards and exfiltrate at the ground surface. Once this occurred, there could have been some surface infiltration as water travelled along a surface flow path. Sand mapped at the surface downslope of the leak provides evidence of the surface flow direction and pathway to the entry pits, as shown in Figure 8.16.

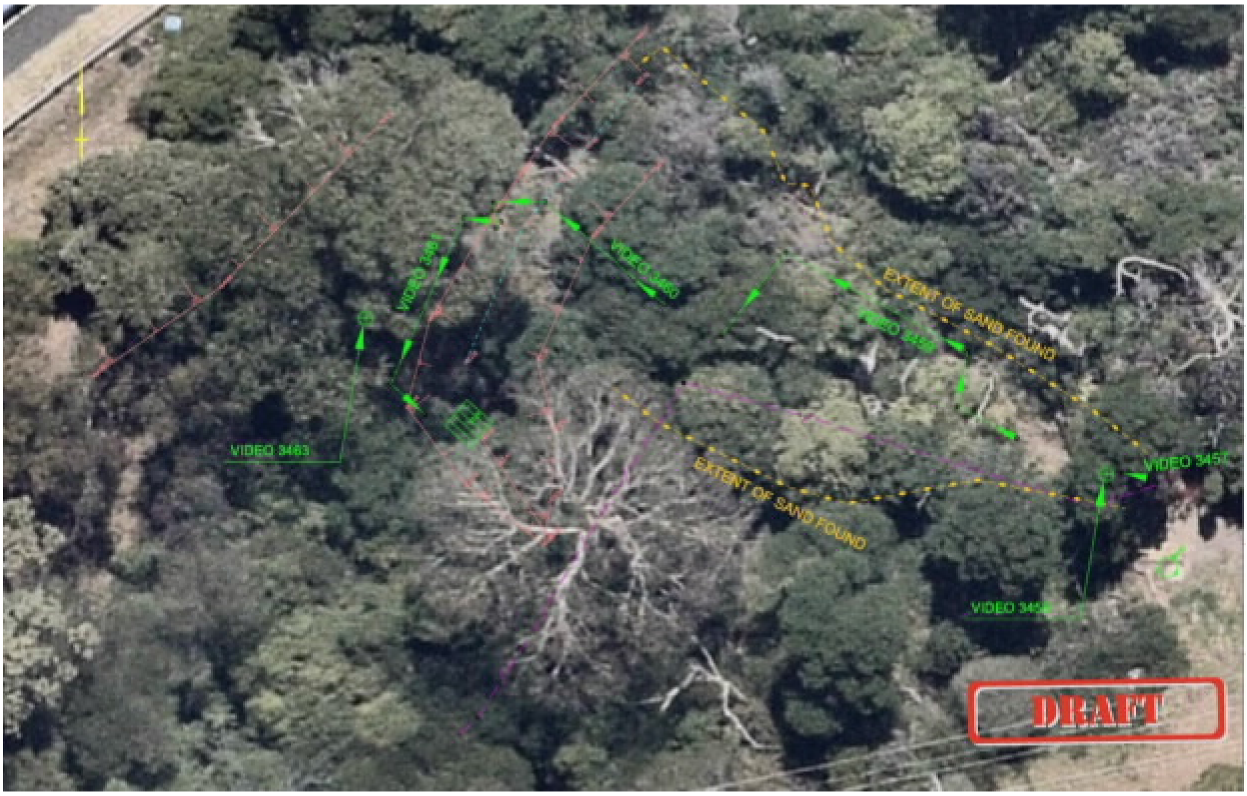

Figure 8.16 Plan showing inferred water flow path (green arrows) for water that issued at the surface from the leaking main towards pit entry (ref: SME.0001.0001.0139).

160) As shown in Figure 8.17, at the location of the leak, the pipe appears to be buried within a sandy material, underlain by colluvium, which is consistent with the other observations via pits and boreholes in that vicinity (for example borehole NDT13, MSC.5067.001.0040) and as described in Section 6.3. The sand mapped at the surface and shown on Figure 8.16 is likely to have derived from the vicinity of the pipe. However, it is uncertain once water was exfiltrating at the ground surface, what proportion was directed towards the stormwater system via entry pits compared to the proportion that infiltrated into the ground. There is no evidence for significant erosion of the ground over which water flowed between the pipe burst and stormwater pit (for example video in SME.0001.0001.0237). Rather, material was deposited over this area suggesting low energy flow.

Figure 8.17 Photo of pipe repair (SME.0001.0001.0047).

8.7.2 Potential Flow Paths for Water Issued from Pipe

161) Water that infiltrated into the ground, could have flowed into a natural colluvium infilled channel or could have flowed through colluvium and entered the nearby sewer or stormwater trenches which are located within about 3 m and 30 m of the leak respectively. Water could have also flowed along the water main trench and into the stormwater or sewer trenches noting that these trenches must intersect the water main trench. Figure 8.18 and Figure 8.19 shows the spatial relationship between the pipe burst location, the sewer and stormwater trenches.

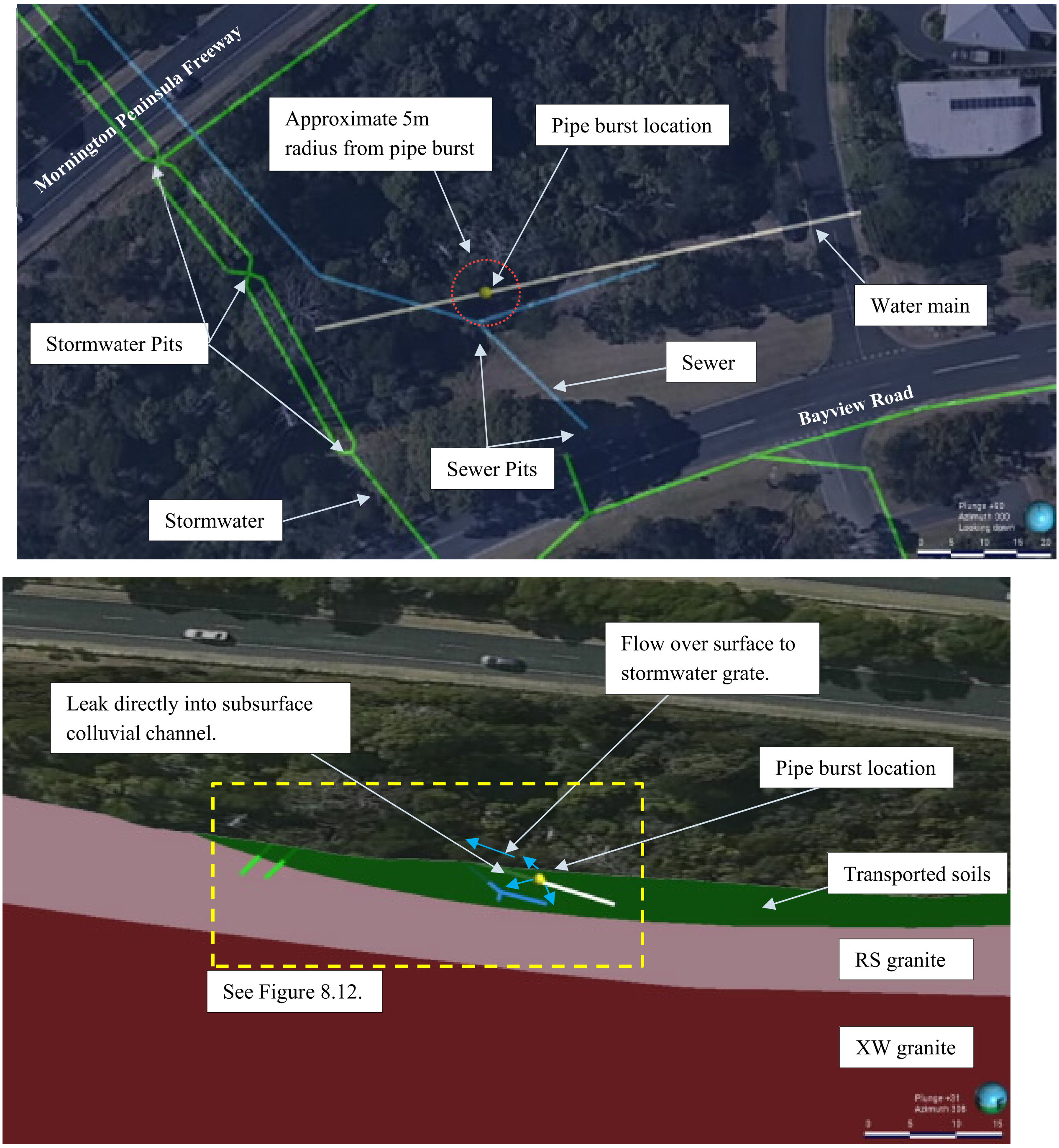

Figure 8.18 Isometric view showing relationship between pipe burst location, and infilled colluvial channel.

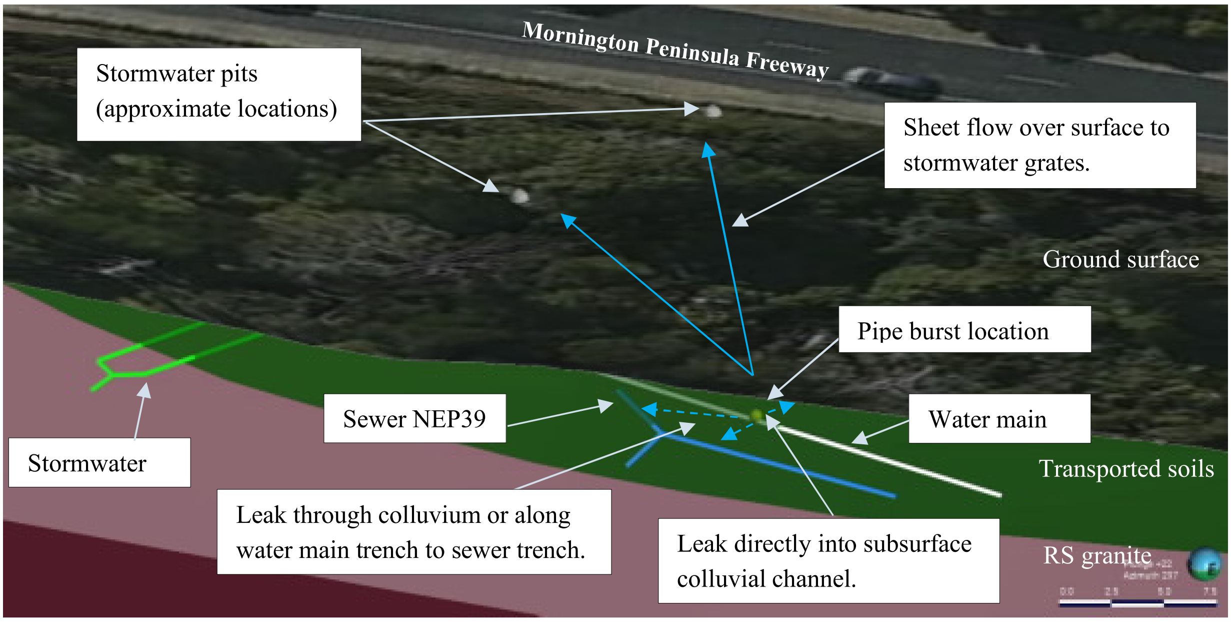

Figure 8.19 Isometric view showing relationship between pipe burst location, sewer and stormwater trenches and potential flow paths.

162) To assist with identifying the actual pathways taken by water that leaked from the pipe burst, Table 8.1 summarises evidence for anomalous ground and surface water observations made downslope of the pipe leak over the time it occurred. These observations are compiled from witness statements and South East Water maintenance records as indicated and are provided to give an indication of the timing of events. These observations are shown spatially in Figure 8.20. The sequence of events relating to the timing of the pipe burst and observations is also set out sequentially in Appendix G.

Table 8.1 Table setting out observations of anomalous water seepage observations

Location	Observation	Date	Reference	Approx daily leakage rate from pipe burst[1]
Intersection Charlesworth St. and Waller Pl.	Deterioration of road, water beginning to leak from road.	Early November 2024	RES.0004.0002.0008_0	200,000L/day
9/11 Viewpoint Rd	Customer reported leak - SEW concluded caused by groundwater.	26/11/2024	SEW.0001.0001.0142	500,000L/day
1 Charlesworth St	Customer reported leak - SEW concluded caused by groundwater.	28/11/2024	SEW.0001.0001.0142	500,000L/day
2 Waller Pl	Customer reported leak - SEW concluded caused by groundwater.	1/12/2024	SEW.0001.0001.0142	500,000L/day
Intersection Charlesworth St. and Waller Pl.	Observed road had been repaired following November damage.	11/12/2024	RES.0004.0002.0008_0	700,000L/day

Location	**Observation**	**Date**	**Reference**	**Approx daily leakage rate from pipe burst[1]**
1 Charlesworth St	SES and customer report leak - SEW conclude caused by groundwater.	16/12/2024	SEW.0001.0001.0142	900,000L/day
34 Coburn Ave	SES and customer report leak - SEW conclude caused by groundwater.		SEW.0001.0001.0142	900,000L/day
The boulevard	A water main burst was identified and repaired.		SEW.0001.0001.0142	900,000L/day
2 Waller Pl	Customer reported leak - SEW cannot locate leak.	17/12/2024	SEW.0001.0001.0142	900,000L/day
4 Waller Pl	Notes groundwater bubbling up from ground		SEW.0001.0001.0142	900,000L/day
4 Waller Pl	Unusually high flow along stormwater drain observed		RES.0004.0002.0008_0	900,000L/day
General McCrae area	SEW informed by Fulton Hogan that they believe water is coming from SEW assets after checking stormwater system on behalf of council	20/12/2024	SEW.0001.0001.0142	1,000,000L/day
3 Charlesworth and 4 Waller Pl	Water coming out in 2 places. In the middle of the road opposite 3 Charlesworth St and water seeping from the nature strip and going over the road opposite 4 Waller Pl. 'good flow coming from the leak in the road in Charlesworth St.'	21/12/2024	SEW.0001.0001.0142	1,000,000L/day
	Water leaking from repaired (11/12/2025) cracks in road.		RES.0004.0002.0008_0	1,000,000L/day
4 Waller Pl	Water flowing up from road at 10+L/min. Storm water drain 'raging', nature strip saturated. SEW could not find any leak.	24/12/2025	SEW.0001.0001.0142	1,050,000L/day
Intersection Charlesworth St. and Waller Pl.	Water coming up from sewer manhole in intersection. Noted a small sinkhole forming at manhole location.	27/12/2025	RES.0014.0001.0002	1,200,000L/day

Location	Observation	Date	Reference	Approx daily leakage rate from pipe burst[1]
34 Coburn Ave. and 1 Waller Pl	Customers reported leak - SEW concluded caused by groundwater. 1 Waller Pl notes fence is underwater with area flooded and swampy.	29/12/2024	SMEC McCrae Landslip Project Report	1,300,000L/day
General McCrae Area	SEW conducting leak detection in the area - leak not found.	30/12/2024	SMEC McCrae Landslip Project Report	1,300,000L/day
1 Waller Pl	House foundations flooded. Road crumbling and 3 sinkholes developed. Leak on Bayview Road identified but could not be repaired due to safety concerns.	31/12/2025	SEW.0001.0001.0142	1,300,000L/day
Bayview Rd.	Bayview Rd pipe burst repaired. Following repair water still flowing up through road but SEW note a reduction in flow through the stormwater.	1/01/2025	SEW.0001.0001.0142	Leak repaired
565 Point Nepean Road	Second hand account of water flowing from the escarpment at 'The Eyrie' throughout January and February. The Eyrie is approximately 360m NE of the landslide site and coincides with an existing gully.	January 2025 to February 2025	Joint witness statement of Kevin Hutchings and John Bolch	Leak repaired
10-12 View Point Rd.	Initial landslide at 10-12 View Point. SEW investigate for leaks but found none.	5/01/2025	SEW.0001.0001.0142	N/A
10-12 View Point Rd.	Water flowing from landslide headscarp, reduces to approximately 5L/min on 10th Jan.	5/01/2025 to 10/01/2025	RES.0001.0003.0001	N/A
10-12 View Point Rd.	Main landslide at 10-12 View Point.	14/01/2025	SEW.0001.0001.0142	N/A
3 Charlesworth St.	Water upwelling from street has stopped	19/01/2025	SEW.0001.0001.0142	N/A

[1] – Taken from Figure 8.15.

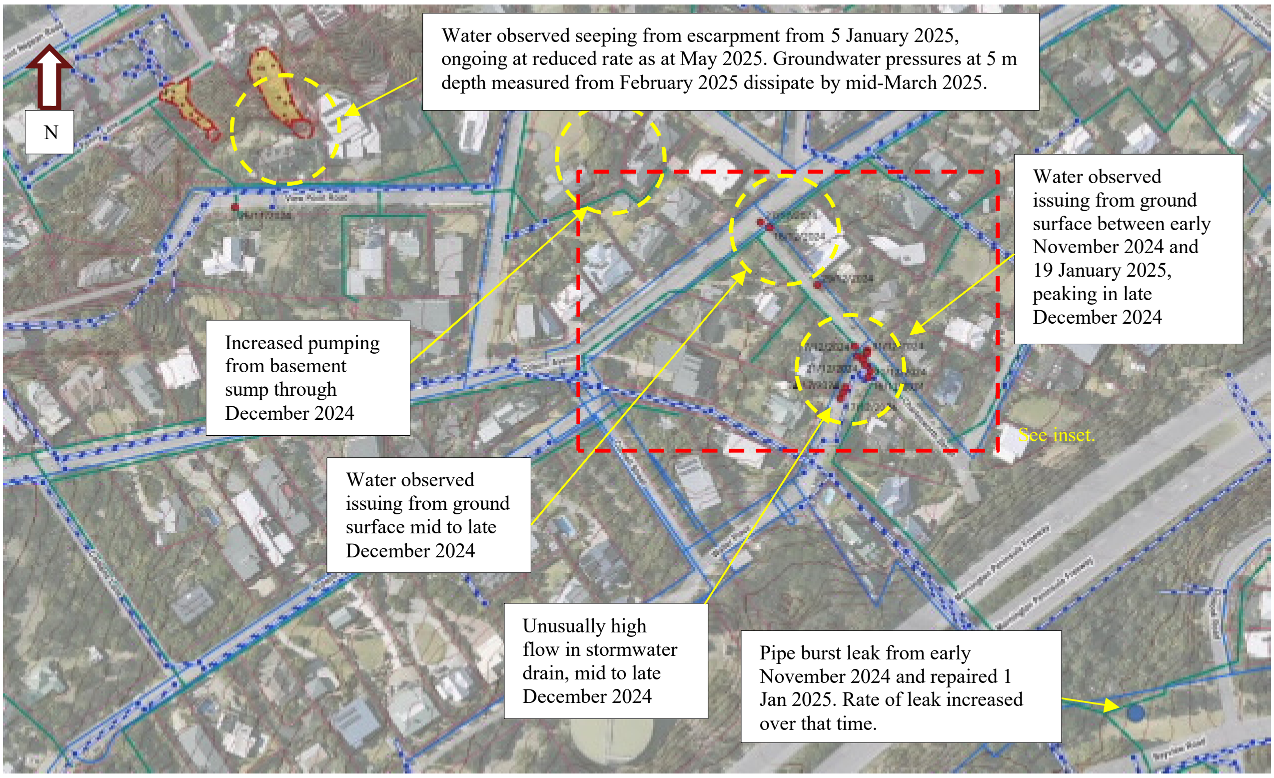

Figure 8.20 Plan showing locations and timing of surface water observations between October 2024 and March 2025. Locations estimated based on report of leak.

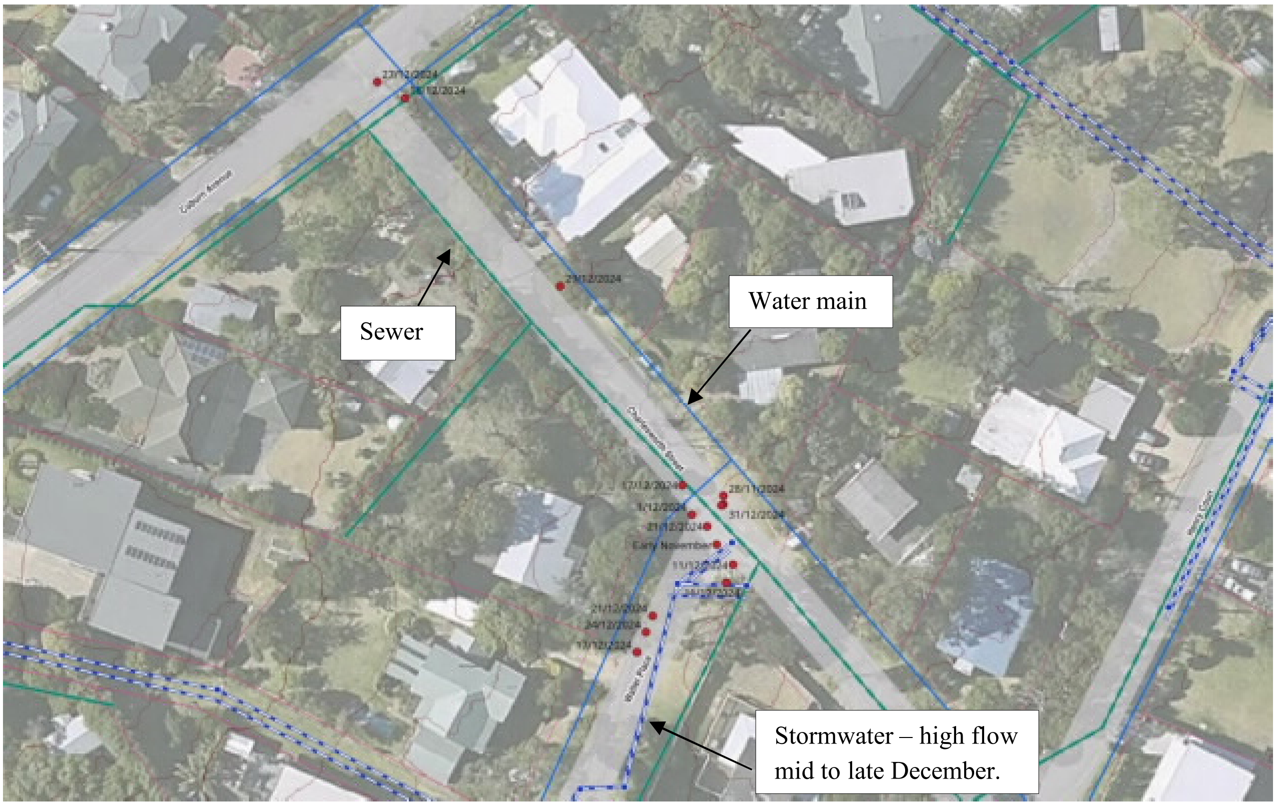

Figure 8.21 Inset from Figure 8.20 Showing location and timing of reported surface water observations around Charlesworth Street and Coburn Avenue.

163) Three potential subsurface flow paths have been identified between the pipe burst on Bayview Road and the January 2025 landslides for which we have undertaken further hydrogeological assessment:

a. Through natural soils only, specifically along the base of channels infilled with colluvium containing silt, sand, gravel and cobbles. Water enters the colluvium directly from the pipe burst. See Figure 8.25. Evidence for the feasibility of this flow path includes:

   i. the observation that the leaking pipe is in contact with colluvial material at the pipe burst site and that water exits from colluvial material at the 2025 landslide headscarp.

   ii. Upwelling of water at locations without service trenches including at 4 and 2 Waller Place and the corner of Coburn Avenue and Prospect Hill Road.

   iii. Increased pumping required from the basement at 5 Prospect Hill Road which does not intersect major service trenches.

b. Through the stormwater pipes, with water issuing from the pipe burst entering the stormwater pipes via the inlet pits between the pipe burst and freeway. The water is then assumed to exit the stormwater pipe through breaches in the pipe, noting a breach near 25 Coburn Avenue which is directly upslope of the 2025 landslide before flowing through natural transported soils to the escarpment. The break in the stormwater pipe at this location is described via an email issued on 25 March 2025 as a cavity adjacent to the break measured as being 900 mm along the pipe, 200 mm to the side and 800 mm up. The break is near the base of a stormwater pit 2.2 m below the surface (MSC.5031.0001.4490) as shown in Figure 8.22 . The pit is inferred to have been installed in 1981 (SME.0001.0001.0309). It is not clear when the pipe break occurred nor whether the break existed prior to the January 2025 landslides, however if caused by erosion which is consistent with the photograph, this would have taken some time, likely years to form. See Figure 8.26. Evidence for this flow path includes:

   i. The hole in the stormwater pipe and voiding of adjacent soils at 25 Coburn Ave. The immediate area has a history of water ingress through the ground after a 2022 water main burst resulted in upwelling of water over 5 m from the burst site and the development of a sinkhole in a nearby property as shown in Figure 8.23.

   ii. Witness reports of high stormwater flows along the stormwater pipes in December 2024, for example the witness statement of Brett Cooper (RES.0004.0002.0008) that coincide with the time during which the SEW pipe was known to be leaking.

   iii. Sediment deposition between the pipe burst and stormwater pit as shown in Figure 8.16.

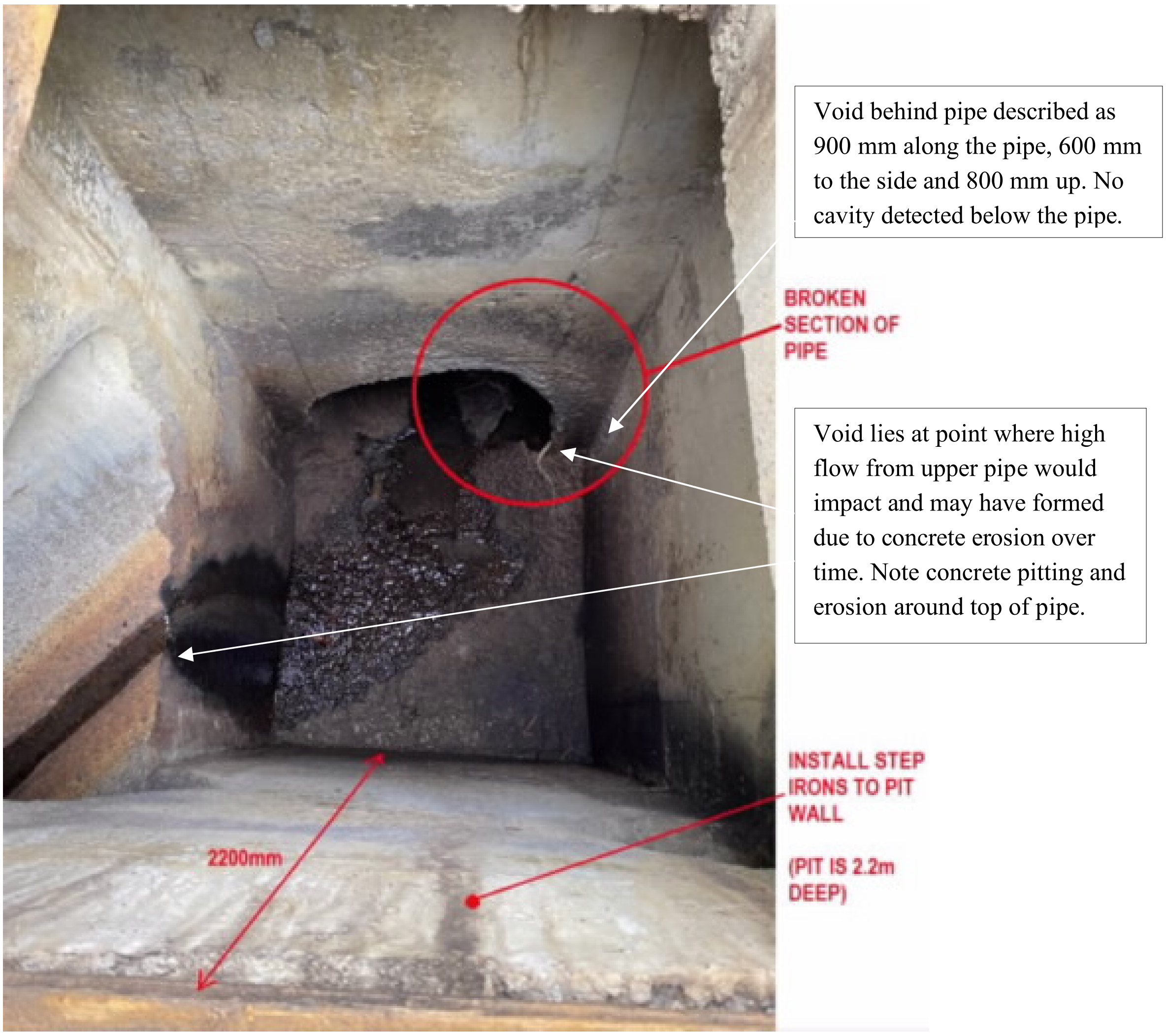

Figure 8.22 Breach in stormwater pipe and associated void formation adjacent to stormwater pipe at 25 Coburn Avenue observed in March 2025. Mornington Peninsula Shire annotations in red, my annotations in white (MSC.5031.0001.4490).

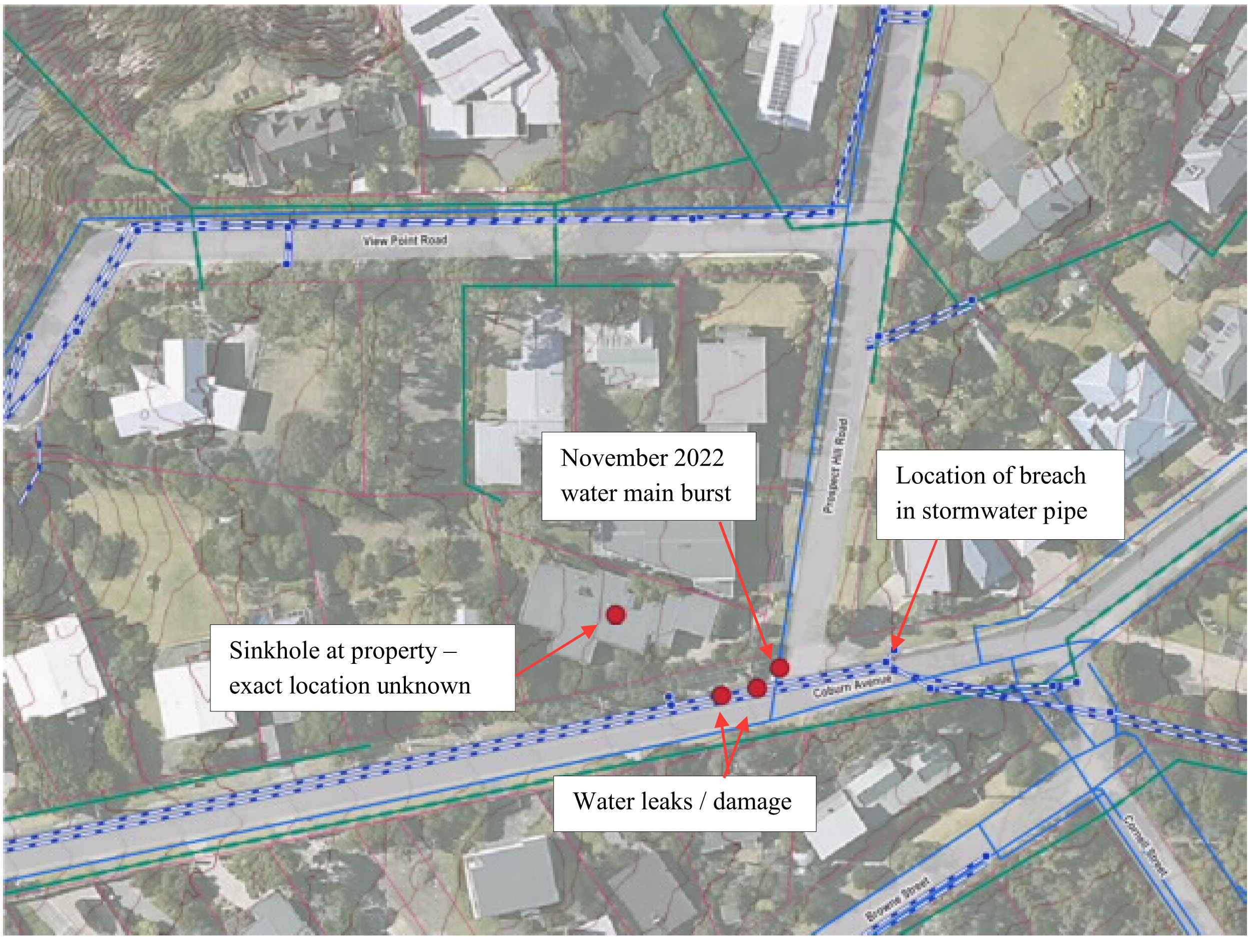

Figure 8.23 Location of stormwater pipe breach and adjacent impact of adjacent water main burst in 2022 (compiled from information provided in (SEW.0001.0001.0142).

c. Through sewer trenches with water from the pipe burst flowing through either natural soils or along the water pipe trench for about 20 m before entering the sewer trench. Water would need to further flow through sections of natural soils between the intersection of Charlesworth Street and Coburn Avenue and the sewer in Prospect Hill Road then again from the sewer at View Point Road to the landslide headscarp. See Figure 8.27. Evidence for this flow path includes:

   i. Upwelling of water and exfiltration at ground surface in Charlesworth Street, Coburn Avenue and Prospect Hill Road in close proximity to the sewer trenches.

   ii. Dye tracer test between borehole NDT01 which is adjacent to a sewer trench at 6 Prospect Hill Road and the 2025 landslide headscarp in which dye was observed to issue from the landslide headscarp (PSM.5000.0004.4640) after a relatively short time.

   iii. Subsurface voids detected near the stormwater and sewer trench in View Point Road. Figure 8.24 shows an image of a void observed during the 2023 council works to upgrade the stormwater drainage on View Point Road (RES.0001.0003.0001). Evidence of subsurface voiding was also identified in a 2023 CivilTest report (MSC.5000.0001.0246) following ground penetrating radar (GPR) of the area. The results of the GPR identified a void near the sewer pipe at 10-12 View Point Road and noted voids deeper that the 1.5m range of GPR would not be identified.

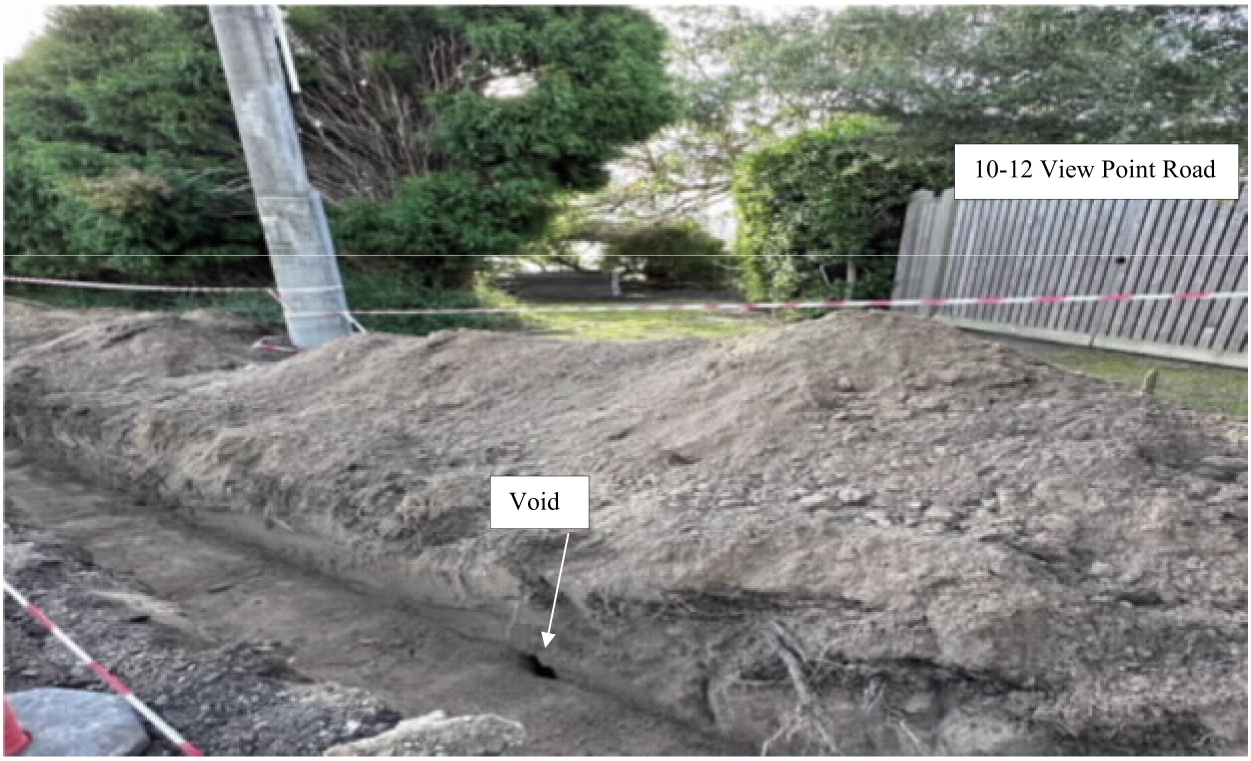

Figure 8.24 Image taken during excavation works for stormwater upgrade on View Point Road in 2023. Void observed within excavated trench (RES.0001.0003.0001).

164) These three potential flow paths have been selected for further assessment because of the distinct differences between them. There is the possibility that all of these flow paths convey water or that they combine to convey water over different sections between the pipe burst and landslide headscarp.

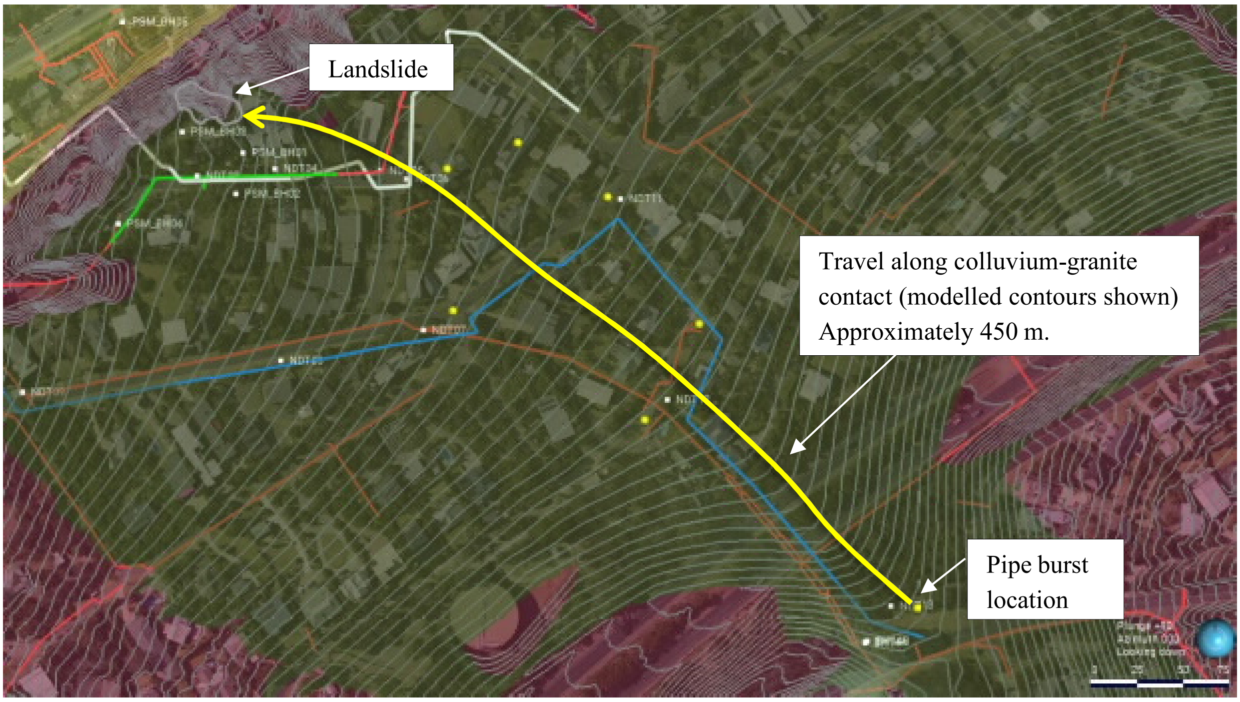

Figure 8.25 Plan showing potential flow path through natural soils. Modelled surface geology shown where green is transported soil and red is RS/XW granite.

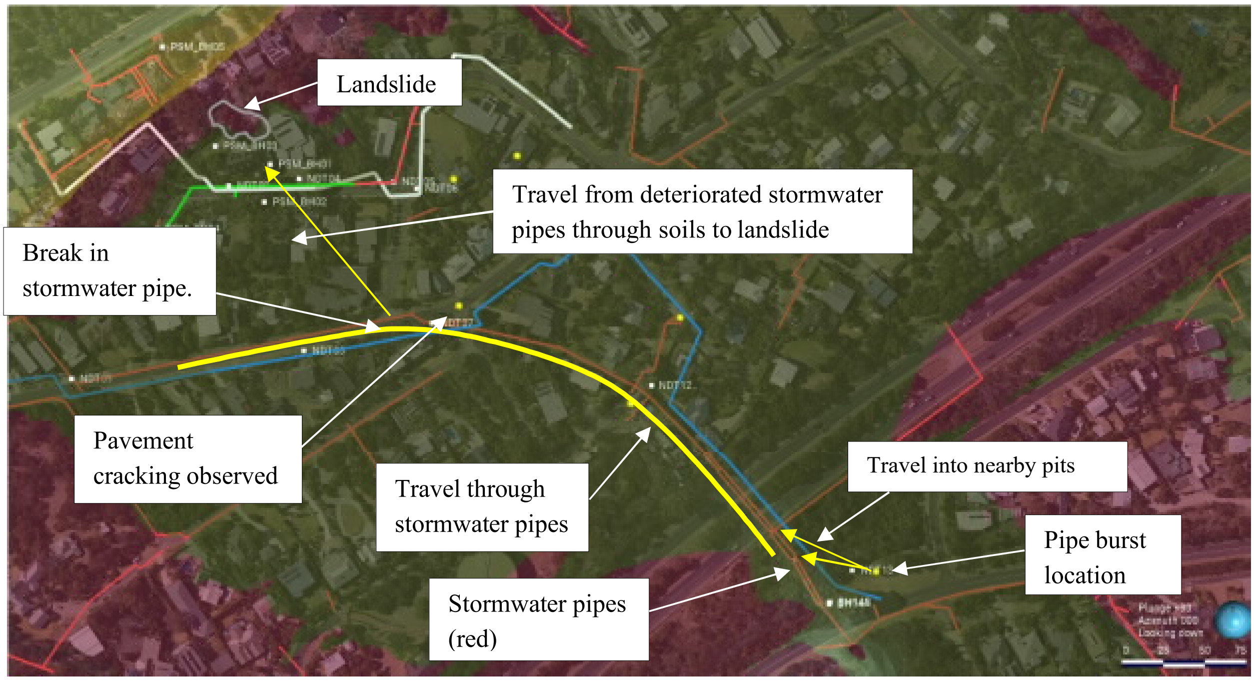

Figure 8.26 Plan showing potential flow path through stormwater pipe. Modelled surface geology shown where green/yellow is transported soil and red is RS/XW granite.

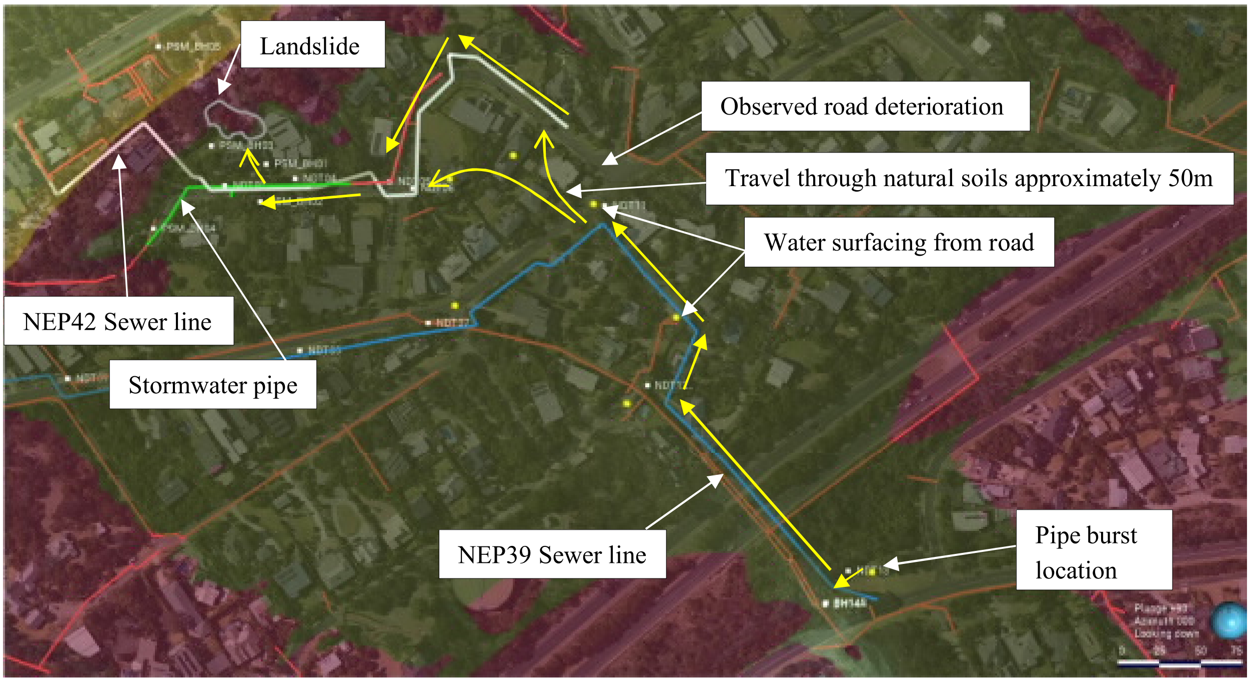

Figure 8.27 Plan showing potential flow path through sewer trenches. Modelled surface geology shown where green/yellow is transported soil and red is RS/XW granite.

8.7.3 Hydrogeological Assessment of Flow Paths

165) The hydrological assessment set out below has been undertaken by Principal Hydrogeologist, Mr. Stephen Makin.

166) An estimate of the potential rate of infiltration from the leak was made using the method of Hantush (1967)[12], as implemented in Aqteolv Pro software. For a constant rate of recharge for 60 days over a rectangular area of 10 m by 5 m, the height of groundwater mounding is shown in Figure 8.28 for hydraulic conductivity, K of 10^{-4} m/s, such as may be typical of sandy gravel, and Figure 8.29 for K of 10^{-3} m/s, typical of a gravel material. This indicates that depending on the flow rate and the available thickness of the colluvial aquifer below the leak, the aquifer would become fully saturated at varying times after the start of the leak. After that time, continued recharge could result in water exfiltration at the ground surface over the leak. For example, for a 10 m thick gravel aquifer, recharge rates over around 2 m^3/day would fully saturate the aquifer after around 60 days. Higher recharge rates would bring water to the ground surface earlier, noting that the flow rates from the pipe reached 1,400,000 litres, 1,400 m^3 per day. Given excessive water flow was not observed through stormwater pipes until mid-December 2025, the ground in the vicinity of the pipe burst was likely relatively permeable to absorb the very high volume of water it did over the time it did before excessive water could no longer be absorbed by the ground and issued at the ground surface to be collected by the stormwater pit between the pipe burst and Mornington Peninsula Freeway.

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[12] Hantush, M.S., 1967. Growth and decay of groundwater mounds in response to uniform percolation, Water Resources Research, vol. 3, no. 1, pp. 227-234.

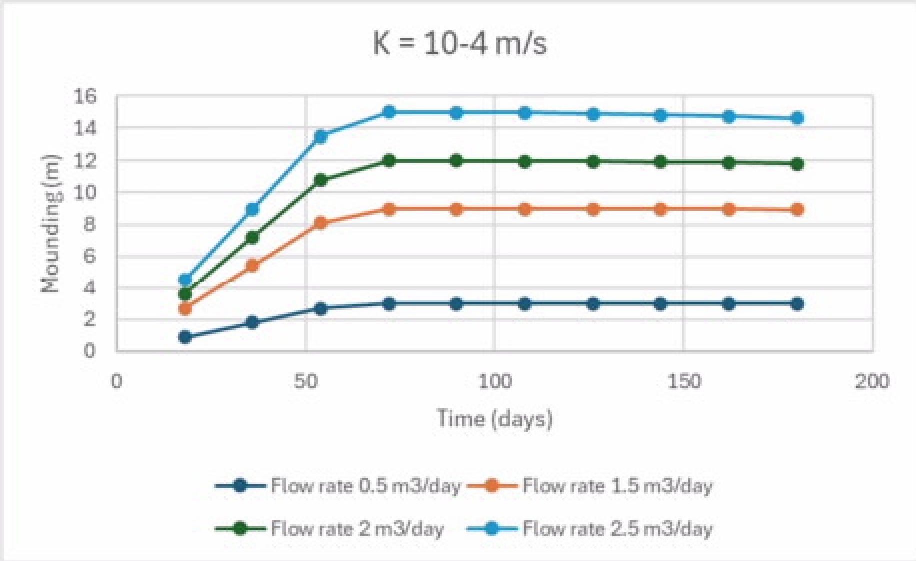

Figure 8.28 Groundwater mounding at K = 10^{-4} m/s

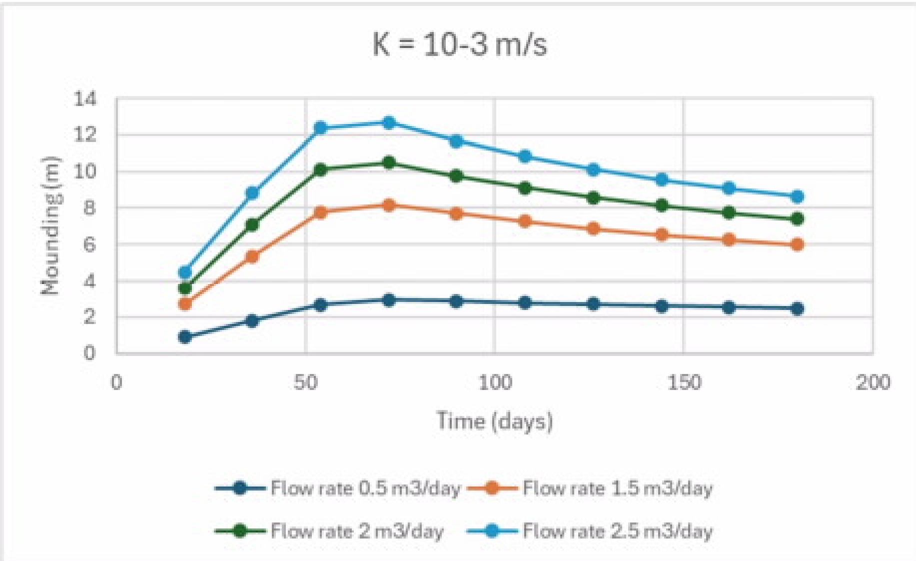

Figure 8.29 Groundwater mounding at K = 10^{-3} m/s

167) Fully saturating one area of the aquifer may have the effect of enlarging the recharge area, by surface water flow spreading out. By this mechanism, higher recharge rates could be sustained to a wider area of the aquifer.

168) An estimate of possible water travel time via different potential pathways was made in order to assess the physical possibility of these pathways transmitting water from the leak location to the landslip location. Simplified situations were used to illustrate these pathways, using the linear velocity equation stated in Section 102). Darcy's Law can also be used to estimate the groundwater flux (volume flow rate, Q) through a particular cross-sectional area (A):

$$Q = K \cdot \frac{dh}{dl} . A$$

a. Flow through the colluvial aquifer. For a head difference of 40 m over the 450 m distance, this gives a hydraulic gradient of around 0.09. Potential flow velocities, travel times and flux are shown in Table

8.2 for a range of possible aquifer properties. For the flux calculation, a cross-sectional area of 250 m^2 was used, such as 5 m deep by 50 m wide.

Table 8.2 Flow calculation for colluvial aquifer

Aquifer materials	Sand	Gravelly sand	Gravel
Typical K (m/s)	10^{-5}	10^{-4}	10^{-3}
Typical porosity (n)	0.25	0.23	0.2
Linear velocity (v_l) (m/s)	3.6×10^{-6}	3.9×10^{-5}	4.4×10^{-4}
Linear velocity (m/day)	0.3	3	38
Travel time (days)	1465	135	12
Flux (Q) (m^3/s)	2.2×10^{-4}	2.2×10^{-3}	2.2×10^{-2}
Flux (Q) m^3/day	19	192	1920

It is estimated that the water leak started approximately two months (60 days) prior to the 5 January 2025 landslide and given it was estimated to be leaking at rate of up to 1,400 m^3/day the aquifer area available through which the water could flow was sufficiently large to carry the all of the flow if the soil was gravel. For flow only through a layer of the colluvial aquifer, water from the leak may have reached the landslip location in less time than 60 days if it were flowing through gravel with similar properties to that in Table 8.2. Indications of significantly higher hydraulic conductivity have been noted from dye tracer tests, although over short distances (Paragraph 102), however if there were several sections with higher hydraulic conductivity similar to those indicated by the dye test, this could also reduce the time taken for water from the pipe burst to reach the escarpment.

b. Flow through a colluvium filled channel. It is inferred that deeper channels may have been present, which are now filled by colluvium. These may provide more favourable pathways than a continuous thin sheet of colluvium as considered in the previous section. As the hydraulic gradient and aquifer properties are in the same ranges, groundwater flow rates and travel time calculated for this situation are the same as in Table 8.2. However, if there is a greater cross-sectional area available for flow, higher fluxes may be transmitted. For example, a channel 25 m wide by 15 m deep (375 m^2) could allow flux of up to 2,880 m^3/day for the K= 10^{-3} m/s case, more capacity than the maximum approximately 1,400 m^3 per day estimated to have leaked from the pipe.

c. Flow through service trenches. As for natural filled channels, the flow rate and travel time through the backfill material in an underground service trench would have the same relationship with hydraulic conductivity. However, service trenches are more likely to have been backfilled with permeable materials such as gravel, allowing shorter travel times. Volumetric flux would depend on the cross-sectional area, which would be expected to be relatively low. For example, a cross-sectional area of 4 m^2 (e.g. 2 m x 2 m) would allow a flux of around 31 m^3/day for the K= 10^{-3} m/s case. If there are obstructions in a trench, for example a pit, this could reduce the flux along the trench, causing water to divert from the trench, either flow out of the trench or upwell to the surface as was observed in Charlesworth Street. The flux along a trench might be sufficient to carry the volume that issued from the pipe at the commencement of the leak until such point that the flux along the trench was constrained, forcing water to divert or break through to the surface. Further evidence is provided of connectivity between the trench and the landslide because after the water main was repaired on 1 January 2025, the pore water pressure measured in Borehole BH01 at 5 m depth dissipated, with pressure fully dissipating by mid-March 2025 (Figure 8.6). If the pore water pressure at the site of the

2025 landslide is related to the pipe burst, then the time between the pipe burst which is inferred to have occurred in early November 2024 and the occurrence of the landslide in early to mid-January (about 2 – 2.5 months) is similar to the time it took for groundwater pressure to dissipate after the pipe was repaired on January 1 2025.

169) It is physically possible for water to travel over 450 m via subsurface pathways within the observed timeframe of less than 60 days. The travel time is dependent on the permeability of the ground, and the volumetric flux is relative to the available cross-sectional are (depth and width). Based on the estimated rate of leakage from the pipe, a combination of pathways is likely, with water finding the path of least resistance through the natural ground, subsurface infrastructure and backfilled trenches, diverting when the flux of pathways was exceeded and components of flow discharging to the ground surface and recharging back to the ground in various locations along the flow path.

170) The volume of soil that detached in the 14 January 2025 landslide is estimated to be about 300 m^3 (MSC.5047.0001.0001). Assuming a porosity of about 40%, which is typical for the colluvial soils exposed in the McCrae escarpment, the volume of pore space within the soils that were detached in the landslide would be about 120 m^3. As discussed at Section 7.1.1, the volumetric change in water content to reduce soil suctions to the point of causing a landslide is estimated to be between about 10% and 30%. Assuming the upper bound, the water ingress needed to fill 30% of the pore space in the soil, and to then trigger the landslide would be around 36 m^3, or 36,000 L. Assuming the lower bound total leakage from the pipe of 34 ML, the proportion of the total water that issued from the pipe that would have needed to reach 10-12 View Point road and cause the January 2025 landslides is around 0.1%. Whilst this is an approximate estimation only, it indicates that only very a small proportion of the water that leaked from the pipe would have been required to trigger the landslide.

8.7.4 Geochemical Assessment of Water

171) Comparison between the chemistry of water at the source of the leak and water encountered along the flow paths between the leak and the landslide headscarp can allow an assessment of whether water downslope of the leak is likely to have originated from a water main.

172) A geochemical assessment has been undertaken by geochemist Dr Hong Phuc Vu with the aim of evaluating the potential sources of water that may have contributed to increased pore water pressure within the soil at the McCrae escarpment, causing the 2025 landslide. A particular objective was to assess the hypothesis that water from the SEW main burst infiltrated into the ground and then migrated along a pathway to the location of the 2025 landslide.

8.7.4.1 Methodology

173) Surface and groundwater sampling was undertaken in the week of 16 to 20 June 2025, during which water levels or water depths in accessible wells previously installed by PSM were measured using an electronic interface probe. The probe was rinsed with deionised water prior to the water level measurements and between well locations, to minimise the possibility of cross-contamination between wells.

174) Surface water samples were obtained from a number of locations (Figure 8.30 and Figure 8.31) using grab sampling method (an extendable pole and laboratory supplied bottle). Most sampled locations are stormwater pits, with the exception of a private sump associated with the basement at 5-7 Prospect Hill Road. Samples analysed for dissolved metals were collected in the field using 0.45-micron filters and appropriately preserved in laboratory supplied bottles. Other samples were also collected in appropriately preserved laboratory supplied bottles.

Figure 8.30 Sampling locations.

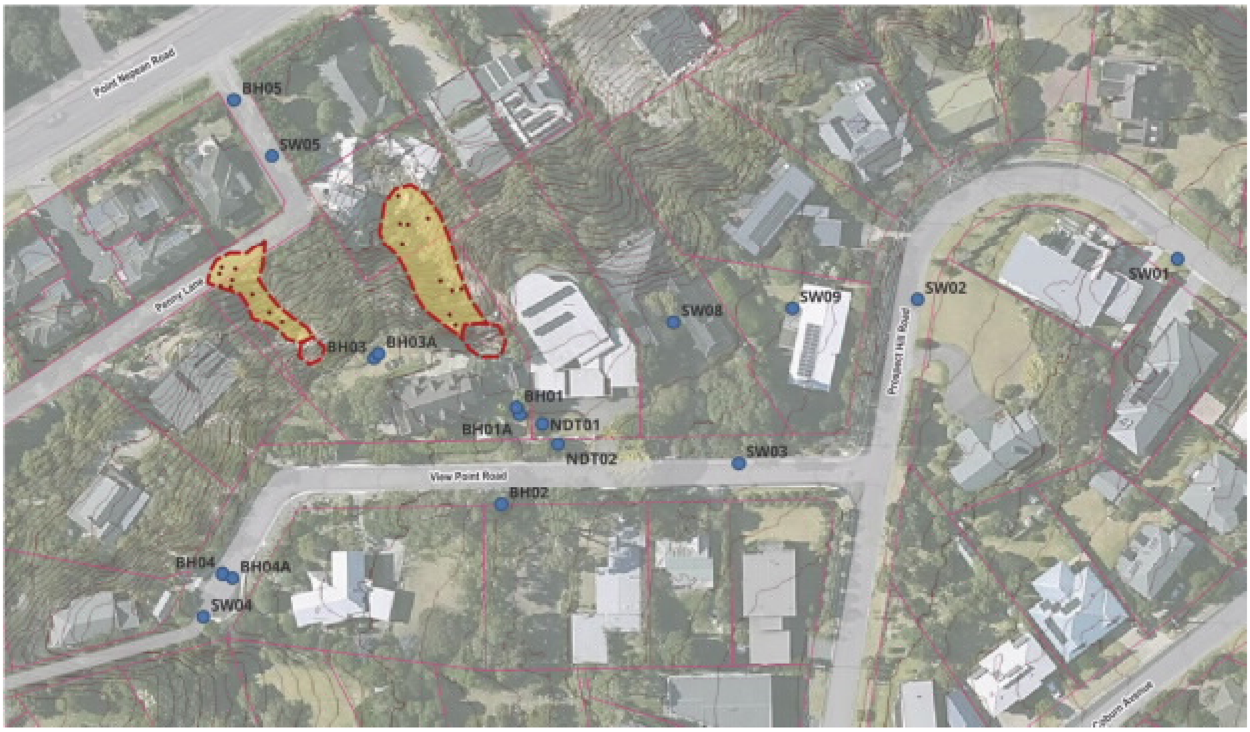

Figure 8.31 Inset of sampling locations.

175) Field monitoring data including TDS and pH (water quality monitoring, WQM) was collected at each of the sampled locations.

Table 8.3 Surface water sampling locations

ID	New ID	Location	Note
Pit01	PIT01	Near corner Bayview Road and Outlook Road.	Sampled
Pit02	PIT02	In between corner Bayview Road and Outlook Road and Mornington Peninsula Freeway	Low flowing water, no sample taken, water quality monitoring (WQM) only
Pit03	PIT03	Next to Mornington Peninsula Freeway	Sampled
Pit04	PIT04	Out front of 4-6 Waller Place	Sampled
SW01	PIT05	Out front of 5-7 Prospect Hill Road	No flow - No sample taken
SW02	PIT06	On edge of 5-7 Prospect Hill Road (private pit)	A private sump, asked for permission, water is flowing - sample taken
SW03	PIT07	Front of 4 View Point Road	Flowing - sample taken
SW04	PIT08	Pit at the end of View Point Road	No flowing water, WQM only
SW08	RW01	Rainwater tank, 4 View Point Road	Accompanied by private owner, sampled. Duplicate and triplicate samples taken
SW09	RW02	Rainwater tank, 2 View Point Road	Accompanied by private owner, sampled

176) Accessible wells installed by PSM (Figure 8.30, Figure 8.31 and Table 8.4) were monitored, and groundwater (GW) was sampled in well BH04 (the only well in which groundwater was present) using a low flow sampling technique. The following measures were implemented during sampling:

a. The flow rate of the pump was regulated to minimise fluctuation of the water level during pumping and sampling.
b. Groundwater drawdown was monitored during purging and sampling using an interface probe.
c. Field parameters (pH, electrical conductivity (EC), reduction/oxidation potential (redox), dissolved oxygen (DO) and temperature) were recorded after every 1.0 Litre (L) of groundwater purged, using a calibrated water quality meter and a flow cell suspended in a bucket.
d. Once field parameters had stabilised, a groundwater sample was collected. Field observations of the colour, turbidity and odour were also noted.
e. Samples analysed for dissolved metals were collected in the field using 0.45-micron filters and appropriately preserved in laboratory supplied bottles. Other samples were also collected in appropriately preserved laboratory supplied bottles.

Table 8.4 Groundwater well locations

ID	Inferred PSM ID	Location	Drilled/measured depth (m)	Note
BH01	BH01	BH01 Carport of 10-12 View Point Road	30	No well installed
BH01A	BH01A	BH01A Adjacent to BH01	6	Dry
BH02	BH02	BH02 Verge in front of 5 View Point Road	30	Dry

ID	Inferred PSM ID	Location	Drilled/measured depth (m)	Note
BH03	BH03	BH03 10-12 View Point Road	29.5	No well installed
BH03A	BH03A	BH03A Adjacent to BH03	6	Dry
BH04	BH04	BH04 Middle of View Point Road	30	Sampled
BH04A	BH04A	BH04A Adjacent to BH04	6	Dry
BH05	BH05	BH05 3 Penny Lane	5	Dry (reported by PSM)
NDT01	NDT01	Front yard of 6 View Point Road	5	Dry
NDT02	NDT02	Verge in front of 6 View Point Road	3.2	No well installed
BH06	NDT13	Near corner Bayview Road and Outlook Road	1.91	Dry
BH06A	BH14B	Near corner Bayview Road and Outlook Road	2.65	Dry
BH07	NDT05	Corner View Point Road and Prospect Hill Road	1.66	Dry

177) Field sampling records and instrument calibration sheets are included in Appendix D. All water samples were stored in insulated cool boxes and dispatched to the primary laboratory (Australian Laboratory Services Pty Ltd, ALS) and secondary laboratory (Eurofins Pty Ltd, Eurofins) under chain of custody (CoC) procedures. Both laboratories are accredited by the National Association of Testing Authorities (NATA). Rainwater, surface water and groundwater samples were tested for:

a. Major cations and anions: (Ca, Mg, Na, K, Cl, SO_4)
b. Alkalinity
c. Electrical conductivity (EC)
d. pH
e. Total dissolved solids (TDS)
f. Nitrate
g. Total organic carbon (TOC)
h. Cyanide (total)
i. Total phosphorus
j. Reactive phosphorus
k. Silica
l. Dissolved metals/metalloids: Arsenic, Beryllium, Boron, Bromide, Cobalt, Cadmium, Calcium, Chromium, Copper, Manganese, Lead, Mercury, Molybdenum, Nickel, Zinc, Silver, Tin, Vanadium, and Selenium
m. Fluoride

8.7.4.2 Results and Discussions

178) The field measurements are summarised in Table 8.5 and presented in Appendix E.

Table 8.5 Summary of field parameters[13]

ID	New ID	EC (µS/cm)	TDS (mg/L)*	pH
Pit01	PIT01	409.9	274.6	6.11
Pit02	PIT02	159.7	107.0	7.45
Pit03	PIT03	109.4	73.3	7.22
Pit04	PIT04	410.9	275.3	7.86
SW02	PIT06	578	387.3	6.85
SW03	PIT07	510	341.7	7.7
SW04	PIT08	520	348.4	8.08
SW08	RW01	329.2	220.6	7.31
SW09	RW02	287.0	192.3	4.50
BH04	-	7121	4771.07	6.21
SW05**	-	1051.0	704.17	7.97

*Estimated TDS from EC measurements using a conversion factor of 0.67 (ANZECC & ARMCANZ (2000)[14].

** Seep from the 2025 landslide (SW05 is one of PSM surface water locations, flowing water along east side of Penny Lane. Sample was collected and measured on 20 January 2025 by PSM).

179) The field measurement results show that:

a. Stormwater samples (water from stormwater pits) have pH in the range of slightly acidic to slightly alkaline, from 6.1 to 8.1.
b. One rainwater sample (RW02) has an acidic pH (pH of 4.5) and the other rainwater sample (RW01) has a neutral pH (pH of 7.3).
c. The groundwater sample has a slightly acidic pH (pH of 6.2).
d. The seep from the landslide (SW05 sampled by PSM) has a slightly alkaline pH (pH of 8.0).
e. EC and TDS from stormwater pits range from 109 to 410 µS/cm and 73 to 387 mg/L, respectively, in the range of fresh water (<1000 mg/L[15]). EC and TDS generally increase in samples tested further from the burst main location, closer to McCrae escarpment and the January 2025 landslide, except for the PIT02 and PIT03, which reported the lowest values.
f. The two rainwater samples have TDS values of 192 mg/L and 220 mg/L, in the typical range of fresh water.
g. The groundwater samples from BH04 have a TDS of 4771 mg/L, in the range of sightly saline water.
h. The seep from the landslide (SW05) has a TDS of 704 mg/L, in the range of fresh water.
i. The pH of the water that has seeped from the landslide is similar to that of water sampled in the stormwater pits.
j. Field measurements for samples from the water main were not available, but the observed TDS values are significantly higher than the typical TDS of mains water[16], except for the sample from PIT03, which reported a TDS of 73 mg/L.
k. The TDS from the seep from the landslide is nearly twice that of water sampled from the stormwater pits.

[13] No water quality data for the mains water.

[14] Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand, Canberra).

[15] https://www.usgs.gov/special-topics/water-science-school/science/saline-water-use-united-states

[16] https://www.melbournewater.com.au/sites/default/files/Typical-water-analysis-data-2016.docx

l. The groundwater sample collected from Borehole BH04 was taken from a depth of greater than 23 m below ground surface, making this water unlikely to have contributed to increased pore water pressure within the soil at the McCrae escarpment.
m. Based on the field measurements, the source of the water that infiltrated and contributed to the 2025 landslide is unclear.

180) The laboratory analytical results are summarised in Table 8.6, Figure 8.32 and Figure 8.33, and are presented in Appendix E.

Table 8.6 Laboratory results for water testing

Parameters	Unit	PIT01	PIT03	PIT04	PIT06	PIT07	BH04	RW01	RW01 - Duplicate	RW02	RW01-Triplicate	SW05[i]
Fluoride	mg/L	<0.1	<0.1	<0.1	0.1	0.1	0.3	<0.1	<0.1	<0.1	< 0.5	<0.5
Bicarbonate Alkalinity as CaCO3	mg/L	120	121	103	98	100	158	9	4		<20	190
Total Alkalinity as CaCO3	mg/L	120	121	103	98	100	158	9	4			
Silicon	mg/L	7.18	7.25	6.74	7.92	7.9	24.7	0.22	0.25		0.5	
Chloride	mg/L	65	66	102	152	154	3260	71	78		56	240
Sulfate	mg/L	26	28	42	39	39	343	11	11		15	100
pH	pH Unit	6.77	7.67	7.78	7.1	7.59	6.65	5.75	5.62	5.87	4.2	8
Electrical Conductivity	µS/cm	515	520	579	744	754	9800	297	318	45	310	1200
Total Organic Carbon	mg/L	6	9	6	6	6	7	3	2	2	< 5	
Total Cyanide	mg/L	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.011	
Nitrate as N	mg/L	1.25	1.18	1.2	0.53	0.52	2.42	0.27	0.3	0.19	2	<0.4
Nitrite as N	mg/L	0.01	<0.01	<0.01	0.01	<0.01	0.02	<0.01	<0.01	<0.01		
Nitrite + Nitrate as N	mg/L	1.26	1.18	1.2	0.54	0.52	2.44	0.27	0.3	0.19		
Reactive Phosphorus as P	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.01	<0.01	0.02	
Total Phosphorus as P	mg/L	<0.01	0.06	0.06	0.04	0.01	0.02	0.02	0.04	0.02	0.02	
Total Dissolved Solids	mg/L	305	290	294	360	381	5800	191	178	72	170	640
Bromide	mg/L	0.29	0.27	0.28	0.35	0.36	5.91	0.14	0.14	0.02	< 1	
Calcium	mg/L	14	14	14	18	19	118	5	4	2	4.3	41
Magnesium	mg/L	18	18	19	17	17	330	5	5	<1	5.1	21
Sodium	mg/L	63	64	70	109	109	1460	40	39	5	41	160
Potassium	mg/L	4	4	5	5	5	21	2	2	<1	2.9	14
Aluminium	mg/L	0.01	<0.01	0.01	0.02	0.01	0.01	0.02	0.02	0.02	< 0.05	
Chromium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.014	0.014	0.013	0.013	0.002
Cobalt	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.009	<0.001	<0.001	<0.001	< 0.001	
Copper	mg/L	0.002	0.005	0.002	0.004	0.004	0.002	0.002	0.002	0.002	0.002	0.008
Lead	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.011	0.011	<0.001	0.01	<0.001
Manganese	mg/L	0.015	0.015	0.019	0.004	0.004	0.2	0.047	0.046	0.002	0.043	
Molybdenum	mg/L	<0.001	<0.001	<0.001	0.001	<0.001	0.002	<0.001	<0.001	<0.001	< 0.005	
Arsenic	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.031	0.03	<0.001	0.029	0.007
Nickel	mg/L	<0.001	<0.001	<0.001	0.001	0.001	0.017	<0.001	<0.001	<0.001	< 0.001	0.002

Parameters	Unit	PIT01	PIT03	PIT04	PIT06	PIT07	BH04	RW01	RW01 - Duplicate	RW02	RW01-Triplicate	SW05[i]
Selenium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	< 0.001	
Beryllium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	< 0.001	
Tin	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	< 0.005	
Vanadium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	< 0.005	
Zinc	mg/L	<0.005	0.012	0.415	0.006	0.007	0.051	0.261	0.266	0.372	0.26	0.009
Boron	mg/L	0.06	0.05	0.06	0.07	0.08	0.06	0.06	0.06	<0.05	< 0.05	
Iron	mg/L	0.35	0.17	0.06	0.07	0.06	<0.05	<0.05	<0.05	<0.05	< 0.05	
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	< 0.0002	<0.0002
Silver	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	< 0.005	

181) The laboratory analytical results acquired by SMEC and PSM are summarised in Table 8.7 and Figure 8.32 to Figure 8.34, and are presented in Appendix E. For comparison typical mains water chemistry is presented noting that we have not been provided with samples taken from the burst at the time it occurred.

Table 8.7 Laboratory results from SMEC and PSM (PSM.5004.0001.0001 to PSM.5004.0001.0001, SME.0001.0001.0234 to SME.0001.0001.0327).

Parameters	Unit	Indicative mains water 1 (SEW - 11045899)	Upwelling within pothole at junction of Waller Pl and Charlesworth St (sampled 16/01/2025)	Upwelling within pothole at junction of Coburn Ave and Charlesworth St (sampled 22/01/2025)	Pavement around Coburn & Charlesworth (sampled 22/01/2025)	Stormwater drain in front of 6 View Point Rd (sampled 08/01/2025)	SW02 - (20/01/2025)	Indicative main water 2[17]
Fluoride	mg/L	0.76	0.28	0.32	0.22	0.13	<0.5	0.8
Bicarbonate Alkalinity as CaCO3	mg/L	23					79	11.6
Total Alkalinity as CaCO3	mg/L	23					79	11.6
Silicon	mg/L							2.1
Chloride	mg/L	20	250	210	270	82	81	7.1
Sulfate	mg/L	2			95		19	0.4
pH	pH Unit	7.7		7.1	7.2		6.9	7.5
Electrical Conductivity	µS/cm	120	1200	1000	1400	570	1400	50
Nitrate as N	mg/L	0.22						7.4
Nitrite as N	mg/L	<0.002						

17 https://www.melbournewater.com.au/sites/default/files/Typical-water-analysis-data-2016.docx

Parameters	Unit	Indicative mains water 1 (SEW - 11045899)	Upwelling within pothole at junction of Waller Pl and Charlesworth St (sampled 16/01/2025)	Upwelling within pothole at junction of Coburn Ave and Charlesworth St (sampled 22/01/2025)	Pavement around Coburn & Charlesworth (sampled 22/01/2025)	Stormwater drain in front of 6 View Point Rd (sampled 08/01/2025)	SW02 - (20/01/2025)	Indicative main water 2[17]
Total Dissolved Solids	mg/L	85	804[$]	670[$]	938[$]	382[1]		39
Calcium	mg/L	8.9					8.4	4.4
Magnesium	mg/L	1.6					7.7	1.4
Sodium	mg/L	9.7					55	4.7
Potassium	mg/L	1.3					2.5	0.7
Iron	mg/L	<0.01						0.06

[1]Estimated TDS from EC measurements using a conversion factor of 0.67.

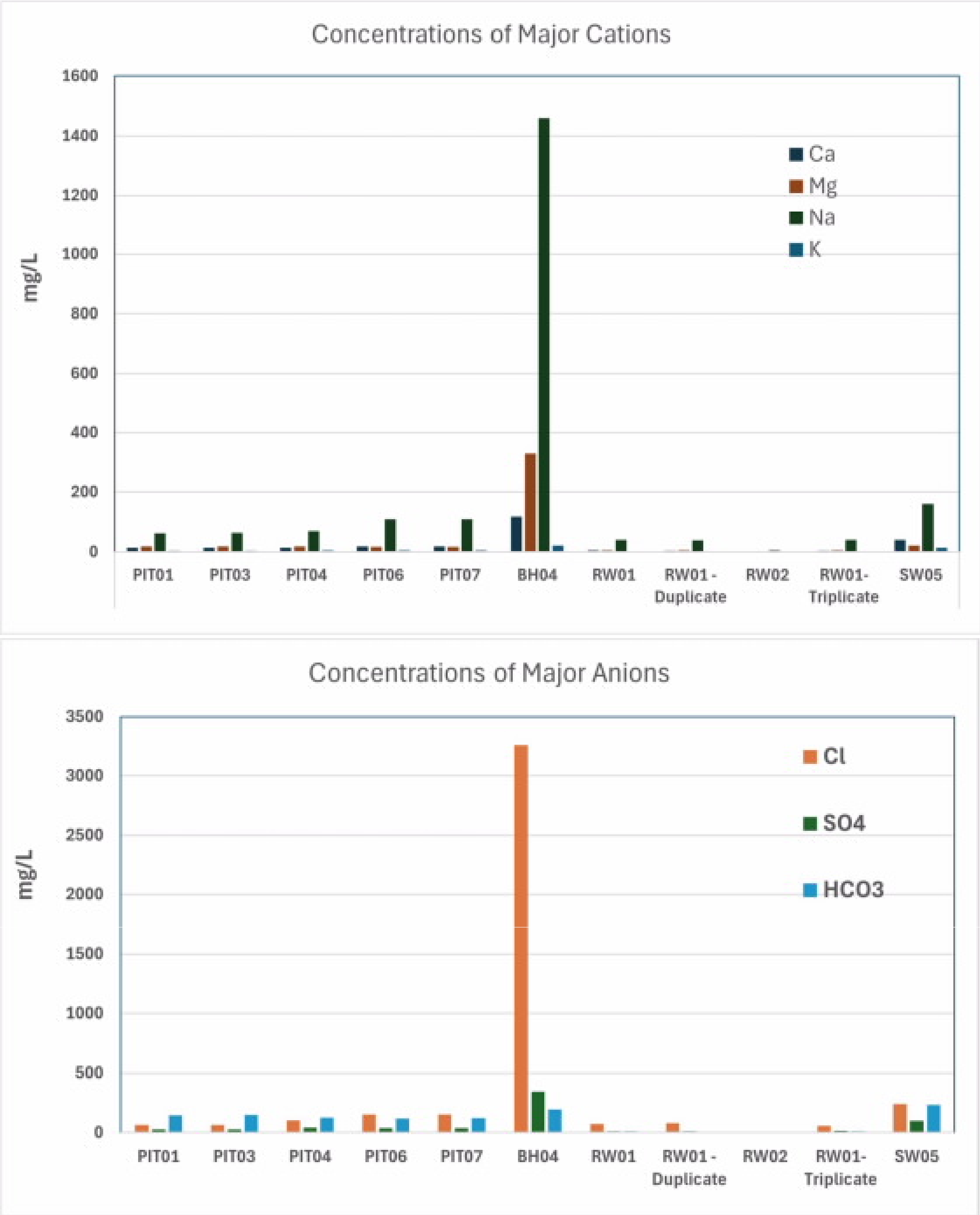

Figure 8.32 Concentrations of major cations and anions (HCO3 was calculated from bicarbonate alkalinity)

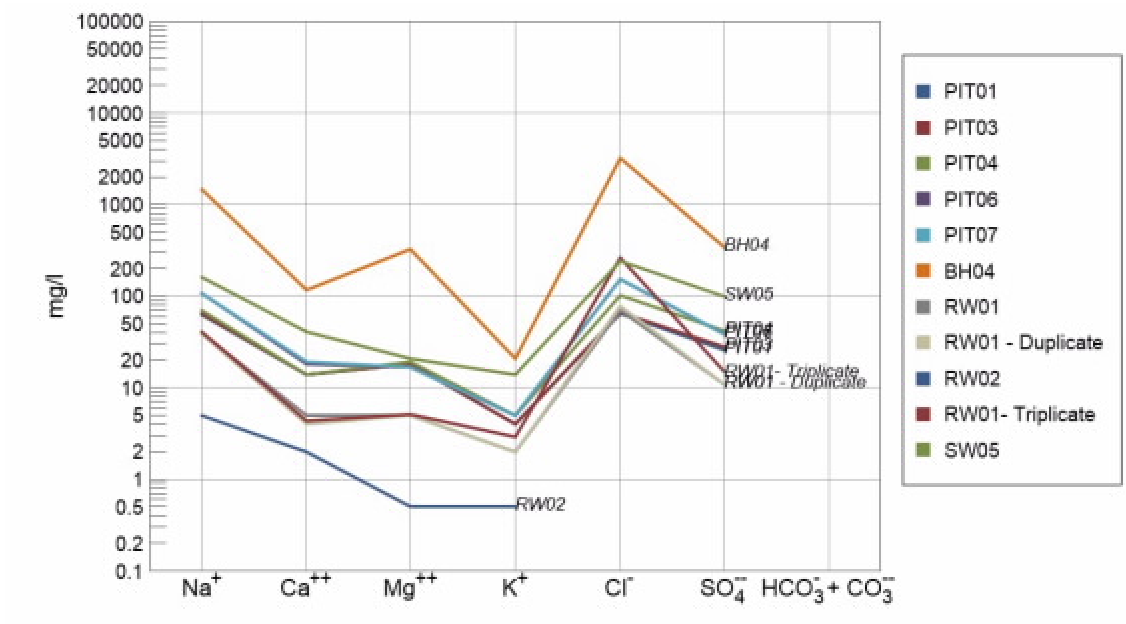

Figure 8.33 Schoeller diagram of water samples taken from Table 8.6

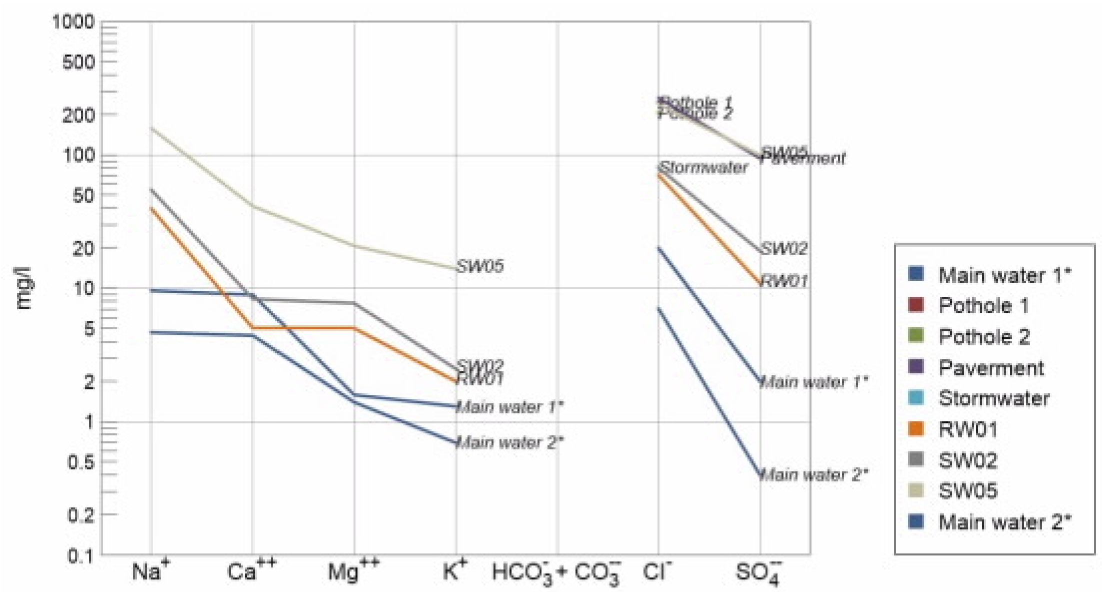

Figure 8.34 Schoeller Diagram of water samples from Table 8.7

Notes:

- Main water 1 and 2 are Indicative main water 1 and 2, respectively. is a proxy for the main water, not a sample from the actual main water at the main burst near Mornington Peninsula Freeway.
- Pothole 1 and 2 are upwelling within pothole at junction of Waller Pl and Charlesworth St and Upwelling within pothole at junction of Coburn Ave and Charlesworth St, respectively.
- Pavement is pavement around Coburn & Charlesworth.
- Stormwater is the stormwater drain in front of 6 View Point Rd. SW02 is one of PSM surface water locations, flowing water from 7 Prospect Hill Road into private storm water pit.
- SW05 is seep from the 2025 landslide (SW05 is one of the PSM surface water locations, with surface water sampled from the east side of Penny Lane. This sample was collected and measured on 20 January 2025 by PSM).
- RW01 is rain water 1 as presented in Table 8.6.

182) The laboratory results show that:

a. pH values are consistent with field measurements:

- Stormwater samples (water from stormwater pits) have pH in the range of neutral to slightly alkaline, from 6.7 to 8.1.
- Rainwater has a slightly acidic pH (pH of approximately 5.8).
- The groundwater sample has a circumneutral pH (pH of 6.7).
- The seep from the landslide (SW05 sampled by PSM) has a slightly alkaline pH (pH of 8.0).

b. TDS and EC values are also consistent with the field measurements:

- Most samples are in the range of fresh water, except for the groundwater sample.
- Rainwater and water from pits have a relatively low TDS compared to seepage (SW05).
- An increasing trend in TDS or EC values from PIT01 to PIT07 suggests an accumulation of solutes downstream.
- The seepage has higher TDS than rainwater and water from pits, likely caused by increasing interaction with solids as water infiltrates through soils.

c. The seepage that issued from the headscarp of the January 2025 landslide is enriched in major cations and anions, including Na, K, Ca, Mg, HCO3, SO_4 and Cl compared to rainwater and water from stormwater pits. Na and Cl are considered conservative tracers; thus, their enrichment suggests some mixing of mains water, stormwater or rainwater with other water (which has higher Na and Cl concentrations) or an accumulation of these ions, for instance via minerals/salt dissolution downstream.

d. Alkalinity in seepage (190 mg/L) is significantly higher than in rainwater (< 20 mg/L) and typical mains water[18]. The seepage alkalinity is more consistent with water (mains water or rainwater or stormwater) that has interacted with carbonate-bearing materials or mixing of mains water or rainwater or stormwater with other water (which has higher alkalinity).

e. Most water samples have fluoride (F) concentrations less than or equal to 0.1 mg/L, with the groundwater and seepage reporting concentrations of 0.3 mg/L and below 0.5 mg/L, respectively. The source of the seepage based on fluoride (F) concentrations alone cannot be assessed conclusively. However, if mains water contributed to the observed seepage at the landslide location, fluoride in the mains water was likely retained in soil via adsorption onto soil components such as iron hydroxides/oxides and clay minerals.

f. Some trace elements (such as nickel and zinc) are observed in the seepage, present at low concentrations, consistent with stormwater or rainwater.

g. Water sampled from potholes, overflow from pavement and stormwater drains between the mains burst and the January 2025 landslide (Table 8.7) has significantly higher chloride, sulfate, EC and TDS compared to indicative mains water. This indicates some water mixing and/or accumulation of major ions downstream of the water source.

h. In contrast, these water samples (from potholes, overflow from pavement and stormwater drains) between the mains burst and the landslide, Table 8.7) have notably lower fluoride compared to the indicative mains water samples, suggesting that fluoride was likely retained in soil matter along the pathway or some dilution with water that has lower fluoride compared to mains water.

183) Column leaching test results on sewer embedment materials have been provided by SMEC and PSM, ALS report number ES2519076, (PSM.5004.0001.0001 to PSM.5004.0001.0001). The results show that ions such as calcium (Ca), sodium (Na), chloride (Cl), and F can be leached from the sewer embedment materials. These

[18] https://www.melbournewater.com.au/sites/default/files/Typical-water-analysis-data-2016.docx.

ions are consistent with the sample of water that issued from the headscarp of the January 2025 landslide which were chemically enriched in similar ions.

184) In summary, the chemical profile of the seepage from the headscarp of the January 2025 landslide is not consistent with those of typical mains water, natural groundwater, rainwater or stormwater at its source. The higher concentrations of bicarbonate, chloride, sulfate, sodium, potassium, calcium, potassium and slightly alkaline pH and moderate TDS suggest some water mixing and/or accumulation of ions along the water movement pathways between the water infiltration and exfiltration points. The testing indicates that a plausible model is that water issuing from the pipe burst travelled along a pathway that included seepage through soil, service trenches or both, mixed with shallow subsurface flow or stormwater and accumulated ions along the pathway.

185) However, the potential contribution of other water such as irrigation water cannot be excluded based on the chemistry testing alone. This uncertainty remains unresolved due to the absence of testing undertaken on the irrigation systems, mains water and water issuing from the headscarp at the time of the landslide.

8.7.5 Plausibility of Flow Paths

186) Based on the hydrogeological and geochemical assessment, there are flow paths between the pipe burst location and the location of the January 2025 landslides. In my opinion water leaked from the pipe for some time infiltrating into the soil and migrating from the burst site through multiple pathways including through natural soils, fill and trench backfill to the landslide site. Where the resistance to subsurface flow was too high for more water to be absorbed, water was pushed up to the surface, including at the pipe burst location and the various locations along Charlesworth Street and View Point Road where water was observed exfiltrating at the surface. Some of the water exfiltrating at the ground surface at the pipe burst location flowed over the ground surface into stormwater pits, likely several weeks or possibly months after the leak first occurred based on the observations of increased flow through stormwater pipes. Given at least one breach is known in the stormwater pipes that could have been present prior to January 2025 (although this is unknown), water may have exited the stormwater pipes and migrated through a subsurface pathway towards the escarpment.

187) Only a very small proportion, about 0.1% of the water that leaked from the pipe burst would have been required to trigger the January 2025 landslides. Whilst there is uncertainty about the exact flow path along which water migrated from the pipe burst to the location of the January 2025 landslide, I have high confidence that water did migrate between these two locations via subsurface pathways.

8.8 Measures to Limit Effect of Causal Factors

8.8.1 Responses to Developing Landslide Emergency

188) The soil that detached from the escarpment in the 5 January 2025 landslide and then travelled towards the house at 3 Penny Lane indicated active landslide processes were occurring on the escarpment. The following presents responses that might typically be worked through from 5 January 2025 in response to what appeared to be a developing landslide hazard. This approach is intended to be generic and indicative of an approach that might be adopted for a developing landslide emergency. I was not involved in the actual landslide response in January 2025 and so have limited knowledge of what means were available to those who responded at the time and which were safe and practical to implement.

a. Protecting life is the first priority in a developing landside event. It would be expected that at the time a landslide occurred, there would initially be high uncertainty with respect to how the landslide might develop, including whether it might get worse and what might be impacted. Because gathering information to seek to understand the landslide process might take some time, it would be prudent to make a quick assessment of the worst feasible outcome if the landslide were to develop further and then based on that assessment outcome recommend steps to protect life. A quick assessment of the areas that could feasibly be impacted would be made and as appropriate an exclusion zone established and people evacuated from the exclusion zone.

b. Once measures have been taken to protect life, consideration can be given to protecting property. This could include measures such as placing barriers between the landslide and assets at risk. Items like concrete road barriers (jersey barriers) and (filled) shipping containers are commonly used for this purpose. With any measures introduced at this stage, an assessment must be made with respect to whether it is safe to encroach upon the landslide and to place or implement protective measures. Considerations can also be given to removing material that might be surcharging the landslide or that has the potential to detach in a further landslide, for example to remove soil from the crest of the slope. A geotechnical practitioner would need to be engaged to advise on what measures could be implemented and whether it would be safe to implement those measures.

c. Once immediate risks to life and property have been addressed to the extent reasonably practical, further investigation can be undertaken to seek to understand the causes of the landslide with the objective of removing the causes and preventing further landslides, if feasible to do so. It is routine now for investigation to be undertaken using unmanned aerial vehicles (UAV's) which can allow observation of areas that it might not be safe for people to access. In my experience, UAV resources can usually be deployed to the site of an emergency very quickly, within a few hours to help with the assessment. A geotechnical practitioner can use observations from the UAV, observations from other areas of the site and perhaps their own experience of the area and landslide processes in the area to form a preliminary view on the causes of the landslide. If water is identified as a cause of the landslide, then it would be reasonable to expect inquiries into the source of water with a view to intercepting and diverting that water away from the landslide. For example, it is typical for trenches or drains to be quickly excavated upslope of the landslide for this purpose.

d. Once an improved understanding of the landslide has been formed, it might be reasonable to then install monitoring instrumentation for the purposes of understanding if soil is moving and to provide early warning of further soil detachment. Initially this would involve monitoring of the surface using instruments like survey points and tilt sensors, however subsurface instrumentation might then be installed to monitor ground movement through the soil profile or to monitor pore pressures.

e. The time it might take to implement the steps set out above will be highly dependent on the actual landslide situation and would need to be assessed on a case by case basis. However, for landslide emergency response I have been involved with steps a-c would be complete within 1-2 days of the landslide and step d within a week.

8.8.2 Impact of responses to the McCrae landslide

189) The following considers the impact that implementing the aforementioned responses might have had on the outcomes of the McCrae landslide. These comments are provided retrospectively, appreciating that the level of information available at the time on the landslide mechanism and the environment surrounding what was a developing emergency, might not have allowed an assessment of which measures might have been effective. The following sets out how mitigation measures implemented from 5 January onwards might have influenced the outcomes of the January 14 2025 landslide event.

190) The evacuation of houses in locations that had the potential to be impacted if the landslide developed further and the development of an exclusion zone on 5 or 6 January once the initial landslide occurred would serve to protect life and could have meant no injuries resulted from the landslide.

191) The 5 January 2025 landslide encroached upon, but at that stage did not impact, the retaining wall at 10-12 View Point Road nor the fill supported by the retaining wall. There were tension cracks developing at the base of the retaining wall which indicate the potential for further landsliding to undermine the wall. The fill behind the retaining wall was applying a surcharge load to the retaining wall at that time and an emergency measure that could have been considered might be to remove the reduce the surcharge load and to reduce the volume of fill that could potentially mobilise as part of the landslide. This would have involved removing the retaining wall and fill. Noting safety considerations, any equipment (e.g. excavator) would need to be sufficiently far back from the scarp so as to not apply a surcharge load and if there were concerns it might have been positioned on unstable ground, this approach may not have been considered safe at the time. Furthermore, survey following the 14 January landslide indicates that the volume of fill that detached from behind the retaining wall was relatively small and may not have significantly contributed to the volume that impacted 3 Penny Lane, so this response may not have had a significant impact on preventing further landsliding or landslide consequences after the 5 January event.

Figure 8.35 Tension Cracking at toe of retaining wall at 10-12 View Point Road (MSC.5035.0001.0033)

192) It was feasible that the placement of barriers between the house at 3 Penny Lane and the 5 January landslide could have prevented or reduced the extent of damage that arose from the subsequent 14 January landslide. For example, temporary barriers could be placed at the toe of the slope between the landslide and 3 Penny Lane. Given safety considerations working under an active landslide, barriers may need to have been craned in and there might not have been a suitable location on which to place them. However, portable temporary barriers such as concrete jersey barriers or shipping containers are commonly used for this purpose and could have been considered here. These would serve to reduce the extent of the area affected by the landslide. However, this statement is made with low certainty noting that because the area in which the barriers were to be installed is hazardous and covered with debris so it might not have been practical for them to be installed.

193) Monitoring instrumentation on or in the immediate vicinity of the 5 January 2025 landslide might have provided early warning of the impending 14 January 2025 landslide, for example by triggering an alarm if movement acceleration was detected. This might have served to help protect life but is unlikely to have provided any risk mitigation for property. If subsurface instrumentation was installed to measure groundwater, then it might have provided evidence to understand how water was infiltrating the landslide.

194) Signs of unusual groundwater conditions had been observed prior to 5 January 2025 and were further observed prior to the occurrence of the landslide on 14 January 2025. For example, Figure 8.36, shows water issuing from the landslide headscarp on 10 January 2025. I consider it reasonable at that stage and probably on 5 January 2025 to strongly suspect the landslide had been caused by elevated pore water pressures and that water must be infiltrating the slope to cause that. It is also reasonable to expect that investigations into the source of the water would commence very soon or immediately after that assessment. This would be done with a view to cutting off the flow or diverting water away from the landslide if it were practical to do so.

Figure 8.36 Water seeping from escarpment at 10-12 View Point Road (MSC.5035.0001.0022)

195) Intercepting and removing groundwater after the 5 January 2025 landslide would have reduced the likelihood of the 14 January landslide occurring. However, it is not possible to offer an opinion as to whether it would have reduced the likelihood to such an extent that it prevented the 14 January 2025 landslide. Measures that could have been implemented quickly after 5 January 2025 in an attempt to lower or prevent further increase in pore water pressure at the site of the January 2025 landslides could have included those set out below:

a. Cutting off mains water flow to the area as a precautionary measure to check whether that action eased the flows from the escarpment.

b. Inspecting water bearing services upslope of the landslide including drains, sewers and water pipes to check for leaks and to effect repairs, isolate or divert water if necessary. This would likely involve engagement with the various asset owners, for example the relevant water authority.

c. If there was no obvious way to prevent water from infiltrating into the landslide by isolating or shutting off services, then works could have been done to attempt to draw water out of the ground, by:

i. Drilling boreholes or auger holes (for example up to 600 mm diameter holes drilled using an auger attachment on an excavator) on View Point Road and between View Point Road and the escarpment. The holes would need to extend to a depth of about 6 m such that they were below the level that water was issuing from the escarpment. Sump pumps could be installed in the boreholes to allow water to be pumped from the holes. It is likely that a number of holes would be needed, for example arranged in a row parallel to the escarpment to increase the chance of intersecting the subsurface flow path as shown on Figure 8.37 and it is uncertain whether groundwater could be intersected and removed quickly enough to have prevented the 14 January 2025 landslide.

ii. Inserting dewatering spears which are steel rods driven into the ground to sufficient depth to intersect subsurface water which is then pumped from the ground through the spear. These are a less certain approach to excavation because there may be obstructions to driving in spears to the depth required to intersect groundwater.

iii. Excavating a trench, for example a trench on View Point Road with the objective of intersecting groundwater and allowing water to be pumped out. Given the trench depth may need to approach 6 m, it is likely that support would need to be provided to the excavation or it would not have been practical to excavate.

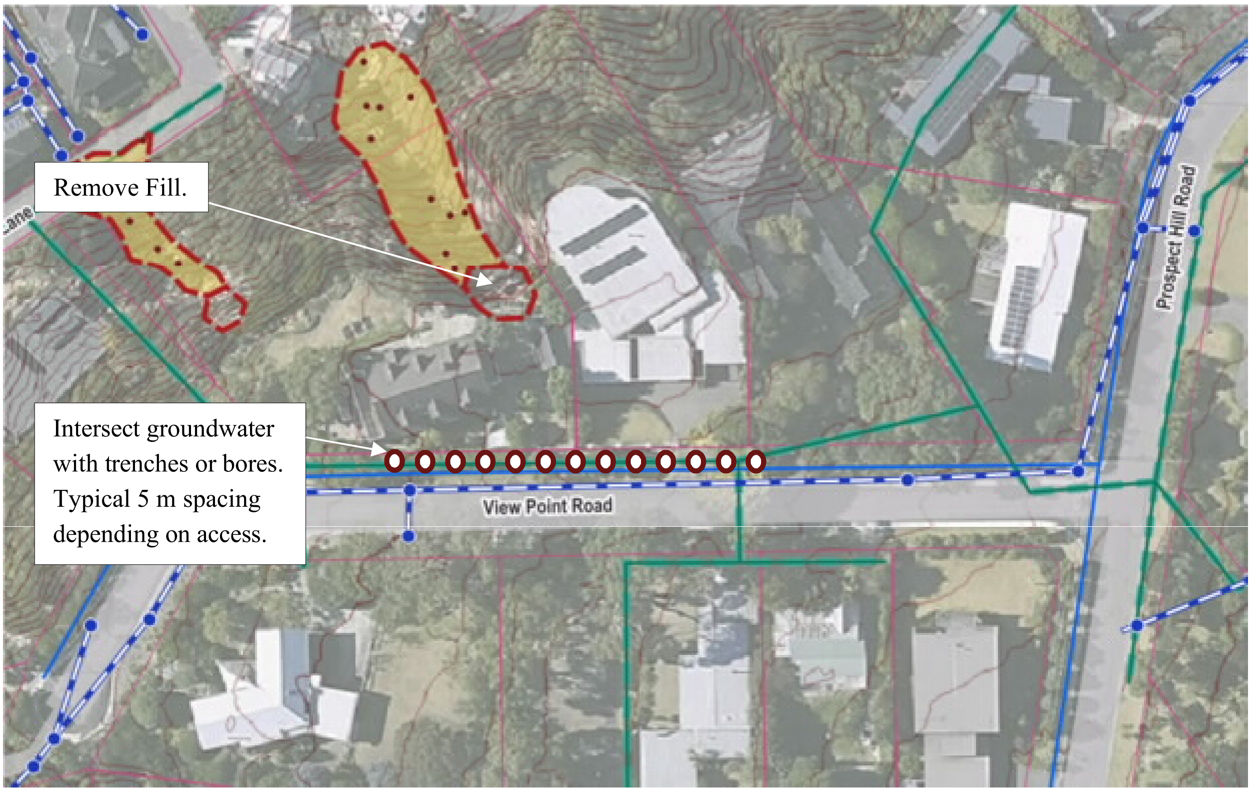

Figure 8.37 Summary of potential mitigations that could have been implemented after 5 January Landslide.

9 Remediation and Mitigation

196) Whilst there is clear overlap, the word remediation is used here to refer to works to repair and reinstate damage to the terrain caused by the January 2025 landslides and mitigation refers to works and controls to minimise the future impact to life and property from landslides within the broader McCrae area.

9.1 Remediation of the 2025 McCrae Landslide

197) Based on our site observation, damage caused by the 2025 landslide includes:

a. The destruction of the house at 3 Penny Lane.

b. The deposition of debris including soil, building materials and vegetation at the toe of the slope below 10-12 View Point Road.

c. The scar formed within the zone of depletion which has formed a subvertical slope below 6 and 10-12 View Point Road.

d. Damage to the retaining wall at 10-12 View Point Road.

e. Encroachment and near undermining of the patio area at 6 View Point Road.

198) An annotated plan showing the damage observed to have been caused by the 2025 landslide is presented in Figure 9.1.

Figure 9.1 Annotated plan showing key damage caused by the 2025 landslide

199) A discussion on works that could be undertaken to remediate the damage identified is set out subsequently.

9.1.1 Removal of Debris from Zone of Accumulation

200) A first step towards mitigation would be to remove the debris displaced and deposited at the toe of the escarpment by the 2022 and 2025 landslides including the wreckage of the house at 3 Penny Lane, soil and vegetation that has been deposited in the accumulation zone at the toe of the landslide. The removal of debris from the zone of accumulation is intended to free space in this area such that debris arising from future landslides can more effectively lose energy and accumulate at the toe of the slope before impact to houses. Safe work methods would need to be developed to effect debris removal, for example the use of a long reach excavator that can access the debris from a safe location or working with smaller equipment from the top down.

9.1.2 Removal of retaining wall, loose fill and surcharge load

201) As far as practical loose fill at the crest of the slope at 10-12 View Point Road should be removed and a stable batter formed. The undermined portion of the retaining wall should be removed. Where the fill is vegetated, with shrubs or deep rooted plants, it might be prudent to leave the fill in place and preserve the vegetation.

202) Surcharge loading including that provided by planter boxes should be removed from the crest of the slope.

203) Plans are provided in Appendix F which indicate the areas from which debris would need to be removed.

Remediation of the landslide affected slope below 6 and 10-12 View Point Road

204) The steep headscarp of the 2025 landslide encroaches on the patio area of 6 View Point Road and has the potential to regress further and to undermine the patio. Although the house at 6 View Point Road is supported on pile foundations, further regression could have the potential to impact the structure. Engineered support will be required for this slope. Options to provide the support include:

a. Soil nails comprising boreholes drilled into the headscarp and into which steel bars are installed and grouted in place. A shotcrete facing can be sprayed over. There could however be constructability issues associated with this approach including how to position a drilling rig on the escarpment in such a way that the soil nails can be installed and safety considerations if there is a requirement to work close to the landslide headscarp. These constructability considerations factors could render this approach infeasible.

b. Reinstate the material that detached from the landslide using engineered fill. The material placed back against the escarpment must be permeable such that water that issues from the landslide headscarp can flow freely through and discharge into stormwater at the base of the slope avoiding pore pressure build up in the slope. Rockfill comprised of angular interlocking boulders could be placed to a slope angle of up to 45° similar to the angle of the slope before the landslide. Rockfill would need to be comprised of high strength, interlocking boulders which could be further reinforced using geogrid. The volume of rock required would be relatively large, however unlike soil nails, this approach would return the slope geometry back to a state close to what it was prior to the 2025 landslide and could be undertaken by placing the rock with machinery mounted in a safe location. If required, an engineered buttress could be constructed to keep the toe of the rockfill in place. Geofabric would need to be placed over the currently exposed soil to prevent fine soil washing into and clogging the pores in the rockfill, with geofabric carefully selected such that it performs a function as a filter material as well as allowing water to issue from the escarpment and to flow freely through. If desired, the aesthetics of the rockfill surface could be improved by including provision to plant vegetation over parts of the surface, for example isolated contained pockets of soil embedded within the rockfill. A 3D image showing the extent of rockfill likely required is shown in Figure 9.2, and an image of another landslide remediated using this method is presented in Figure 9.3. An indicative schematic is shown in Figure 9.4.

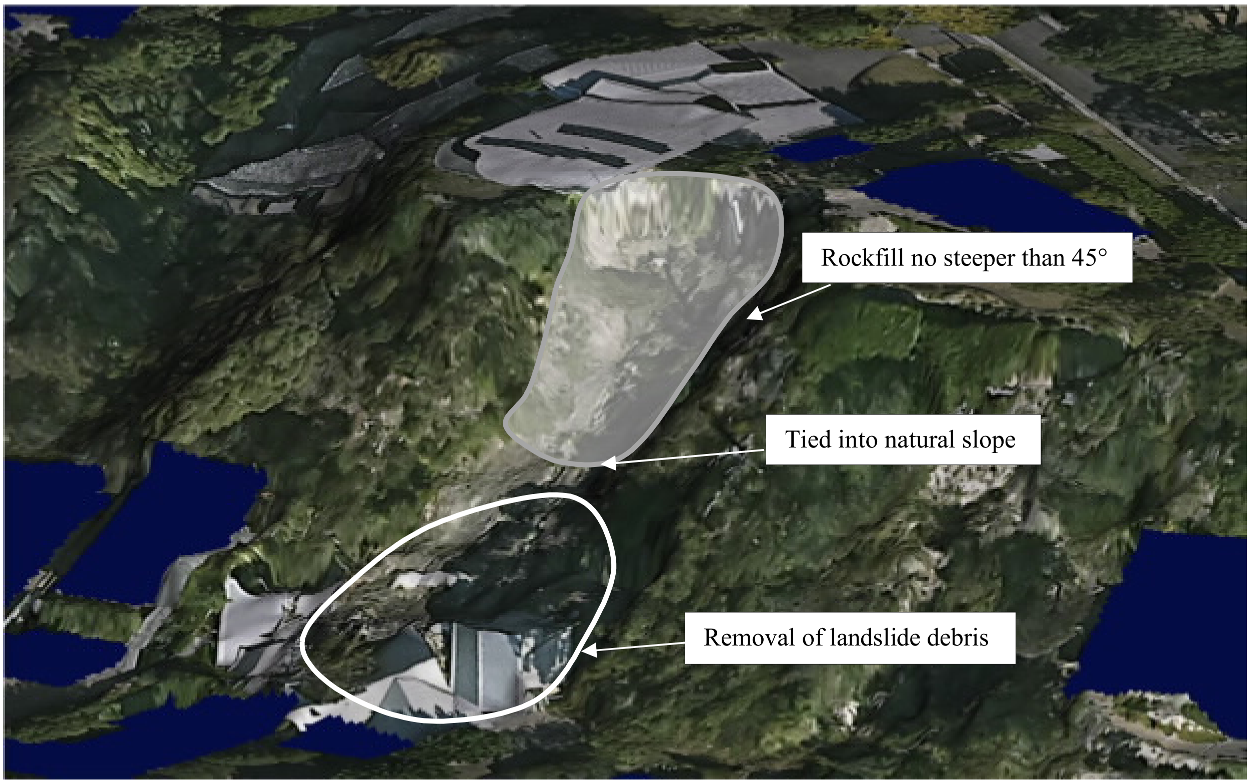

Figure 9.2 3D image showing possible extent of rockfill required to reinstate zone of depletion arising from the 2025 landslide.

Figure 9.3 Image of landslide reinstated using rockfill[19].

[19] Keller G., Sherar, J. (2003) Low Volume Roads Engineer, Best Practice Management Guide, United States Department of Agriculture.

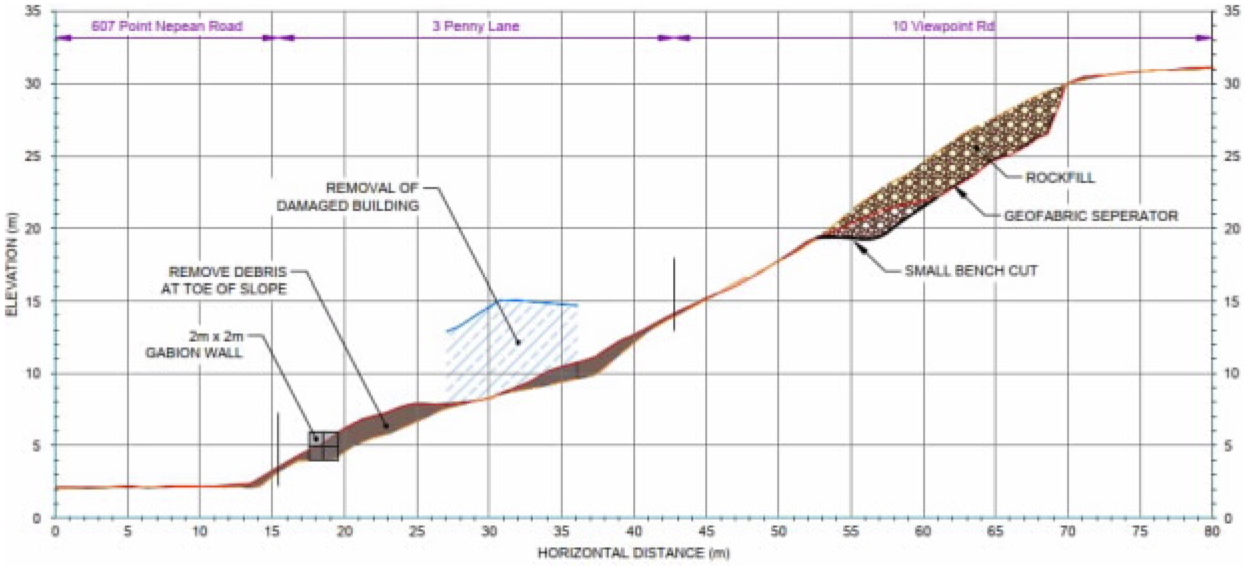

Figure 9.4 Indicative cross section through remediation using rockfill (see Appendix F for further detail)

c. Reinstate the slope using a gabion wall or similar system like a crib wall. This approach would be similar to the rockfill approach and could be combined with rockfill but has the advantage in that gabions can be used to form a steeper slope than can be formed using rock fill. The fill behind the gabion baskets would need to be granular, free draining fill that could be reinforced using geo-grids if required and the lowermost gabions may need to be anchored. Compared to rockfill, gabion baskets might allow the face of the backfill to be constructed at a steeper angle and give more control to the geometry than can be achieved with the finished face.

9.2 Landslide Mitigation

205) Mitigation refers to measures that can be implemented to reduce the risk associated with future landslides. Here, this refers to measures that could be implemented through the broader McCrae area including the area that was evacuated in response to the 2025 landslide. Note that these measures do not necessarily reduce the likelihood of further landslides occurring, some aim to reduce the consequence of a landslide if it were to occur without altering the likelihood of it occurring.

206) Good landslide risk mitigation should seek to remove or avoid landslide hazards in preference to the implementation of works to mitigate risks. Risk avoidance is effected through planning and building controls such as an erosion management overlay which currently do not apply to the McCrae escarpment on which the 2025 and 2022 landslides occurred.

207) Planning and building controls generally seek to safely manage hill side development and avoid inappropriate development in landslide prone areas or to prevent the worsening of preparatory factors for landslide as described in Section 4, by avoiding increasing the susceptibility of a slope to landslide or by reducing the risk from landslide through inappropriate development.

208) Works to reduce landslide risk would generally seek to reduce the potential for a landslide to be triggered or to cause damage by addressing causal factors as described in Section 5.

209) Each of the above points are discussed separately below.

9.2.1 Planning and Building Controls

210) Planning and building controls for landslide would usually be implemented through an erosion management overlay (EMO).

211) The development of an EMO would require mapping to be undertaken that identifies areas susceptible to landslide and associated planning controls assigned via a schedule to the EMO. This would require a detailed study to be undertaken by a suitably qualified geotechnical practitioner.

212) If an EMO were to be implemented across the McCrae escarpment, the accompanying schedule to the EMO would be expected to include the following controls, noting these are similar to those implemented in other landslide prone areas in Victoria:

a. The requirement for a landslide risk assessment to be undertaken by a suitably qualified geotechnical practitioner for new development. The purpose of the landslide risk assessment would be to identify if the development can be undertaken such that the risk from landslide to life and property can be tolerated, or if not, whether development should proceed at all or if risk mitigation measures can be implemented through the building process to reduce the risk to a tolerable level.

b. Restrictions on development near the crest of the escarpment. For example, EMO3 in Frankston applies to an area with very similar terrain characteristics to those in McCrae. In that area the EMO applies on, and 10 m back from the escarpment and there are restrictions on what development can encroach upon the escarpment within the 10 m offset.

c. Restrictions on earthworks. Earthworks within landslide prone areas should be avoided as far as is practical and if necessary should be to the minimum extent required and subject to geotechnical design, risk assessment and mitigation, for example supported by engineer designed retaining walls if required to reduce risk as far as practical.

d. Restrictions to prevent water infiltration into the soil, including avoiding the construction of water holding structures near the escarpment (pools, tanks and spas), and where these are constructed fitting them with underdrainage designed to intercept and prevent infiltration to the ground in the event of a leak.

e. Requirements for the construction of subsurface water bearing services including water mains, stormwater pipes and sewers. These should be constructed to reduce the potential for leakage, including consideration of their location, depth, material of construction, trench backfill, flexibility and leak detection. Examples include strong, flexible pipes such as steel with welded or positive joints in lieu of segmental pipes such as the existing asbestos cement or segmental concrete.

f. Requirements to preserve vegetation as far as is practical in landslide prone areas and to require a permit for significant vegetation removal.

9.2.2 Retrospective application of planning and building requirements

213) The development in the vicinity of the McCrae escarpment has generally not been undertaken in accordance with planning controls because no landslide related planning overlay (i.e. EMO) was applicable over the area when most of the development was undertaken. It may be possible to retrospectively apply some of the development constraints that would usually be managed through planning controls noting that this would be subject to further assessment of where these might apply. For example:

a. The removal of fill, retaining walls or pools close to (nominally within 10 m of the crest of the escarpment).

b. Reinstatement of vegetation across the escarpment to the extent possible.

c. The removal of illegally constructed, dilapidated or failing retaining walls and fill retained behind them as appropriate.

d. Inspection and repair or replacement of water bearing services if there is evidence of them leaking.

e. The installation of impermeable trench stops in existing trenches. This requires excavating previously constructed trenches at regular intervals and backfilling the trench with impermeable backfill such as cementitious low strength grout.

214) There are landslide risk reduction measures that might ordinarily have been installed as part of the development undertaken on and around the McCrae escarpment that were not, likely due to the lack of planning control at the time of development. There may be an opportunity to retrospectively install risk mitigation measures to protect the existing dwellings. Both the 2022 and 2025 landslides involved soil flowing down the escarpment to dwellings on Penny Lane. Debris flow barriers could be constructed along the Penny Lane road reserve for the purpose of intercepting debris flows and reducing the potential for impact to the houses at the toe of the escarpment. There may be various options that could be considered for debris flow barriers including an earthen bund, gabion baskets, anchored concrete barriers, a post and panel wall or proprietary debris flow barrier. Drainage will need to be a consideration for any barrier to ensure it can direct water to the stormwater system or is sufficiently permeable to allow surface water to flow through. Any barrier will require maintenance which includes periodically clearing debris from behind the barrier that will accumulate over time. A potential location for a barrier is indicated in Figure 9.5 and typical cross section in Figure 9.4 (extracts from Appendix F). Examples of other types of barriers are shown in Figure 9.6.

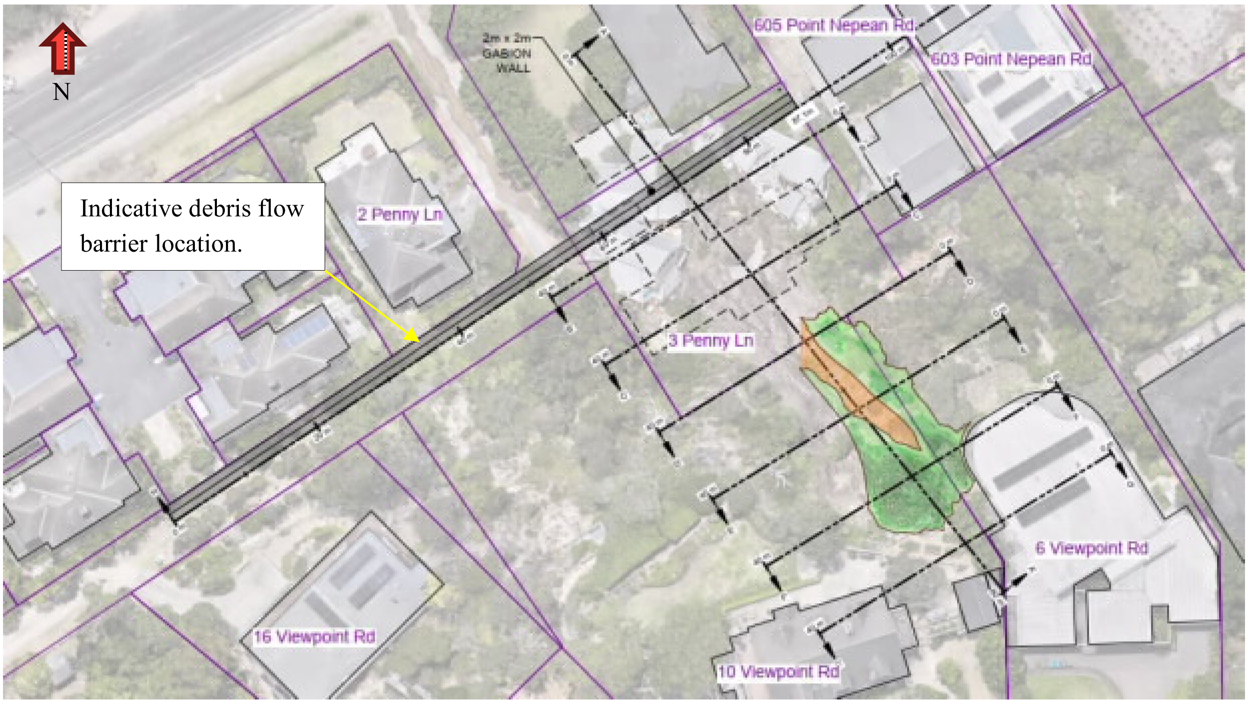

Figure 9.5 Indicative location for bund to intercept debris flowing to base of escarpment.

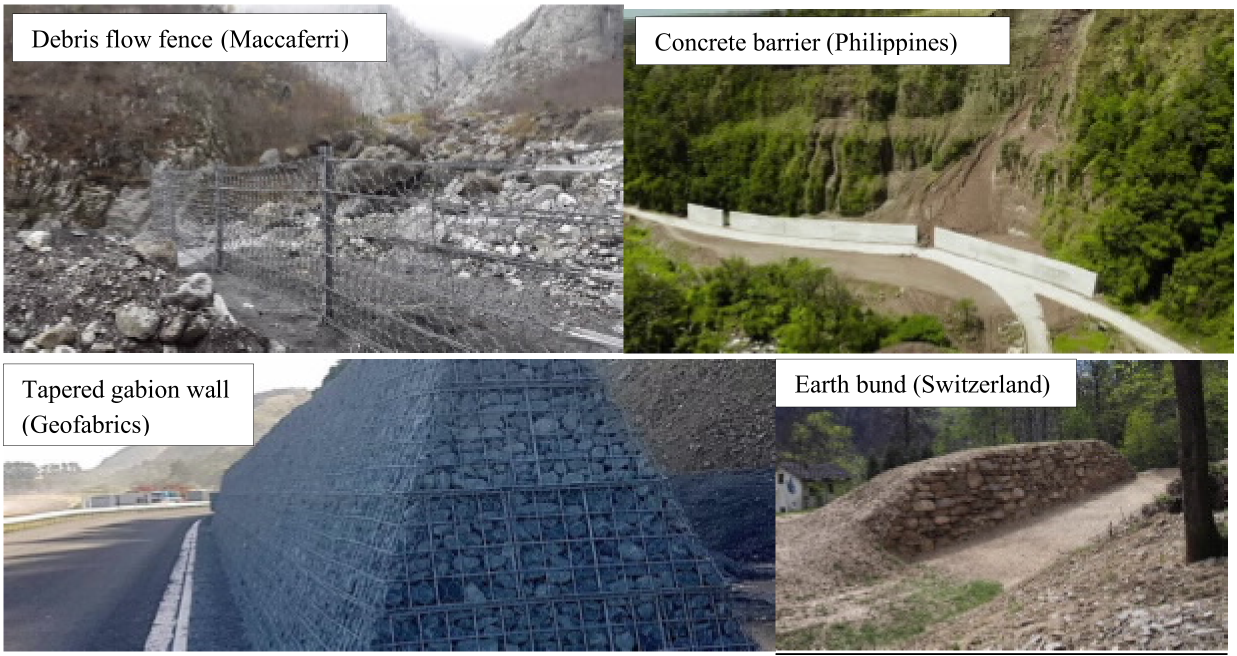

Figure 9.6 Examples of types of barriers to intercept debris flow.

9.2.3 Addressing Causal Factors

215) Recognising that the 2022 and 2025 landslides were very likely caused by pore pressure increases in the slope, measures to detect and relieve elevated pore water pressure could be installed, otherwise called “dewatering” or “depressurisation”. This approach is typically used in construction where excavation is required to extend below the water table or to relieve high inflows into an excavation. In McCrae, dewatering could be effected by installing a series of wells upslope of the escarpment in Prospect Hill and View Point Road and installing monitoring instrumentation and pumps into the wells. When pore pressure elevation is detected, the pumps turn on, draw water out of the ground and direct it to an appropriate point of discharge. This concept is similar to that used in basement sumps. Hydrogeological investigation and studies would be necessary to design the system with consideration given to the number of wells and pumps and the locations in which they are needed. Indicative well locations are shown in Figure 9.7. Alternatively, a deep trench could be installed designed to intercept water and pipe it to the stormwater system. However, the depth of the trench, which would need to be in the order of 5 m to 6 m reach the residual granite could be prohibitive.

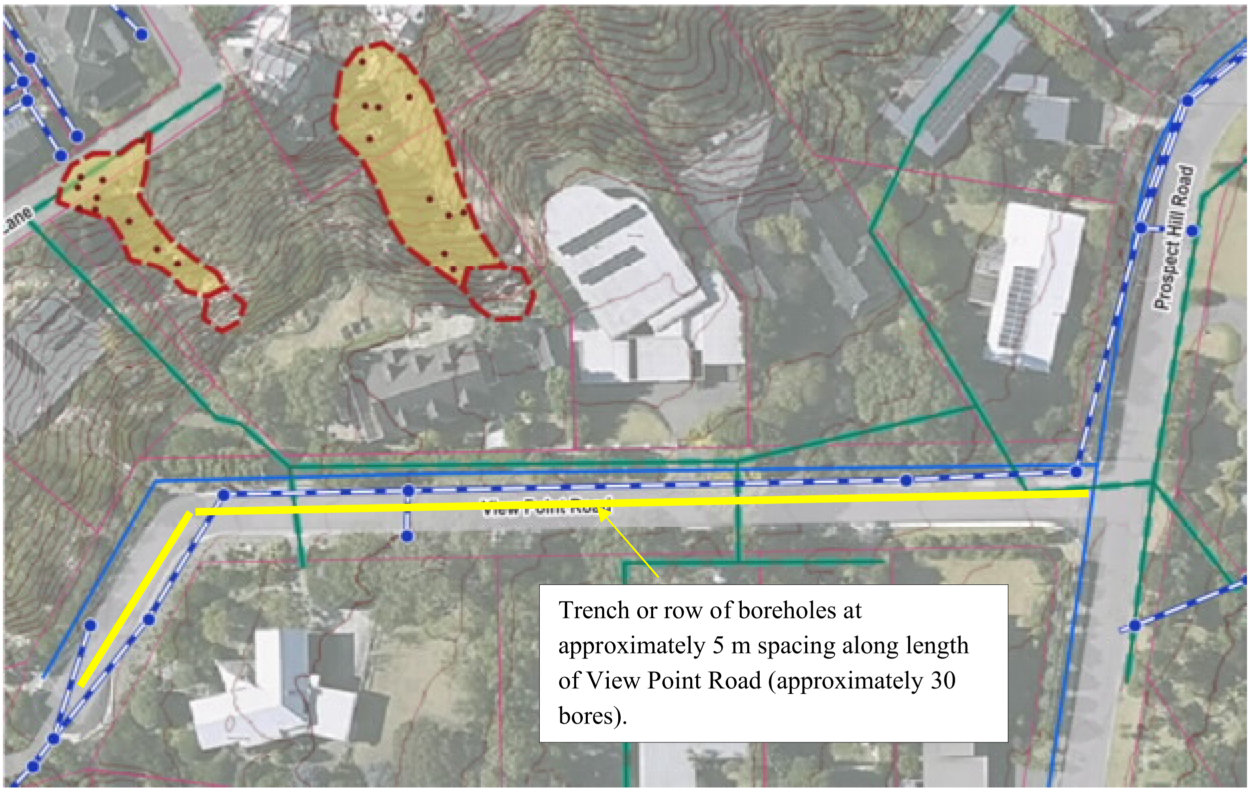

Figure 9.7 Potential locations for well installation or intercepting trench.

216) Given leaking pipes are likely to have contributed to the 2025 landslide and potentially the 2022 landslide, improved leak detection systems may allow leaks to be addressed early and reduce the potential for significant water build up in the soil. Given the susceptibility of the escarpment to landslide, it may be prudent to upgrade aging vitreous clay sewer pipes and asbestos cement water mains in the McCrae area to reduce the likelihood of future leaks. If this approach is taken, trench backfill could be selected to prevent the migration of water along trenches, for example by using impermeable backfill such liquid cementitious backfill or by using trench stops (impermeable barriers in the trench to intercept flow along the trench, also called trench breakers). These force water flowing along the trench to the surface where it can be detected and repairs implemented before it reaches a point that could cause a landslide. Examples of trench breakers are shown in Figure 9.8.

Figure 9.8 Example of trench stops using sandbags (left[20]), and foam (right[21])

[20] Polylevel.com

[21] Bairdfoundationrepair.com

10 Summary of Opinion

10.1 Overall summary factors that caused the 2025 McCrae Landslide

217) Arthurs Seat is formed from granite which has eroded over geological time through chemical weathering processes whereby some of the minerals of the granitic rock degrade to clay. This forms residual soil which is typically clayey sand with relatively low hydraulic conductivity. Through a process of mass wasting over geological time (1000's of years), landslides within the residual granite and underlying rock have transported debris to the foot slopes of the hill. The debris infills channels and leaves a drape of transported soils at the surface within what is now the McCrae area.

218) Relative movement along the Selwyn fault over geological time has caused uplift of Arthurs Seat and subsidence of Port Philip Bay. The surface expression of the Selwyn Fault forms the McCrae escarpment on which the November 2022 and January 2025 landslides occurred.

219) Channels infilled with colluvium act as subsurface conduits for water that has recharged on Arthurs Seat to flow through the subsurface, with water issuing around the McCrae escarpment. This forms natural springs which have been identified on the escarpment prior to modern development. The springs are fed by rainfall that infiltrates on Arthurs Seat and are therefore intermittent, with exfiltration from the spring dependent on the magnitude and rate of recharge.

220) Residual soils and colluvium that underlies the McCrae escarpment are above the permanent water table and in a partially saturated state. This allows suction stresses to form between soil particles that have the effect of binding the soil particles together. This allows the soils to form steep slopes. Wetting of the soils causes an increase in the pore water pressure within the soil pores which reduces the forces binding the soils together. When this happens, the soils lose strength, leading to erosion or landslide if those soils form a slope steep enough to allow the soils to move downslope under the action of gravity. The McCrae escarpment has marginal stability and is susceptible to landslide upon wetting of the soils and has been subject to naturally occurring landslides within recorded history, including some significant landslides in the 1950's which coincided with extreme rainfall events.

221) Anthropogenic effects (changes to the landscape made by humans) can increase susceptibility to landslide. Changes in the McCrae area that increased the susceptibility of the escarpment to landslide include:

   a. The placement of fill, sometimes retained fill at the crest of or on the face of the escarpment which can block natural springs, apply a surcharge load and increase the volume of soil that can mobilise in the event of a landslide.

   b. The removal of vegetation which otherwise helps reduce the pore water pressure in the soils and prevent infiltration..

   c. The construction of service trenches which are backfilled with material that has a higher permeability than the surrounding soils and can therefore act as a preferential flow path to allow water to migrate towards the escarpment.

222) There have been no formal development controls such as the Erosion Management Overlay applied to the development on and in the vicinity of the McCrae escarpment which could have restricted some of the anthropogenic changes described above. Furthermore, if development controls had been in place, it is conceivable that development would have incorporated measures to protect life and property from landslide, or that some development might not have proceeded at all.

223) A burst water main occurred about 450 m uphill from the site of the January 2025 landslides near the corner of Bayview and Outlook Roads in early October 2024. There are a number of flow paths that could convey water from the leak to the site of the January 2025 landslides within the time between the commencement of the leak and the occurrence of the landslide. These include:

a. Through permeable natural colluvial soils along the same flow paths that feed natural springs.

b. Partly through stormwater pipes, with leakage from the pipes entering colluvial soils and migrating through natural subsurface flow paths to the landslide site.

c. Through the backfill of sewer and stormwater trenches including gravel bedding on which the vitreous clay sewer pipes are founded.

d. A combination of the above.

224) In comparison to the large volume of water that leaked from the burst, the proportion of water that would have needed to reach and trigger the January 2025 landslide is very low (about 0.01%). With very high confidence, water that issued from the burst flowed through multiple subsurface pathways.

225) Comparison between the chemistry of water that issued from the escarpment formed by the Janaury 2025 landslide to mains water, rainwater and groundwater in the McCrae area indicates that the water that seeped from the landslide escarpment is inconsistent with rainwater, stormwater or groundwater at its source and is likely from a mixed source. Water from the main is likely to have flowed through soil which changed its chemistry, including leaching out of fluoride and an increase in dissolved cations as it migrated through subsurface pathways.

226) With high confidence, the most significant source of water that contributed to the January 2025 landslide is the water main leakage near the corner of Bayview Road and Outlook Roads in November and December 2024.

227) Given an understanding of the preparatory factors that make the McCrae escarpment susceptible to landslide and the causal factors that lead to the landslide occurring when it did, there are options that can be explored to remediate the 2025 landslide site and to reduce the risk to life and property in the future. This might include reinstating the zone of depletion at the site of the landslide with rockfill, for example (as well as other options), removing fill from the crest of the escarpment, providing a debris barrier at the toe of the escarpment to protect dwellings on Point Nepean Road and providing means to intercept unusual (higher) subsurface flows before they reach the escarpment.

11 Limitations

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Appendix A

Curriculum Vitae

Darren Paul

Technical Director - Engineering Geology

25 years with WSP (formerly Golder Associates)

Areas of expertise

Engineering Geology and Geomorphology

Ground Risk

Landslides and Slope Instability

Ground Models

Geotechnical Interpretation

Profile

Darren is an Engineering Geologist with 25 years' experience. He has undergraduate qualifications in civil engineering and geology and postgraduate qualifications in engineering geology. He has extensive experience in designing and managing geotechnical investigations for tunnels, buildings, roads, pavements and other infrastructure, developing ground models and undertaking assessment of ground related hazards and undertaking geotechnical interpretive reporting.

Throughout his career Darren has been involved in all aspects of engineering geology including geohazard assessments for many different applications including for town planning, roads, rail, tunnels, coasts pipelines and national parks. He has expertise in ground model development and geotechnical interpretation. Darren recently has lead several major landslide risk assessment projects, including the extensive Victorian Alpine resorts 2020 risk assessment program which involved risk assessment across all assets in Victorias alpine resorts. He also authored the New South Wales National Parks and Wildlife Service Guidelines for Rock Fall risk assessment, is currently leading a revision of the Australian Geomechanics Society Guidelines for Landslide Risk Management 2007 and is an instructor and manager of the Australian Geomechanics Society Landslide Risk Assessment Course.

Darren leads a team of 15 engineering geologists within the WSP Melbourne Office who have a broad engineering geology skillset, including expertise in geotechnical data management, 3D visualisation, geohazard assessment, slope stability and landslide assessment. He also teaches engineering geology at Monash and Melbourne Universities.

Education

Master of Science in Engineering Geology (Distinction), Imperial College, London,	2004
Diploma of Imperial College, London,	2004
Bachelor of Engineering (Civil) (Hons 1) University of Melbourne,	1999
Bachelor of Science (Geology) University of Melbourne,	1999

Professional Associations

Chartered Geologist

Geological Society of London, Fellow

Chartered Professional Engineer

Institution of Engineers Australia, Fellow

International Association of Engineering Geology, Member

Australian Geomechanics Society, Member, National Chair 2014 - 2015

Monash University, Teaching Fellow

University of Melbourne, Honorary Fellow

Registered Engineer, Victoria

Darren Paul

Technical Director - Engineering Geology

Professional experience

SLOPE STABILITY

Caraar Creek Landslip Assessment Melbourne, Australia

Investigation for potential instability on a proposed housing development site. Required historical review, geomorphological and geological mapping.

Warburton Slope Stability Assessment, Warburton, Australia

Mapping of landslips in an area with a long history of instability. Historical review, geomorphological mapping and zoning of areas based on potential instability

South Gippsland Highway Slope Stability Assessment. Leongatha, Australia

Slope stability assessment of proposed cuts along a realignment of an existing highway. Involved historical review, rock slope mapping, geomorphological mapping and computer analysis.

Doncaster Quarry Stability Review, Melbourne, Australia

Slope stability assessment of a former quarry proposed as a landfill development. Review of previous stability assessments, new rock face mapping, collation of data and stability analysis.

Ben Cairn Estate, Don Valley, Victoria, Australia

Risk Assessment for residential estate upon which a large scale landslip has been identified. Required extensive geomorphological mapping, liaison with landowners and conduct of a risk assessment, Provided advice to the Shire of Yarra Ranges with respect to future planning within the Estate.

Dutton Way Coastal Stability Assessment, Portland, Victoria, Australia

Stability assessment of coastal cliffs along a major road in Portland. Provided advice to the Glenelg Shire Council on risks associated with cliff erosion and slope instability. Recommended remedial and support measures.

Shire of Yarra Ranges Landslip Review, Yarra Ranges, Victoria, Australia

Review of planning applications for the Shire of Yarra Ranges with respect to landslip. Requires site visits, stability assessment, geomorphological mapping and preparation of expert witness statements for VCAT.

Landfill Slope Stability Assessment

Analysis of the stability of numerous landfill slopes within South Australia and Western Australia composed of composites of synthetic liners and clay.

Council Trench Reserve, Bacchus Marsh, Victoria, Australia

Slope stability analysis with respect to rockfall within a public reserve at Bacchus Marsh. Involved geomorphological mapping and risk assessment. Provided advice to the Council Trench Reserve Committee on appropriate ways to lower the risk associated with rockfall within the Council Reserve.

Road Batter Assessment, Shire of Yarra Ranges, Victoria, Australia

Assessment of four road batters that failed after heavy rain in February 2005. Performed basic site investigation and assisted in the development of a remedial system.

Scoresby Clay Quarry, Scoresby, Victoria, Australia

Slope stability assessment within a former quarry for which residential development is proposed. Required geomorphological mapping and slope stability analysis.

Study Tour, UK and Greece

Darren Paul

Technical Director - Engineering Geology

Visited and studied numerous major landslides during Masters Degree Course. Including Folkestone Warren and the Isle of Sheppey in the UK and the Makassar Landslide in Greece.

Royal Avenue Beach Sandringham, Sandringham, Victoria, Australia

Detailed slope stability risk assessment in accordance with the Australian Geomechanics Society Guidelines. Involved site assessment, review of available information, reporting in writing and presentation to local council.

RTA Slope Risk Assessment, New South Wales, Australia

Undertook week long training course to become accredited slope risk assessor for Roads and Traffic Authority in New South Wales. Conducted detailed slope risk assessment of 30 road cuttings and fill embankments in the Coffs Harbour region of New South Wales.

City of Moreland, Victoria, Australia

Development of the Moreland City Council Erosion Management Overlay including expert witness evidence to the planning panel.

DPLTI Victoria. Victoria, Australia

Development of Alpine Shire Erosion Management Overlay and input to the drafting of the Erosion Management Overlay Schedule.

Frankston City Council, Victoria, Australia

Development of Erosion Management Overlay for Frankston City Council and review of planning application submitted under the overlay.

Valley Lake, Niddrie., Victoria Victoria, Australia

Supervision of rock scaling works and installation of support measures

PNG LNG Expansion Project, Western Province, Papua New Guinea

Geomorphological mapping of PNG highlands area and route assessment for proposed gas pipeline. Included geological traverses to ground truth assessment made using remote sensing imagery, identification of landslides and routing nomination of pipeline routes to avoid landslides

Cosgrove 3 Quarry, Cosgrove, Victoria, Australia

Assessment of quarry stability associated with redevelopment of the quarry as a landfill.

Grampians Peaks Trail, Grampians National Park, Victoria, Australia

Landslide risk assessment for proposed walkway. Included rock fall analysis and advice on mitigation measures.

Apollo Bay – Proposed Resort, Apollo Bay, Victoria, Australia

Landslide risk assessment for proposed walkway. Included rock fall analysis and advice on mitigation measures.

Baw Baw Shire – Development of Erosion Management Overlay, Victoria, Australia

Review of Baw Baw Shire erosion management overlay and recommendations for improvements to the overlay and its administration.

Palmerston Highway, Far North Queensland, Australia

Road batter slope stability assessments for major highway in tropical area of Queensland. Included recommendations for remedial works.

Lamington National Park, Gold Coast, Queensland, Australia

Stability assessment of road batters following major rainfall event which damaged and blocked road. Included development of remedial designs.

Darren Paul

Technical Director - Engineering Geology

Mt Buller, Victoria, Australia

Assessment of landslides affecting roads, identification of failure mechanisms and design of landslide mitigation solutions.

Victorian Alpine Resorts, Victoria, Australia

Technical lead and project manager for landslide risk assessment for all assets across Victoria's 6 alpine resorts, undertaken between 2021 and 2022. Involved risk assessment for around 750 assets.

Bogong High Plains Road Landslide, Victoria, Australia

Technical lead for the assessment and remediation of a major landslide which occurred in Victoria's alpine area, causing a major road to be blocked. Undertook assessment into the cause of the landslide and designed mitigation measures for both an interim and permanent mitigation solution.

Professional history

WSP Technical Director – Engineering Geology Lead Technical Director (August 2024 – Present)	2021 - Present
Golder Associates Principal Engineering Geologist (January 2007 – Present) Geotechnical Group Leader (January 2008 to March 2013)	2007 – 2021
Golder Associates Engineering Geologist	1999 – 2006

Awards

Australian Geomechanics Award (Best paper in Australian Geomechanics Journal)	2014
Richard Wolters Prize. International Award of the IAEG	2010
Victorian Young Engineer of the Year, Engineers Australia,	2008
Glossop Award, Geological Society of London, Runner Up,	2007
Lapworth Medal, Dux of Imperial College Engineering Geology Masters Course,	2004
Rae and Edith Benett Travelling Scholarship, University of Melbourne,	2003

Darren Paul

Technical Director - Engineering Geology

Publications

Albrecht, R.A., Tutton, M.A., Paul, D.R., Bohra, N. Managing Geotechnical Risk at an LNG Development in Papua New Guinea., Proceedings of World Gas Congress, Paris, 2015.

Benson, N.D., Haberfield, C.M., Paul, D. Geotechnical Design and Construction of Invert Anchors Proceedings of the 12th Australian Tunnelling Conference, 2005.

Gniel, J., Lenthall, C., Paul, D. Recent Experiences with soil nailing in deep cuts as part of level crossing removal works in Melbourne, Australian Geomechanics, Vol 54, No.1 March 2019.

Haberfield, C.M., Paul, D.R., Ervin, M.C., Chapman, G.C., Cyclic loading of barrettes in soft calcareous rock using Osterberg Cells, Frontiers in Offshore Geotechnics, Gourvenec and White (eds.), Balkema, 2011.

Haberfield, C.M., D.R. Paul and M.C. Ervin. Geotechnical design for the Nakheel Tall Tower. ISSMGE Bulletin, Vol 2, Issue 4, pp. 5-9, 2008.

Miner, A.S., Paul, D.R., Parry, S., Flentje, P. What does Hazard mean? Seeking to provide further clarification to commonly used landslide terminology, Proceedings of the 12th Congress of the IAEG, Torino, 2014.

Parry, S., Baynes, F.J., Culshaw, M.G., Eggers, M., Keaton, J.F., Lentfer, R., Novotny, J., Paul, D. Engineering Geological Models: IAEG Commission 25, Bulletin of Engineering Geology and the Environment, Vol 73, 3, 2014, pp. 689 - 706.

Paul, D.R., A simple method of estimating ground model uncertainty for linear infrastructure projects, Proceedings of the 13th Congress of the IAEG, San Francisco, USA, 2018.

Paul, D.R., Miner, A.S., Fifteen years of slope stability and risk assessment for local government planning in Victoria, a discussion of common mistakes and shortcomings, Australian Geomechanics Society Victoria Symposium, Melbourne 2016.

Paul, D.R., Barrett, S., Stewart, P.S., Webster, M.W., The Geological Evolution of the Jolimont Valley, Melbourne, Victoria, Australian Geomechanics, Vol. 49, No 2, June 2014. (winner Australian Geomechanics Award for best paper, 2014)

Paul, D.R., Skelley, M., Daniel, G., Sinkhole formation in central Victorian alluvial gold mining areas, Proceedings of the 11th Australia New Zealand Conference on Geomechanics, 2012.

Paul, D.R., Miner, A.S., Landslide risk assessment in Australia: background, current practice and future developments, Proceedings of the 14th Australia and New Zealand Conference on Geomechanics, Cairns, July 2023.

Paul, D.R., C.M. Haberfield and M.C. Ervin. Laboratory and in situ stiffness assessment in weak carbonate rock, Dubai, UAE. Proceedings of the 11th Congress of the IAEG, 444, 2010.

Paul, D.R., Haberfield, C.M., Foundation Investigation in Weak Slaking Rock, Darwin Australia, Australian Geomechanics Society, Foundation Symposium, Sydney 2008.

Paul, D.R., Ervin, M.C., Haberfield, C.M., Landslide Risk Assessment for Residential Dwellings on Known Landslides, Proceedings of the 10th Australia New Zealand Conference on Geomechanics, 2007.

Paul, D., Barrett, S., Jones, T., Bennett, A., Development of Geotechnical Units and Geotechnical Design Parameters for the Melbourne Formation,

16th Australasian Tunnelling Conference, Sydney, 2017.

Paul, D., Webster, M., Griffith, J., Stewart, M. A Method of Visualising Uncertainty in Three Dimensional Digital Ground Models, Proceedings of the 14th Congress of the IAEG, 2023.

Paul, D., The State of Engineering Geology Education in Australia, Australian Geomechanics, Vol 59, No.3, September 2024.

Darren Paul

Technical Director - Engineering Geology

Paul, D., A Matrix Based Framework for Rapid Landslide Risk Assessment, Australian Geomechanics, Vol, 59, No.4, December 2024

Paul, D., Miner A.S., Practical Communication of Uncertainty In Quantitative Landslide Risk Assessment, Australian Geomechanics, Vol, 60, No.1, March 2025

Srithar, S., Paul, D., Settlement behaviour of a mined, waste backfilled site, Proceedings of the 19th International Conference on Soil Mechanics and Ground Engineering, Seoul, 2017.

Stewart, D, Grieve, S., Harbig, S., Paul, D. What does the slope monitoring toolbox look like in 2025?, Australian Geomechanics, Vol, 60, No.2, June 2025

Webster, M., Paul, D.R., Griffith, J., O'Shannessy, T., Weaver, J., Leveraging geotechnical databases to improve outcomes for land development and infrastructure projects, Proceedings of the 14th Australia and New Zealand Conference on Geomechanics, Cairns, July 2023

HONG PHUC VU

Senior Associate Geochemist/Geochemical Modeller

> 5 years with WSP

> 15 years of experience

LOCATION

Melbourne (Collins Street), Australia

TECHNICAL SKILLS

Waste Classification and Treatment

Acid sulfate soil

Geochemistry

Hydrogeochemistry

Groundwater Characterisation & Modelling

Carbon Capture and Storage

PROFILE

EDUCATION

PhD Geochemistry, University of Leeds	2010
MSc in Geochemistry, University of Leeds	2005
BSc in Geology, Hanoi University of Mining and Geology	2000

PROFESSIONAL ASSOCIATIONS

- Australasian Land and Groundwater Association
- Australian Contaminated Land Consultants Association

PROFESSIONAL EXPERIENCE

Fluoride contamination

- **A major infrastructure project in Victoria and an oil operation decommissioning project in Western Australia, Australia (2022 - present): Geochemist**

  I lead the geochemical characterisation of impacted soils, focusing on the leachability and transport of fluoride within soil and water systems.

Surface Water Quality and Mine Water Discharge

- **A Coal Mine, NSW, Australia (2022 - 2024): Geochemist**

  I led the geochemical characterisation of mine tailing's materials. I also assisted in the assessment of surface water quality and mine water discharge.

Hydrogeological Conceptual Site Model

- **Wastewater Treatment Plant, Western Australia, Australia, a Manufactured Gas Plant site, and a project in South Australia, Australia, (2020 - 2022): Geochemist**

  - I assisted in developing preliminary hydrogeological conceptual site model (CSM) and assessment of natural attenuation of phosphorus for the wastewater treatment plant.
  - I played a key role in assessing the fate and transport of cyanide complexes, significantly contributing to the remediation efforts and the application for site closure.
  - A site contamination assessment of the integrated multi-metals recovery facility. I provided technical assistance in assessing acid drainage and developing geochemical conceptual site model.

Acid Mine Drainage

- **A Project in South Australia, Australia (2020 - 2022): Geochemist**

A site contamination assessment of the integrated multi-metals recovery facility. I provided technical assistance in assessing acid drainage and developing geochemical conceptual site model.

Managed Aquifer Recharge (MAR)

- **A Project in South Australia, Australia (2020 - 2022): Geochemist**

  An investigation into the water quality and impacts to water quality to help our client in application for a mining permit. I developed mixing models to understand aquifer water quality and assist Managed Aquifer Recharge (MAR) proposal in support of permitting.

Geochemical Assessment

- **A Project in Western Australia, Australia (2020 - 2021): Geochemist**

  A project that helps the construction of a full-scale groundwater barrier wall at a site in the Pilbara. I conducted geochemical assessment of lignite and grout lignite samples; risk assessment of geochemical hazard and AMD associated in support of permitting and regulatory requirement.

Waste Acid Sulfate Soil

- **Major infrastructure projects in Victoria, Australia (2019 - present): Geochemist**

  - I have been a key personnel member, providing technical assistance in assessing waste acid sulfate soil (WASS) and tunnelling hazards.
  - Successfully converted WASS (Silurian bedrock) to non-WASS, leading to significant cost savings for the client. This achievement is recognised as a pioneering milestone in Victoria's construction industry.

- **Various projects in Victoria, Western Australia and Northen Territory, Australia (2020 - present): Geochemist (technical lead and reviewer)**

  - Projects ranges from site investigations to ASS management plans and closure reports, encompassing both inland and coastal ASS.

Remediation Treatments

- **Stawell Gold Mine, Australia (2011 - 2014): Stawell Gold Mine, Geochemist**

  I led an environmental consulting project that established remediation treatments for cyanide and its complexes in a tailings storage facility. The project could help in recycling water and provides substantial cost savings for gold mining companies in Australia.

Carbon Capture, Utilisation and Storage

- **A Project in Queensland, Australia (2021): Geochemist**

  I was the technical lead for geochemistry, developing geochemical models to predict the evolution of fluid-rock reactions and the respective formation water

HONG PHUC VU

Senior Associate Geochemist/Geochemical Modeller

composition over time to identify characteristic trends and water quality indicators for different reservoir conditions.

- **Otway 2BX, Victoria, Australia (2014 - 2016): CO2CRC, Geochemist**

  I led a field study on the impact of CO2 impurities (SO2, NOx and O2) on the quality of Carbon Capture and Storage reservoir water (Otway Basin, Victoria, Australia).

PROFESSIONAL HISTORY

Golder/WSP, Senior Associate Geochemist/Modeller	2019 - Present
University of Melbourne, Geochemist/Reservoir Geochemist	2011 - 2018
University of Leeds, Research Assistant	2009 - 2010
Hanoi University of Mining and Geology, Vietnam, Teaching Assistant and Lecturer	2001 - 2004

AWARDS

Best poster presentation at the Australian Research Conference for Carbon Capture and Storage (2017)	2017

PUBLICATIONS AND PRESENTATIONS

Publications

Seventeen peer-reviewed journal articles, three theses, sixteen conference abstracts, and numerous technical reports. My Google Scholar profile: https://scholar.google.com.au/citations?user=wTvFlgwAAAAJ&hl=.	2019

Stephen Makin

Principal Hydrogeologist

11 years with WSP

25 years of experience

Areas of expertise

Conceptual hydrogeological model development for landfills, quarries, tailings dams and contaminated sites

Landfill gas assessment and monitoring

Contaminated land assessment and remediation

Contaminant fate and transport assessment, natural attenuation

Physical hydrogeology for NAPL and aquifer characterisation

GIS

Project management

Languages

English

Profile

Stephen Makin is a Senior Hydrogeologist with WSP in Melbourne. He has worked in environmental hydrogeology since 2005, with previous experience in mining and exploration geology from 1999. Experience ranges from project management and technical roles in investigation, modelling and remediation projects at landfills, tailings dams, quarries, and service station sites to operating major industrial facilities, and remote decommissioned sites. Stephen is also skilled in GIS and database development both as a tool for assimilating and interrogating spatial geological and hydrogeological data and for production of presentation maps.

Education

M.Env. Hydrogeology, GIS, The University of Melbourne, Australia	2004
B.Sc.(Hons) Geology & Geophysics, The University of Melbourne, Australia	1998

Professional experience

— **Proposed Quarry, Origin Energy, Beaufort, Victoria, Australia.**

Hydrogeological investigation and conceptual model development in support of works approval and expert witness support for planning panel hearing. Focus was the potential impact of quarrying on groundwater recharge and relationship to springs in the area.

— **Proposed Quarry, Hanson, Coimadai, Victoria.**

Assessment of dewatering impacts from proposed quarry. Included hydrogeological conceptual model development and SEEP/W groundwater flow modelling. Impacts to existing groundwater wells considered.

— **Multistorey building development, Rosebud, Victoria**

Hydrogeological report to satisfy planning permit condition for a coastal development. Advice on the likely effect on adjacent vegetation of groundwater drawdown due to construction dewatering of a basement. Involved review of site investigations and publicly available groundwater information, and groundwater flow modelling using SEEP/W.

Post-construction site investigation of sub-slab and external groundwater pressures, including monitoring of groundwater levels for tidal variation using dataloggers.

— **Former Spring Valley landfill, City of Greater Dandenong, Springvale South, Victoria**

Hydrogeological assessment of former landfill to develop conceptual model of interaction of landfill leachate with groundwater and surface drainage. Project included installation of leachate monitoring wells, leachate extraction and infiltration trials and groundwater and leachate sampling.

Conceptual design of groundwater collection drain system.

Update of Landfill Gas Risk Assessment and Aftercare Management Plan.

Management of groundwater and landfill gas monitoring and reporting.

Review of third party landfill gas risk assessments to support planning permits in the surrounding area.

— **Elder Street South former landfill, City of Kingston, Clarinda, Victoria**

Landfill hydrogeological assessment for leachate management and site redevelopment; groundwater and landfill gas monitoring.

- **Rowan Road former landfill, City of Kingston, Clarinda, Victoria**

  Management of landfill monitoring and gas management measures, updates to landfill gas risk assessment and hydrogeological assessment.

- **Inkerman Landfill, Cleanaway Pty Ltd, Inkerman, South Australia**

  Hydrogeological investigations to support approvals for landfill deepening and extension. Tasks completed included:

  - Multi-aquifer well installation
  - Aquifer testing via pump tests
  - Acid sulphate soil assessment
  - Hydrogeological conceptual model development
  - Inflow rates and extent of drawdown influence estimates using analytical and numerical methods (SEEP/W models).

- **Calder Park Raceway, Calder Park, Victoria**

  Groundwater, landfill gas and surface water assessment and monitoring for former solid inert waste repository.

- **Kealba Landfill, Barro Group, Kealba, Victoria**

  Hydrogeological assessment and development of Environmental Monitoring Plan in support of approval for new solid inert waste landfill.

- **Urban development, Villawood Properties, Clyde North, Victoria**

  Hydrogeological and salinity assessment to satisfy planning permit condition for proposed development of farmland for residential use. Considered potential effects of groundwater on the development and potential impacts to groundwater from the development.

- **River Valley Estate, YourLand Developments, Sunshine North, Victoria**

  Investigation of soil, groundwater and vapour impacts at former quarry site being redeveloped for residential development.

- **Golden Plains Windfarm, West Wind Energy, Rokewood, Victoria**

  Salinity assessment and salinity management plan for project, responding to requirements of Salinity Management planning overlay.

- **Stockyard Hill Wind Farm, Origin Energy, Beaufort, Victoria**

  Groundwater and surface water investigation and management plans to support approvals and planning panel expert witness for new on-site quarry development with wind farm.

- **CSA Mine, Cobar, NSW**

  Groundwater impact assessment of south tailings storage facility. Tailings sampling and desktop hydrogeology study to assess the potential risks to groundwater from the tailings disposal system. Review of groundwater monitoring programme, and recommendations for data collection to support the current operation and future closure.

- **Ranger Uranium Mine, Northern Territory**

  Hydrogeologist assistant to Independent Reviewer for tailings dam review. Tasks included development of a groundwater database and GIS, collation of data from various sources of groundwater and surface water monitoring, geological and mine infrastructure data, assessment of solute transport rates and breakthrough curves, preparation of figures and presentation of results to multidisciplinary working group panel.

- **Grampians Wimmera Mallee Water, North-western Victoria**

  Data and GIS manager for four groundwater appraisal projects. Tasks completed included:

  - Compilation of diverse spatial datasets including SAFE boundaries, Groundwater Catchments, Groundwater Dependent Ecosystems, gaining and losing stream data, geological and topographic information;
  - Interrogating Victorian Aquifer Framework 3D layers in ArcGIS and ArcGIS Spatial Analyst to produce data such as aquifer extents, thicknesses and cross-sections and assign aquifer elevation data to borehole locations. Creating Aquifer Groups by merging separate surfaces;
  - Extraction of registered bore information from GMS database. Writing SQL queries in Microsoft Access to classify bore data to aquifers and by data availability;
  - Production and interpretation of hydrographs, groundwater elevation maps and groundwater quality maps;
  - Aggregation and data cleaning of multiple borehole datasets (GMS, licenced extraction bores, GEDIS, CLPR);
  - Use of ArcGIS and ArcGIS 3D Analyst to produce aquifer elevation, thickness and extent maps, groundwater elevation and quality maps;
  - Production of report figures using ArcGIS.

- **Orica Australia Pty Ltd, Yarraville, Victoria**

  Groundwater condition report to support site Audit for site divestment following remediation.

- **Mobil Oil Australia, Former Naracoopa Fuel Terminal, King Island, Tasmania**

  Programme manager for implementation of a multi-disciplinary scope of works at a former fuel terminal. Works included:

  - Site assessment via monitoring well installation, test pits, and groundwater, surface water and sediment sampling;
  - Development and execution of a groundwater/surface water interaction investigation including tidal influence monitoring via pressure transducers and geochemical sampling and interpretation of resulting hydrographs;
  - Management of ecological receptor survey and human health risk assessment;
  - Development of remedial options and site maintenance works;
  - Implementation of remediation including chemical injection and site earthworks.

- **Esso Australia Resources Ltd, Long Island Point and Longford Gas Facilities, Victoria**

  Site history investigations (Phase 1 Environmental Site Assessments) for major upstream oil and gas processing facilities.

  Project management of soil and groundwater monitoring at these operating sites.

- **Mobil Oil Australia, Yarraville Terminal, Victoria**

  Project management, fieldwork and reporting of environmental monitoring and investigations related to site operational regulatory compliance and environmental audit. Site includes fractured rock and porous aquifers, impacted with LNAPL and DNAPL, groundwater interaction with river and tidal estuary. Tasks included:

  - Development of database and GIS for site,

- Project management and supervision of drilling programmes including multiple aquifer well installations,
- LNAPL mobility testing and interpretation,
- Aquifer hydraulic testing and monitoring of tidal interactions,
- Investigations to determine performance of groundwater interception trench,
- Reporting for groundwater monitoring and drilling works,
- Reporting for site environmental audit, including groundwater numerical modelling.

Various sites - Vic, SA, NSW, Tas

Soil and groundwater assessment and remediation for fuel terminals, depots and service stations.

Interpretation of LNAPL mobility via baildown tests.

Aquifer testing by slug tests and pumping tests.

Installation, monitoring and optimisation of a total fluids extraction groundwater remediation system.

Remedial options studies and remediation technology selection.

Contaminant fate and transport modelling for hydrocarbons and chlorinated solvents.

Due diligence studies for land divestment and acquisition.

Environmental Audit support including preparation of CUTEP and Audit reports.

Annual reporting for landfill licence compliance.

Professional history

WSP / Golder Associates Pty Ltd – Melbourne – Senior Hydrogeologist	2013 – Present
URS Australia Pty Ltd – Melbourne – Environmental Hydrogeologist	2005 – 2013
BHPBilliton Iron Ore – Pilbara, Western Australia – Resource Definition Geologist.	2003 – 2004
OMG International Ltd/Centaur Mining and Exploration Ltd – Cawse Nickel Operations – Kalgoorlie, Western Australia – Graduate to Acting Senior Mine Geologist.	1999 – 2003

Appendix B

Letter of Instruction

Board of Inquiry
into the McCrae landslide

Darren Paul
Technical Director – Engineering Geology
WSP Australia Pty Limited
Level 27, 680 George Street
Sydney NSW 2000

14 May 2025

By email: Irrelevant & Sensitive

Dear Darren

BOI into the McCrae Landslide – Letter of Instruction for Causation Report

1 As you know, on 18 March 2025, Renee Enbom KC was appointed under section 53(1) of the *Inquiries Act 2014*, to constitute a Board of Inquiry (**BOI**) to inquire into, report on, and make recommendations in respect of, the cause(s) of the "McCrae Landslide" and other matters, pursuant to the BOI's Terms of Reference.

2 The McCrae Landslide was a significant landslide of approximately 120 tonnes, that occurred at 10-12 View Point Road, McCrae on 14 January 2025. It resulted in the destruction of one house – 3 Penny Lane – damage to three other houses, and an MPSC worker suffering significant injuries.

3 You are instructed by the Solicitors Assisting the BOI to prepare a report into the cause(s) of the McCrae Landslide that addresses the matters set out below.

Landslides in the McCrae area

4 Landslides and landslips have previously occurred in the McCrae area, within the Mornington Peninsula Shire Council (**MPSC**).

5 Prior to the McCrae Landslide, the most recent landslides to occur in the area included:

5.1 a landslide of approximately 20 tonnes in the vicinity of the west end of View Point Road over two days – 14 and 15 November 2022 – causing damage to two townhouses (**November 2022 Landslides**); and

5.2 a landslide of approximately 30 tonnes at 10-12 View Point Road on 5 January 2025, causing damage to the rear of 3 Penny Lane (**5 January Landslide**),

(together with the McCrae Landslide, **the Landslides**).

Potential contributing factors to the Landslides

6 In his opening submissions at the commencement of the Inquiry, Counsel Assisting listed the following factors that may have contributed to the McCrae Landslide:

6.1 The effect of building works undertaken on View Point Road.

6.2 The removal of vegetation from the top of the escarpment.

6.3 The adequacy of stormwater diversion in the vicinity of the landslide site.

6.4 The existence of natural springs in the area.

6.5 Damaged infrastructure, and specifically, a burst water main located in the vicinity of the landslide site.

7 We consider these factors to be potential lines of enquiry.

Reports compiled

8 To date, we understand that:

8.1 the MPSC has retained Dane Pope, PSM to prepare reports including but not limited to:

(a) a risk assessment of 10-12 View Point Road dated 3 November 2023;

(b) a landslide assessment, further risk assessment, and expert opinion on rectification works required for 10-12 View Point Road dated 11 June 2024;

(c) a preliminary advice on emergency orders for selected dwellings dated 11 February 2025;

(d) a landslide incident temporary works proposal dated 25 February 2025; and

(e) a landslide evacuation order area geotechnical factual report dated 9 April 2025.

8.2 the owners of 10-12 View Point Road have retained CivilTest Geotechnical Engineering to prepare reports including:

(a) a geotechnical assessment of 10-12 View Point Road dated 22 December 2022;

(b) land stability assessments of 10-12 View Point Road dated 24 March 2023 and 2 August 2023;

(c) risk to life assessments dated 26 August 2024, 26 September 2024 and 27 March 2025; and

(d) a causation report dated 4 April 2025.

8.3 other affected residents have retained A.S. James to prepare reports including but not limited to:

(a) a preliminary comments report dated 13 October 2023; and

(b) a geotechnical opinion dated 24 July 2024.

8.4 South East Water retained SMEC to prepare a multidisciplinary report in relation to the McCrae Landslide dated 2 April 2025.

9 A complete list of the reports obtained by the MSPC, the owners of 10-12 View Point Road, affected residents, South East Water, and others is included in the Hyperlinked Index of Expert Reports referred to at paragraph 11.1 below.

10 We understand that the MPSC has also briefed Mr Pope of PSM to prepare a further report addressing risk to life, and a causation report in respect of the McCrae Landslide. We will provide you with those materials upon receipt.

Materials

11 To assist in preparation of your report, we enclose the following materials:

11.1 Hyperlinked Index of Expert Reports.

11.2 Transcript of the evidence given by Dane Pope on Thursday 8 May 2025.

12 Mr Pope referred to a 3D Pointerra Model in his reports. To access the 3D Pointerra Model, please click on this link. The password to access the link is *Mornington* .

13 We have also issued Notices to Produce to South East Water, Mr Pope as Principal of PSM, and SMEC, for all materials and raw data relevant to their investigations into the McCrae Landslide. We will provide you with those materials upon receipt.

14 We may also provide you with additional materials including expert reports, as and when we receive them.

Board of Inquiry
into the McCrae landslide

Instructions

15 Please review the materials available and identify any further primary investigation work that you consider to be required, in particular, any further testing and whether a site inspection is required.

16 Please prepare a report that considers the cause(s) of the McCrae Landslide, and addresses the following matters:

16.1 Your professional qualifications and experience.

16.2 The conditions that generate landslide risk generally, including but not limited to:

(a) geological conditions;

(b) vegetation; and

(c) landslide history.

16.3 The conditions that you consider likely to have generated a landslide risk at the site of the McCrae Landslide.

16.4 Factors that may trigger landslides, including but not limited to:

(a) earthworks;

(b) water; and

(c) de-vegetation.

16.5 The factors that you consider likely to have triggered the McCrae Landslide, including but not limited to, the factors referred to at paragraph 6 above.

16.6 Any other matters that you consider relevant.

Contact details and invoicing

17 Your contacts in respect of this brief are:

17.1 Georgie Austin – Georgie.Austin@mccraeinquiry.vic.gov.au

17.2 Samantha Saad – Samantha.Saad@mccraeinquiry.vic.gov.au

17.3 Michelle Rich – Michelle.Rich@mccraeinquiry.vic.gov.au

Board of Inquiry
into the McCrae landslide

18 If you have any questions in relation to this brief, please do not hesitate to contact us.

Your sincerely

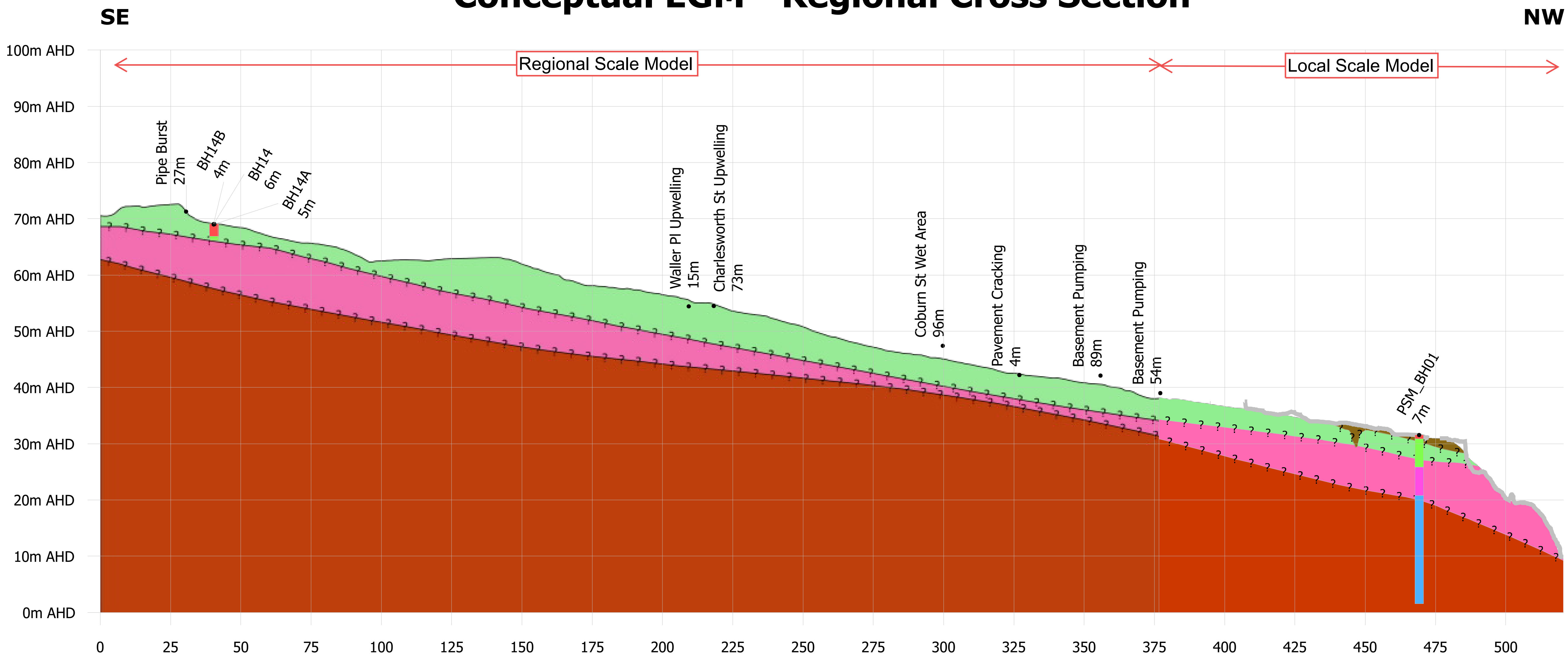
Irrelevant & Sensitive

Georgie Austin
Solicitor Assisting
Board of Inquiry into the McCrae landslide

Appendix C

Select Cross Sections and Model Renders

Conceptual EGM - Regional Cross Section



Legend

Modelled Geology

- Granite: RS
- Granite: XW or better
- Transported Soils (Colluvium)
- Fill

Logged Geology on Boreholes

- Aeolian
- Colluvium
- FILL
- RS
- XW Granite

2025 Ground surface

This section is taken from the conceptual egnineering geological model for the McCrae site. Refer to PS224394-WSP-MEL-GEO-REP-001 for a disucssion on the EGM inputs and limitations.

Fill has only been modelled were an appropriate number of boreholes are available to inform interpretation.

Responsible dept.	Technical reference	Creator	Approved by
		AJD	DRP

Legal owner	Document type	Document status
wsp	Geological Section	For Information
	Title Regional Cross Section	**Identification number**

Rev.	Date of issue	Sheet
B	11/07/2025	

Location

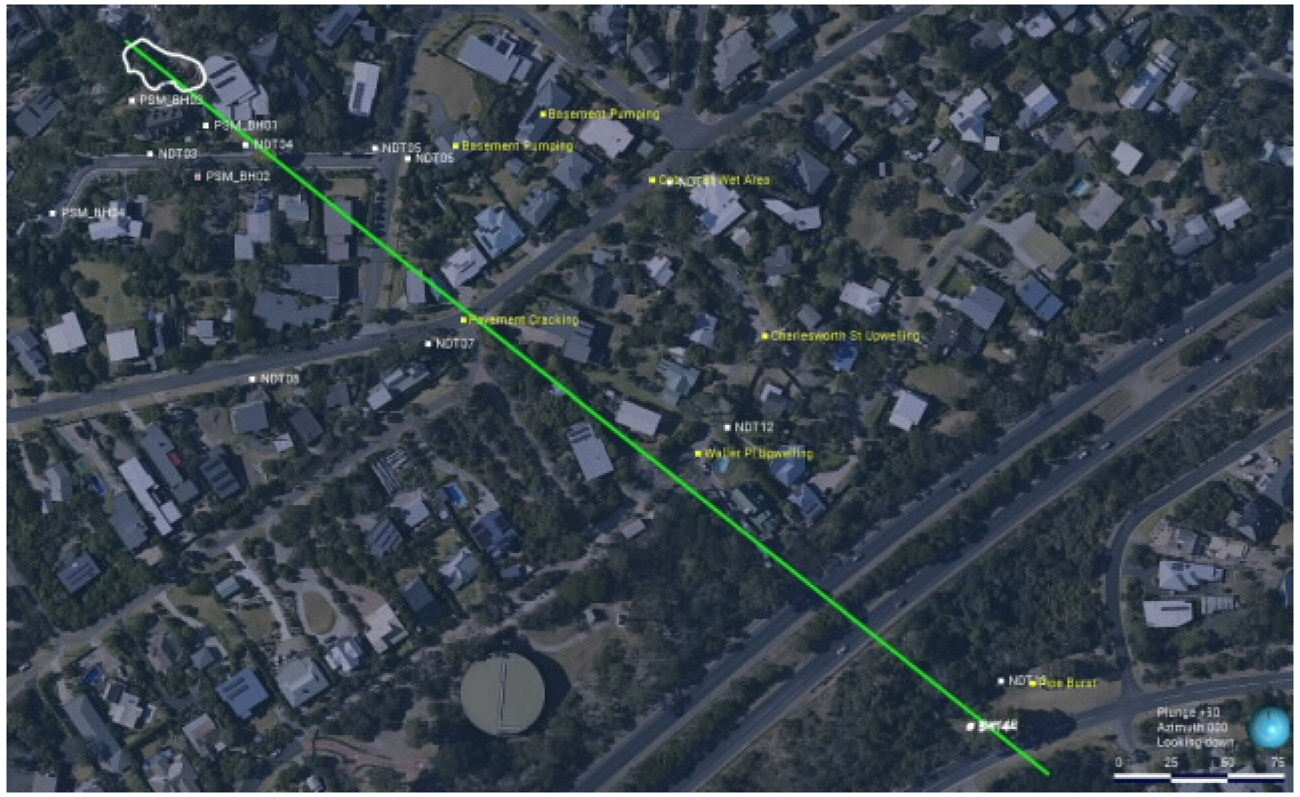
SE: 319938, 5753418

NW: 319530, 5753742

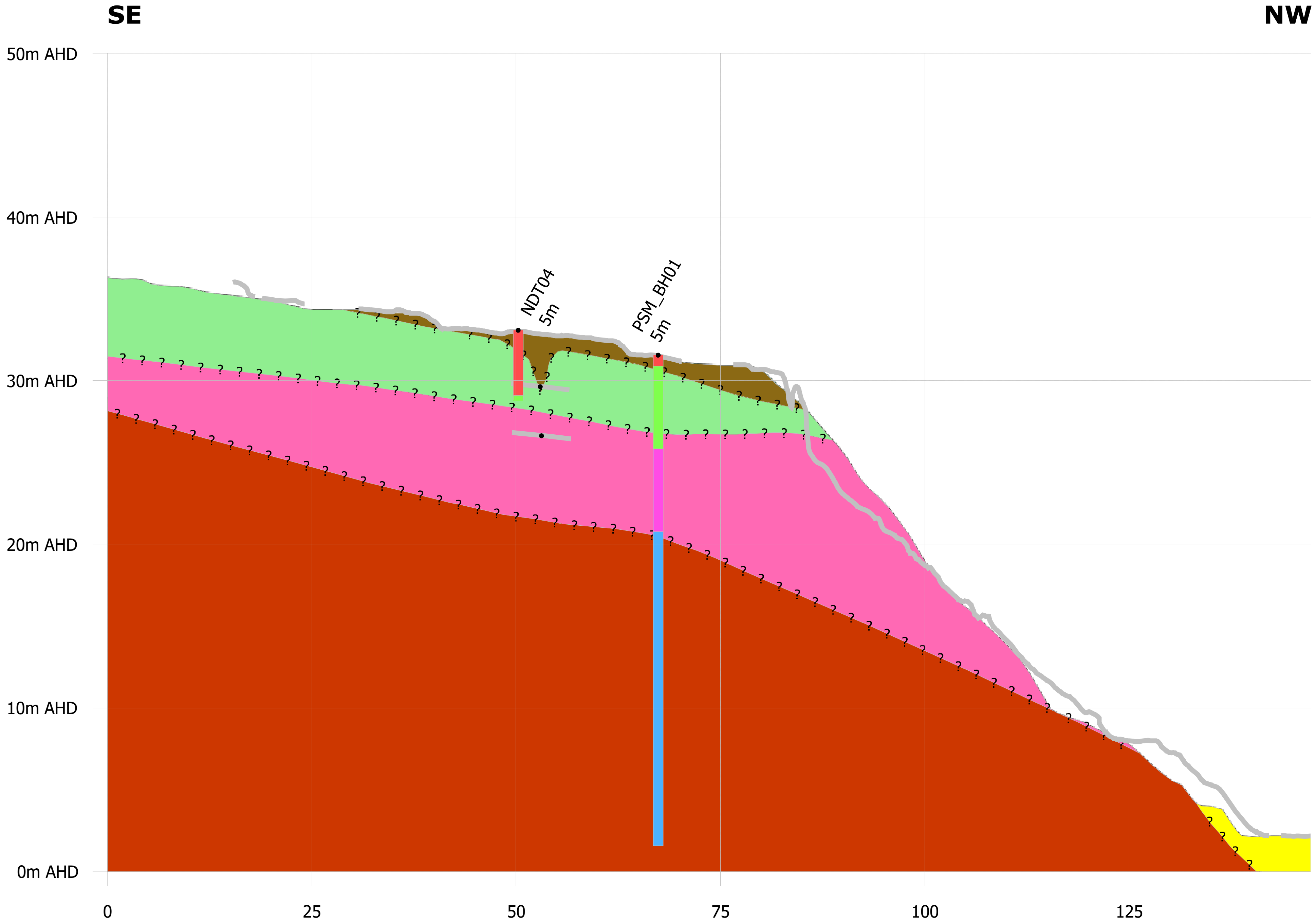
Scale: 1:1,500

Vertical exaggeration: 2x

0m 50m



Conceptual EGM - Local Cross Section



Legend

Modelled Geology

- Granite: RS
- Granite: XW or better
- Transported Soils (Colluvium)
- Fill
- Transported Soils (Aeolian Sands)

Logged Geology on Boreholes

- Aeolian
- Colluvium
- FILL
- RS
- XW Granite

- 2025 Ground surface
- NEP42 - from SEW plans
- NEP42 - inferred from PSM investigation

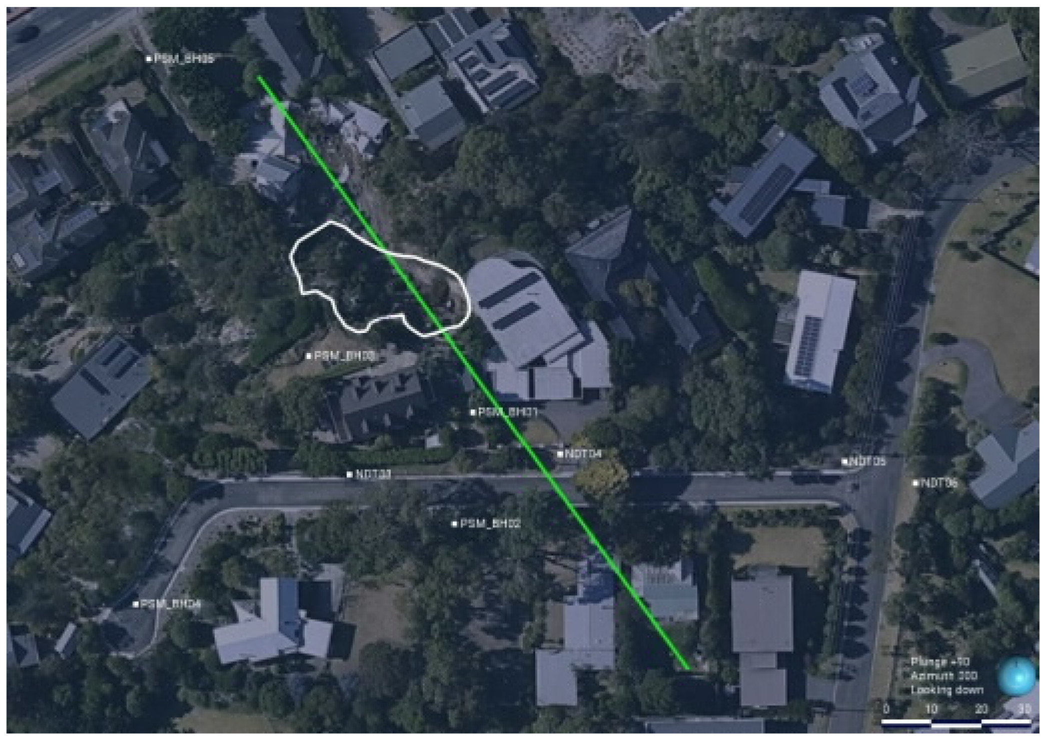
Scale: 1:600
Vertical exaggeration: 2x
0m 50m

This section is taken from the conceptual egnineering geological model for the McCrae site.
Refer to PS224394-WSP-MEL-GEO-REP-001 for a disucssion on the EGM inputs and limitations.

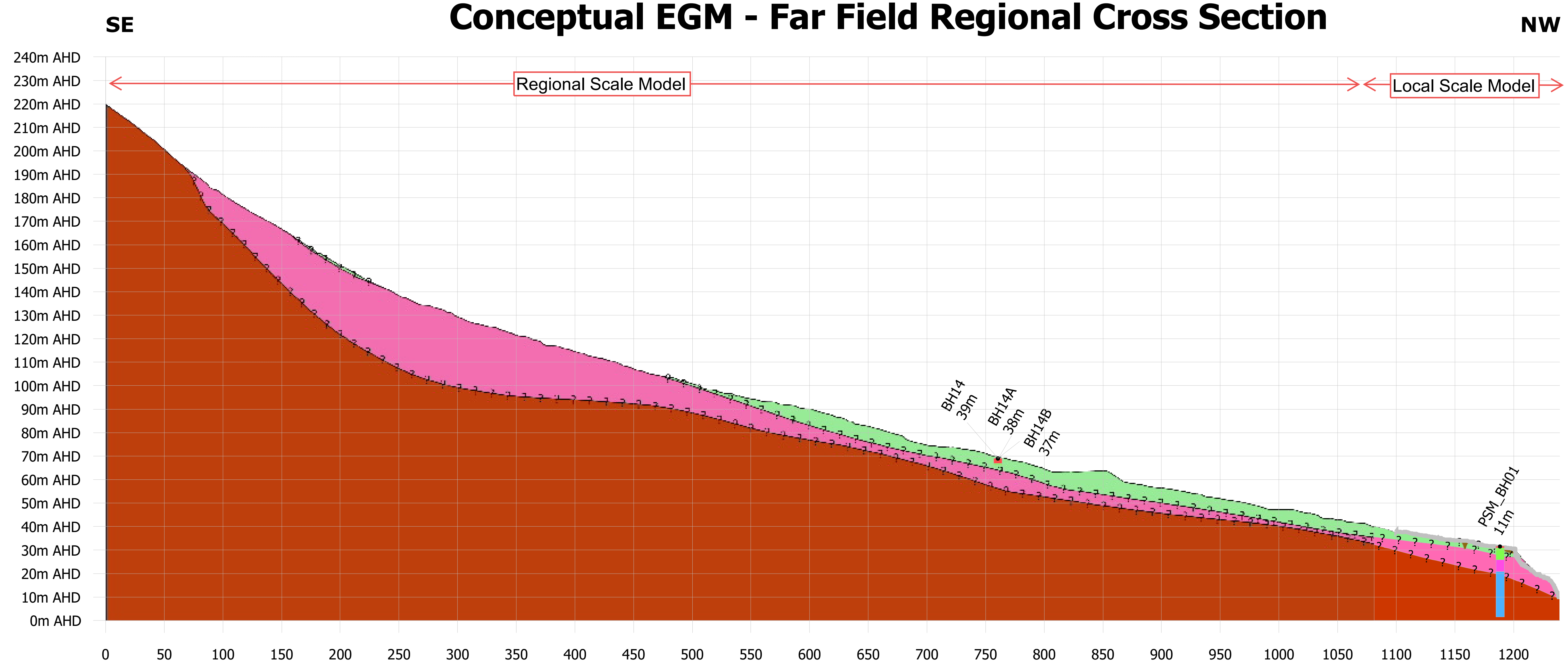
Responsible dept.	Technical reference	Creator	Approved by		
		AJD	DRP		
Legal owner		Document type: Geological Section	Document status: For Information		
wsp		Title: Local Cross Section	Identification number		
			Rev.: B	Date of issue: 11/07/2025	Sheet

Location

SE: 319609, 5753653
NW: 319523, 5753772



Conceptual EGM - Far Field Regional Cross Section



Legend

Modelled Geology

- Granite: RS
- Granite: XW or better
- Transported Soils (Colluvium)
- Fill

Logged Geology on Boreholes

- Aeolian
- Colluvium
- FILL
- RS
- XW Granite

2025 Ground surface

This section is taken from the conceptual egnineering geological model for the McCrae site. Refer to PS224394-WSP-MEL-GEO-REP-001 for a disucssion on the EGM inputs and limitations.

Fill has only been modelled were an appropriate number of boreholes are available to inform interpretation.

Responsible dept.	Technical reference	Creator	Approved by		
		AJD	DRP		
Legal owner		Document type	Document status		
wsp		Geological Section	For Information		
		Title	Identification number		
		Regional Cross Section			
			Rev.	Date of issue	Sheet
			B	11/07/2025	

Location

SE: 320552, 5753041

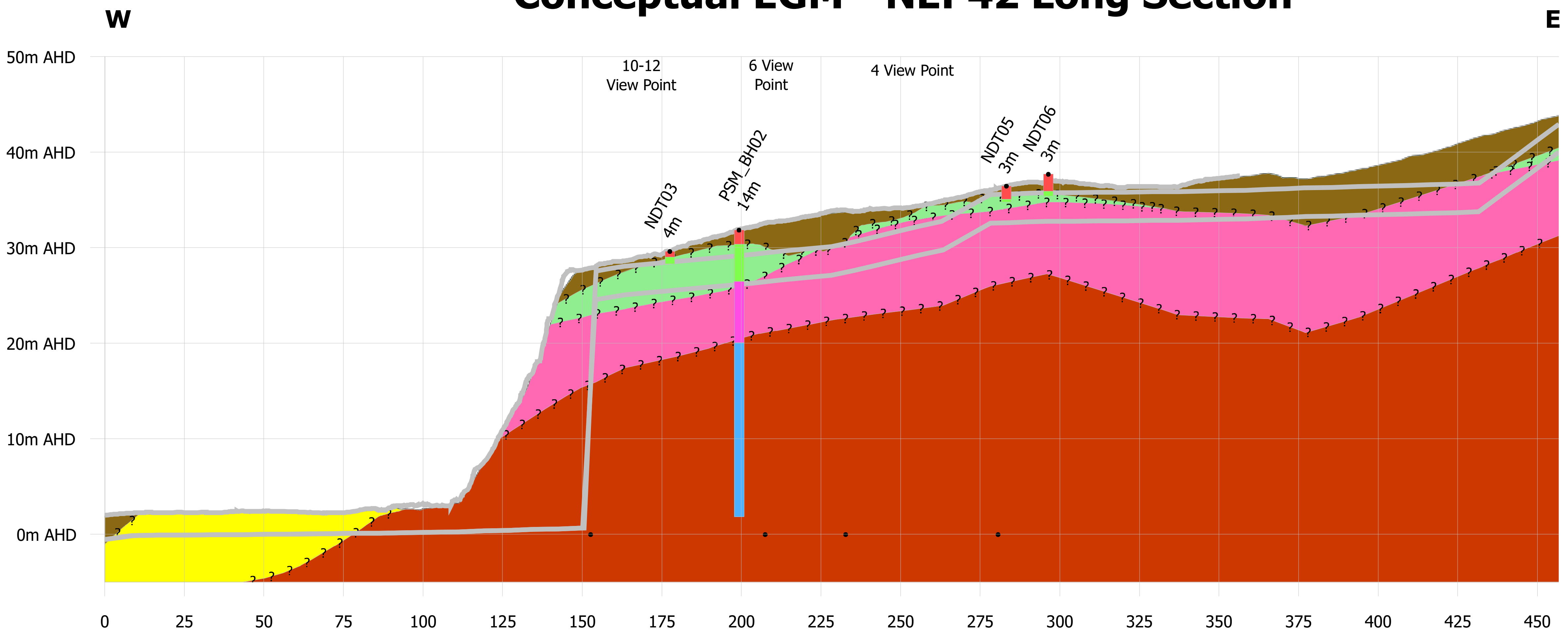
NW: 319530, 5753742

Scale: 1:3,500

Vertical exaggeration: 2x

0m 200m

Conceptual EGM - NEP42 Long Section



Legend

Modelled Geology
- Fill
- Transported Soils (Colluvium)
- Transported Soils (Aeolian Sands)
- Granite: RS
- Granite: XW or better

Logged Geology on Boreholes
- Aeolian
- Colluvium
- FILL
- RS
- XW Granite

- 2025 Ground surface
- NEP42 - from SEW plans
- NEP42 - inferred from PSM investigation

Location

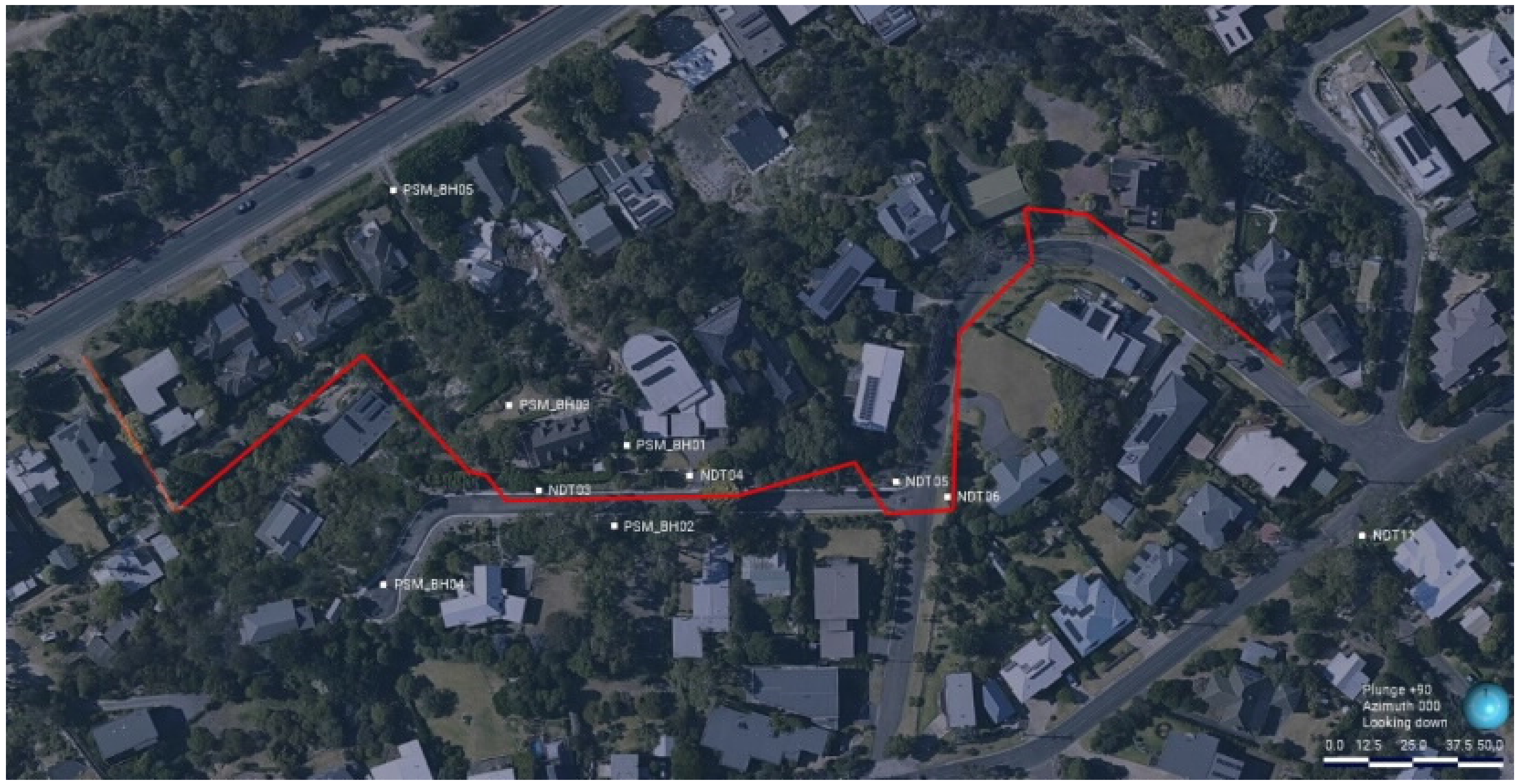
W: 319412, 5753731

E: 319749, 5753724

Scale: 1:1,500

Vertical exaggeration: 3x

0m 50m



This section is taken from the conceptual egnineering geological model for the McCrae site. Refer to PS224394-WSP-MEL-GEO-REP-001 for a disucssion on the EGM inputs and limitations.

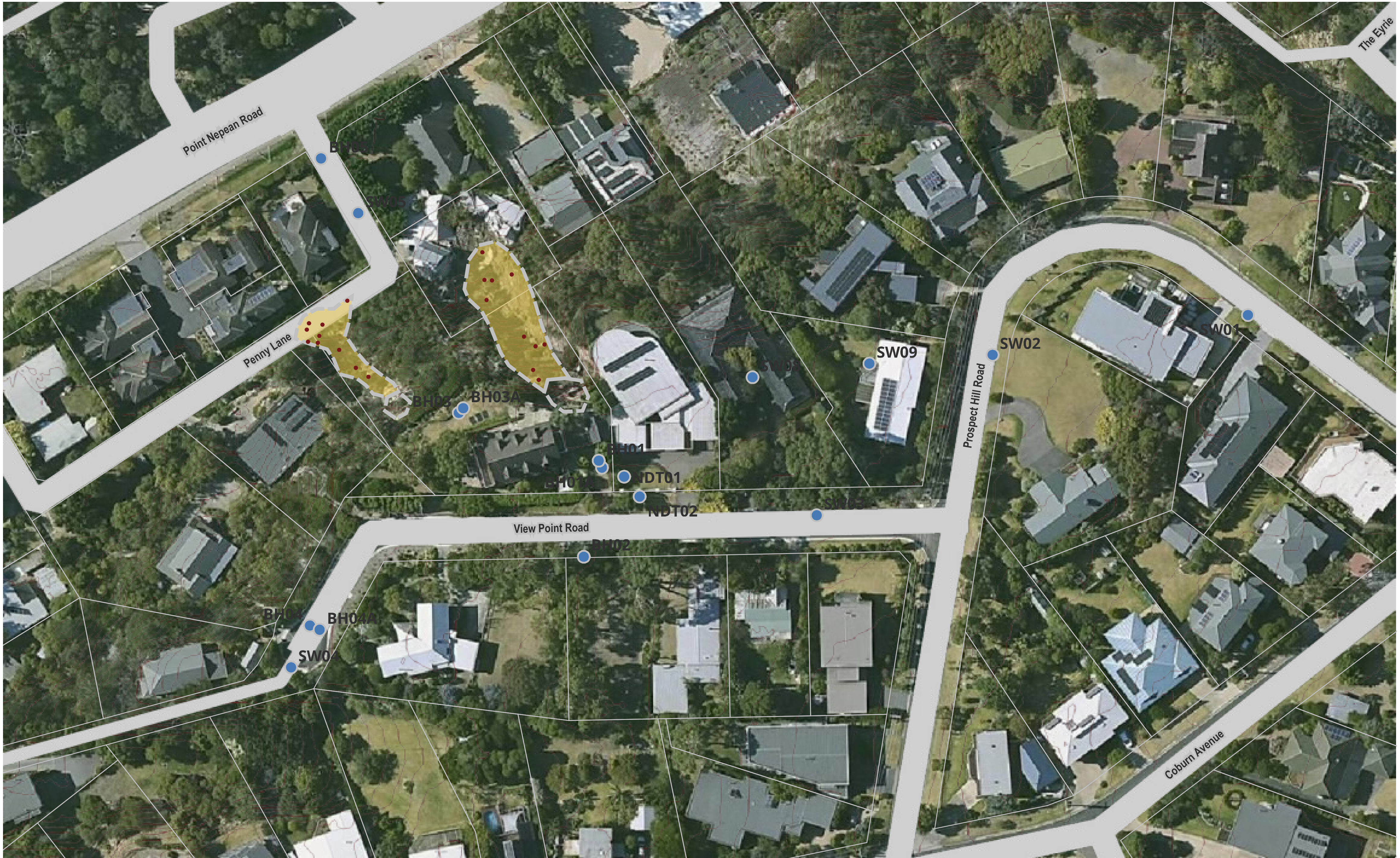
Responsible dept.	Technical reference	Creator	Approved by
		AJD	DRP

Legal owner	Document type	Document status
wsp	Geological Section	For Information
	Title: NEP42 Long Section	Identification number
		Rev.: B / Date of issue: 11/07/2025 / Sheet

Appendix D

Water Sampling Field Records


Point Nepean Road
Penny Lane
BH03
BH03A
ND101
BH01
ND102
SW03
View Point Road
BH02
BH04
SW04
BH04A
Prospect Hill Road
SW02
SW01
The Eyrie
Wonga Grove
Wonga Lane
Henry Court
Charlesworth Street
Coburn Avenue
Cornell Street
Waller Place
Pit04
Browne Street
Corbens Lane
Mornington Peninsula Freeway
Mornington Peninsula Freeway
Outlook Road
Bayview Road
The Boulevard
Pit01


Point Nepean Road
The Eyrie
Penny Lane
BH03A
SW09
SW02
Prospect Hill Road
NDT01
NDT02
View Point Road
BH04A
Coburn Avenue

GROUNDWATER SAMPLING FORM
LOW FLOW PURGING and SAMPLING

PROJECT INFORMATION

WELL ID	bh01a	Project Number:	PS224394	Site Name:	Mccrae landslide	Date:	06/17/2025
		Client:		Monitoring Round:	June	Sampled By:	Sb

WELL INFORMATION	
Casing diameter (mm)	
TOC height above/below ground level (m)	
Depth to top of filter pack from log (mbgl)	
Top of screen from log (mbgl)	
Bottom of screen from log (mbgl)	
Depth of well from log (mbgl)	
Depth to bottom of filter pack from log (mbgl)	

GAUGING INFORMATION (PRE-SAMPLING)	
PID Reading (ppm)	
Interface Probe Used?	
Initial Depth to Water (mbTOC)	
Depth to Product (mbTOC)	
Thickness of Product (m)	
Bailed Product Thickness (m)	
Measured Depth to Bottom of Well (mbTOC)	

LOW FLOW SAMPLING	
Depth of pump intake (mbTOC)	
Diameter of hose (inches)	
Length of hose above TOC (m)	
Volume in hose (L)	
Volume in casing per m screen (L)	
Meters of saturated screen	
Minimum Target Purge Vol (L)	
DTW after placement of pump (mbTOC)	
DTW at end of purging (mbTOC)	
DTW after collection of samples (mbTOC)	

WQM INFORMATION	
WQM Model	
WQM serial number	
WQM cal date and certificate	

CONTROLLER SETTINGS			
Controller - CPM	Controller - Refill	Controller - Discharge	Controller Throttle - Pressure (PSI)

Maintenance needed or other remarks	. Dry at 5.95

Samples Collected	Yes/No	Sample Id
Primary Sample ID	Yes	
Primary Duplicate ID		
Secondary Duplicate ID		
Rinsate ID		
Rinsate Collected From		
Trip Blank ID		
Trip Blank Batch no./Expiry		
Trip Spike ID		
Trip Spike Batch no./Expiry		
Field Blank ID		
Field Blank Collected From		

SAMPLE CONTAINERS				
Bottle Type	Number of bottles	Filtered or Unfiltered?	Preserved or Unpreserved?	Remarks

RINSATE & DI BATCH NUMBERS	
Volatiles Rinsate Water Batch No. and /or Date/Expiry Date	
Semi-volatiles Rinsate Water Batch No. and /or Date/Expiry Date	
Inorganics/Metals Rinsate Water Batch No. and /or Date/Expiry Date	
PFAS Rinsate Water Batch No. and / or Date/Expiry Date	

PURGING INFORMATION

Time	Cumulative Volume Purged (L)	Flow Rate (L/min)	Depth to GW (mbTOC)	Drawdown (m)	Temp. (°C) ±0.5	DO (mg/L) ±10%	Cond (µS/cm) ±5%	pH ±0.1	Redox (mV) ±10	Colour	Turbidity	Odour?	Odour Type	Sheen?	Sampling Row

GROUNDWATER SAMPLING FORM
LOW FLOW PURGING and SAMPLING

PROJECT INFORMATION

WELL ID	BH02	Project Number:	PS224394	Site Name:	Mccrae landslide	Date:	06/18/2025
		Client:		Monitoring Round:	June	Sampled By:	Sb

WELL INFORMATION	
Casing diameter (mm)	
TOC height above/below ground level (m)	
Depth to top of filter pack from log (mbgl)	
Top of screen from log (mbgl)	
Bottom of screen from log (mbgl)	
Depth of well from log (mbgl)	
Depth to bottom of filter pack from log (mbgl)	

GAUGING INFORMATION (PRE-SAMPLING)	
PID Reading (ppm)	
Interface Probe Used?	YES
Initial Depth to Water (mbTOC)	
Depth to Product (mbTOC)	
Thickness of Product (m)	
Bailed Product Thickness (m)	
Measured Depth to Bottom of Well (mbTOC)	

LOW FLOW SAMPLING	
Depth of pump intake (mbTOC)	
Diameter of hose (inches)	
Length of hose above TOC (m)	
Volume in hose (L)	
Volume in casing per m screen (L)	
Meters of saturated screen	
Minimum Target Purge Vol (L)	
DTW after placement of pump (mbTOC)	
DTW at end of purging (mbTOC)	
DTW after collection of samples (mbTOC)	

WQM INFORMATION	
WQM Model	
WQM serial number	
WQM cal date and certificate	

CONTROLLER SETTINGS			
Controller - CPM	Controller - Refill	Controller - Discharge	Controller Throttle - Pressure (PSI)

Maintenance needed or other remarks	. Dry at 1.26

Samples Collected	Yes/No	Sample Id
Primary Sample ID	Yes	
Primary Duplicate ID		
Secondary Duplicate ID		
Rinsate ID		
Rinsate Collected From		
Trip Blank ID		
Trip Blank Batch no./Expiry		
Trip Spike ID		
Trip Spike Batch no./Expiry		
Field Blank ID		
Field Blank Collected From		

SAMPLE CONTAINERS				
Bottle Type	Number of bottles	Filtered or Unfiltered?	Preserved or Unpreserved?	Remarks

RINSATE & DI BATCH NUMBERS	
Volatiles Rinsate Water Batch No. and /or Date/Expiry Date	
Semi-volatiles Rinsate Water Batch No. and /or Date/Expiry Date	
Inorganics/Metals Rinsate Water Batch No. and /or Date/Expiry Date	
PFAS Rinsate Water Batch No. and / or Date/Expiry Date	

PURGING INFORMATION

Time	Cumulative Volume Purged (L)	Flow Rate (L/min)	Depth to GW (mbTOC)	Drawdown (m)	Temp. (°C) ±0.5	DO (mg/L) ±10%	Cond (µS/cm) ±5%	pH ±0.1	Redox (mV) ±10	Colour	Turbidity	Odour?	Odour Type	Sheen?	Sampling Row

GROUNDWATER SAMPLING FORM
LOW FLOW PURGING and SAMPLING

PROJECT INFORMATION

WELL ID	BH03	Project Number:	PS224394	Site Name:	McCrae landslide	Date:	06/17/2025
		Client:		Monitoring Round:	June	Sampled By:	Sb

WELL INFORMATION	
Casing diameter (mm)	
TOC height above/below ground level (m)	
Depth to top of filter pack from log (mbgl)	
Top of screen from log (mbgl)	
Bottom of screen from log (mbgl)	
Depth of well from log (mbgl)	
Depth to bottom of filter pack from log (mbgl)	

GAUGING INFORMATION (PRE-SAMPLING)	
PID Reading (ppm)	
Interface Probe Used?	
Initial Depth to Water (mbTOC)	
Depth to Product (mbTOC)	
Thickness of Product (m)	
Bailed Product Thickness (m)	
Measured Depth to Bottom of Well (mbTOC)	

LOW FLOW SAMPLING	
Depth of pump intake (mbTOC)	
Diameter of hose (inches)	
Length of hose above TOC (m)	
Volume in hose (L)	
Volume in casing per m screen (L)	
Meters of saturated screen	
Minimum Target Purge Vol (L)	
DTW after placement of pump (mbTOC)	
DTW at end of purging (mbTOC)	
DTW after collection of samples (mbTOC)	

WQM INFORMATION	
WQM Model	
WQM serial number	
WQM cal date and certificate	

CONTROLLER SETTINGS			
Controller - CPM	Controller - Refill	Controller - Discharge	Controller Throttle - Pressure (PSI)

Maintenance needed or other remarks	. Dry at 6.060

Samples Collected	Yes/No	Sample Id
Primary Sample ID	Yes	
Primary Duplicate ID		
Secondary Duplicate ID		
Rinsate ID		
Rinsate Collected From		
Trip Blank ID		
Trip Blank Batch no./Expiry		
Trip Spike ID		
Trip Spike Batch no./Expiry		
Field Blank ID		
Field Blank Collected From		

SAMPLE CONTAINERS				
Bottle Type	Number of bottles	Filtered or Unfiltered?	Preserved or Unpreserved?	Remarks

RINSATE & DI BATCH NUMBERS	
Volatiles Rinsate Water Batch No. and /or Date/Expiry Date	
Semi-volatiles Rinsate Water Batch No. and /or Date/Expiry Date	
Inorganics/Metals Rinsate Water Batch No. and /or Date/Expiry Date	
PFAS Rinsate Water Batch No. and / or Date/Expiry Date	

PURGING INFORMATION

Time	Cumulative Volume Purged (L)	Flow Rate (L/min)	Depth to GW (mbTOC)	Drawdown (m)	Temp. (°C) ±0.5	DO (mg/L) ±10%	Cond (µS/cm) ±5%	pH ±0.1	Redox (mV) ±10	Colour	Turbidity	Odour?	Odour Type	Sheen?	Sampling Row

GROUNDWATER SAMPLING FORM
LOW FLOW PURGING and SAMPLING

PROJECT INFORMATION

WELL ID	BH04	Project Number:	PS224394	Site Name:	McRae landslide	Date:	06/18/2025
		Client:		Monitoring Round:	June	Sampled By:	Sb

WELL INFORMATION	
Casing diameter (mm)	50
TOC height above/below ground level (m)	
Depth to top of filter pack from log (mbgl)	
Top of screen from log (mbgl)	
Bottom of screen from log (mbgl)	
Depth of well from log (mbgl)	
Depth to bottom of filter pack from log (mbgl)	

GAUGING INFORMATION (PRE-SAMPLING)	
PID Reading (ppm)	
Interface Probe Used?	YES
Initial Depth to Water (mbTOC)	22.85
Depth to Product (mbTOC)	
Thickness of Product (m)	
Bailed Product Thickness (m)	
Measured Depth to Bottom of Well (mbTOC)	30.4

LOW FLOW SAMPLING	
Depth of pump intake (mbTOC)	27
Diameter of hose (inches)	0.375
Length of hose above TOC (m)	1
Volume in hose (L)	1.96
Volume in casing per m screen (L)	2
Meters of saturated screen	
Minimum Target Purge Vol (L)	
DTW after placement of pump (mbTOC)	
DTW at end of purging (mbTOC)	
DTW after collection of samples (mbTOC)	

WQM INFORMATION	
WQM Model	YSI Pro
WQM serial number	18G103115
WQM cal date and certificate	Sb.18.6,25

CONTROLLER SETTINGS

Controller - CPM	Controller - Refill	Controller - Discharge	Controller Throttle - Pressure (PSI)
2	12	8	40

Maintenance needed or other remarks	No.

Samples Collected	Yes/No	Sample Id
Primary Sample ID	Yes	BH04/50180525
Primary Duplicate ID		
Secondary Duplicate ID		
Rinsate ID		
Rinsate Collected From		
Trip Blank ID		
Trip Blank Batch no./Expiry		
Trip Spike ID		
Trip Spike Batch no./Expiry		
Field Blank ID		
Field Blank Collected From		

SAMPLE CONTAINERS

Bottle Type	Number of bottles	Filtered or Unfiltered?	Preserved or Unpreserved?	Remarks

RINSATE & DI BATCH NUMBERS	
Volatiles Rinsate Water Batch No. and /or Date/Expiry Date	
Semi-volatiles Rinsate Water Batch No. and /or Date/Expiry Date	
Inorganics/Metals Rinsate Water Batch No. and /or Date/Expiry Date	
PFAS Rinsate Water Batch No. and / or Date/Expiry Date	

PURGING INFORMATION

Time	Cumulative Volume Purged (L)	Flow Rate (L/min)	Depth to GW (mbTOC)	Drawdown (m)	Temp. (°C) ±0.5	DO (mg/L) ±10%	Cond (µS/cm) ±5%	pH ±0.1	Redox (mV) ±10	Colour	Turbidity	Odour?	Odour Type	Sheen?	Sampling Row
09:50	1.0	0.2	22.85	0.0	15.7	82.6	7027	6.09	97.8	Grey	Low	No		No	No
10:12	2	0.2		23.101											
12:56	3	0.2	22.85	0	15.6	69.0	7026	6.23	67.7	Grey	Low	No		No	No
12:56	4	0.2	22.85	0	15.6	71	7121	6.21	79.1	Grey	Low	No		No	No
12:57	5	0.2	22.85	0	15.6	71	7121	6.21	80.4	Grey	Low	No		No	No

GROUNDWATER SAMPLING FORM
LOW FLOW PURGING and SAMPLING

PROJECT INFORMATION

WELL ID	NDT01	Project Number:	PS224394	Site Name:	McCrae landslide	Date:	06/17/2025
		Client:		Monitoring Round:	June	Sampled By:	Sb

WELL INFORMATION	
Casing diameter (mm)	
TOC height above/below ground level (m)	
Depth to top of filter pack from log (mbgl)	
Top of screen from log (mbgl)	
Bottom of screen from log (mbgl)	
Depth of well from log (mbgl)	
Depth to bottom of filter pack from log (mbgl)	

GAUGING INFORMATION (PRE-SAMPLING)	
PID Reading (ppm)	
Interface Probe Used?	
Initial Depth to Water (mbTOC)	
Depth to Product (mbTOC)	
Thickness of Product (m)	
Bailed Product Thickness (m)	
Measured Depth to Bottom of Well (mbTOC)	

LOW FLOW SAMPLING	
Depth of pump intake (mbTOC)	
Diameter of hose (inches)	
Length of hose above TOC (m)	
Volume in hose (L)	
Volume in casing per m screen (L)	
Meters of saturated screen	
Minimum Target Purge Vol (L)	
DTW after placement of pump (mbTOC)	
DTW at end of purging (mbTOC)	
DTW after collection of samples (mbTOC)	

WQM INFORMATION	
WQM Model	
WQM serial number	
WQM cal date and certificate	

CONTROLLER SETTINGS			
Controller - CPM	Controller - Refill	Controller - Discharge	Controller Throttle - Pressure (PSI)

Maintenance needed or other remarks	. Dry at 5.90

Samples Collected	Yes/No	Sample Id
Primary Sample ID	Yes	
Primary Duplicate ID		
Secondary Duplicate ID		
Rinsate ID		
Rinsate Collected From		
Trip Blank ID		
Trip Blank Batch no./Expiry		
Trip Spike ID		
Trip Spike Batch no./Expiry		
Field Blank ID		
Field Blank Collected From		

SAMPLE CONTAINERS				
Bottle Type	Number of bottles	Filtered or Unfiltered?	Preserved or Unpreserved?	Remarks

RINSATE & DI BATCH NUMBERS	
Volatiles Rinsate Water Batch No. and /or Date/Expiry Date	
Semi-volatiles Rinsate Water Batch No. and /or Date/Expiry Date	
Inorganics/Metals Rinsate Water Batch No. and /or Date/Expiry Date	
PFAS Rinsate Water Batch No. and / or Date/Expiry Date	

PURGING INFORMATION

Time	Cumulative Volume Purged (L)	Flow Rate (L/min)	Depth to GW (mbTOC)	Drawdown (m)	Temp. (°C) ±0.5	DO (mg/L) ±10%	Cond (µS/cm) ±5%	pH ±0.1	Redox (mV) ±10	Colour	Turbidity	Odour?	Odour Type	Sheen?	Sampling Row

Surface Water Sampling

PROJECT INFORMATION

Sampling Location	Pit01

Project Number: PS224394
Client:
Site Name: McCrae landslide
Project Name: McCrae Landslide
Monitoring Round: June
Sampled By (initials): Sb
Date: 06/16/2025

Weather Conditions	Sampling Method	WATER QUALITY PARAMETER READINGS						Location Type	Estimated Depth (m)	Estimated Width of SW Body (m)	Water Flow (L/Sec)	Comments
		pH	EC (uS/cm)	Temp. (°C)	Redox (mV)	DO (mg/L)	Turbidity (NTU)					
Cloudy|Partly Cloudy|Rain	Pole	6.11	409.9	16.5	60.4	30.9		Pit	2.2			Clear, colourless, low turb

WATER QUALITY METER RECORDS	
Make:	18g103115
Serial Number:	Ysi pro
Calibration Date:	06/19/2025
Calibration Certificate:	12 June - aurmet

Samples Collected	Yes/No	Sample ID
Primary Sample ID	Yes	Pit01/25160625
Primary Duplicate ID		
Secondary Duplicate ID		
Rinsate ID		
Rinsate Collected From		
Trip Blank ID		
Trip Blank Batch no./Expiry		
Trip Spike ID		
Trip Spike Batch no./Expiry		
Field Blank ID		
Field Blank Collected From		

SAMPLE CONTAINERS					
Containers	Analytes	Number of Containers	Filtered (F) or Unfiltered (UF)?	Preserved (P) or Unpreserved (UP)?	Comments
		6			

Photos

Surface Water Sampling

PROJECT INFORMATION

Sampling Location	pit02

Project Number: PS224394
Client:
Site Name: McCrae landslide
Project Name: McCrae Landslide
Monitoring Round:
Sampled By (initials): SB
Date: 06/16/2025

Weather Conditions	Sampling Method	WATER QUALITY PARAMETER READINGS						Location Type	Estimated Depth (m)	Estimated Width of SW Body (m)	Water Flow (L/Sec)	Comments
		pH	EC (uS/cm)	Temp. (°C)	Redox (mV)	DO (mg/L)	Turbidity (NTU)					
Partly Cloudy|Partly Sunny		7.45	159.7	15.4	11.8	67.5		Pit				3 m to water

WATER QUALITY METER RECORDS	
Make:	Ysi Pro
Serial Number:	18G103115
Calibration Date:	
Calibration Certificate:	Airmet

Samples Collected	Yes/No	Sample ID
Primary Sample ID	Yes	
Primary Duplicate ID		
Secondary Duplicate ID		
Rinsate ID		
Rinsate Collected From		
Trip Blank ID		
Trip Blank Batch no./Expiry		
Trip Spike ID		
Trip Spike Batch no./Expiry		
Field Blank ID		
Field Blank Collected From		

SAMPLE CONTAINERS					
Containers	Analytes	Number of Containers	Filtered (F) or Unfiltered (UF)?	Preserved (P) or Unpreserved (UP)?	Comments

Photos

Surface Water Sampling

PROJECT INFORMATION

Sampling Location	pit03

Project Number: PS224394
Client:
Site Name: McCrae landslide
Project Name: McCrae Landslide
Monitoring Round: June
Sampled By (initials): SB
Date: 06/16/2025

Weather Conditions	Sampling Method	WATER QUALITY PARAMETER READINGS						Location Type	Estimated Depth (m)	Estimated Width of SW Body (m)	Water Flow (L/Sec)	Comments
		pH	EC (uS/cm)	Temp. (°C)	Redox (mV)	DO (mg/L)	Turbidity (NTU)					
Cloudy|Partly Cloudy|Rain	Pole	7.22	109.4	15.5	-5.5	84.8		Pit	1.901			Light grey, low turn, odourless

WATER QUALITY METER RECORDS	
Make:	Ysi pro
Serial Number:	18G103115
Calibration Date:	
Calibration Certificate:	Airmet

Samples Collected	Yes/No	Sample ID
Primary Sample ID	Yes	Pit03/25160625
Primary Duplicate ID		
Secondary Duplicate ID		
Rinsate ID		
Rinsate Collected From		
Trip Blank ID		
Trip Blank Batch no./Expiry		
Trip Spike ID		
Trip Spike Batch no./Expiry		
Field Blank ID		
Field Blank Collected From		

SAMPLE CONTAINERS					
Containers	Analytes	Number of Containers	Filtered (F) or Unfiltered (UF)?	Preserved (P) or Unpreserved (UP)?	Comments

Photos

Surface Water Sampling

PROJECT INFORMATION

Sampling Location	pit04

Project Number: PS224394
Client:
Site Name: McCrae landslide
Project Name: McCrae Landslide
Monitoring Round:
Sampled By (initials): SB
Date: 06/16/2025

Weather Conditions	Sampling Method	pH	EC (uS/cm)	Temp. (°C)	Redox (mV)	DO (mg/L)	Turbidity (NTU)	Location Type	Estimated Depth (m)	Estimated Width of SW Body (m)	Water Flow (L/Sec)	Comments
Partly Sunny| Partly Cloudy	Pole	7.86	410.9	14.5	64.4	73.9		Pit	1.95			Grey, low- med turb, odourless

The pH to Turbidity (NTU) columns come under the heading WATER QUALITY PARAMETER READINGS.

WATER QUALITY METER RECORDS	
Make:	Ysi pro
Serial Number:	18G103115
Calibration Date:	
Calibration Certificate:	Airmet

Samples Collected	Yes/No	Sample ID
Primary Sample ID	Yes	Pit04/25160625
Primary Duplicate ID		
Secondary Duplicate ID		
Rinsate ID		
Rinsate Collected From		
Trip Blank ID		
Trip Blank Batch no./Expiry		
Trip Spike ID		
Trip Spike Batch no./Expiry		
Field Blank ID		
Field Blank Collected From		

SAMPLE CONTAINERS					
Containers	Analytes	Number of Containers	Filtered (F) or Unfiltered (UF)?	Preserved (P) or Unpreserved (UP)?	Comments

Photos

Surface Water Sampling

PROJECT INFORMATION

Sampling Location	sw02

Project Number: PS224394
Client:

Site Name: McCrae landslide
Project Name: McCrae Landslide

Monitoring Round: June
Sampled By (initials): SB
Date: 06/18/2025

Weather Conditions	Sampling Method
Partly Sunny| Partly Cloudy	Direct to Bottle

WATER QUALITY PARAMETER READINGS						Location Type	Estimated Depth (m)	Estimated Width of SW Body (m)	Water Flow (L/Sec)	Comments
pH	EC (uS/cm)	Temp. (°C)	Redox (mV)	DO (mg/L)	Turbidity (NTU)					
6.85	578	15.8	49.1	65.0		Pit				Grey, low turb, odourless

WATER QUALITY METER RECORDS	
Make:	YSI Pro
Serial Number:	18G103115
Calibration Date:	06/19/2025
Calibration Certificate:	Airmet

Samples Collected	Yes/No	Sample ID
Primary Sample ID	Yes	SW03/25180625
Primary Duplicate ID		
Secondary Duplicate ID		
Rinsate ID		
Rinsate Collected From		
Trip Blank ID		
Trip Blank Batch no./Expiry		
Trip Spike ID		
Trip Spike Batch no./Expiry		
Field Blank ID		
Field Blank Collected From		

SAMPLE CONTAINERS					
Containers	Analytes	Number of Containers	Filtered (F) or Unfiltered (UF)?	Preserved (P) or Unpreserved (UP)?	Comments

Photos

Surface Water Sampling

PROJECT INFORMATION

Sampling Location	SW03

Project Number: PS224394
Client:
Site Name: McCrae landslide
Project Name: McCrae Landslide
Monitoring Round: June
Sampled By (initials): SB
Date: 06/18/2025

Weather Conditions	Sampling Method	WATER QUALITY PARAMETER READINGS						Location Type	Estimated Depth (m)	Estimated Width of SW Body (m)	Water Flow (L/Sec)	Comments
		pH	EC (uS/cm)	Temp. (°C)	Redox (mV)	DO (mg/L)	Turbidity (NTU)					
Cloudy|Partly Sunny	Direct to Bottle	7.7	510	14.5	42.2	88.6		Pit				Light grey, low turb, odourless

WATER QUALITY METER RECORDS	
Make:	ysi pro
Serial Number:	18G103115
Calibration Date:	06/19/2025
Calibration Certificate:	Airmet

Samples Collected	Yes/No	Sample ID
Primary Sample ID	Yes	SW03/25180625
Primary Duplicate ID		
Secondary Duplicate ID		
Rinsate ID		
Rinsate Collected From		
Trip Blank ID		
Trip Blank Batch no./Expiry		
Trip Spike ID		
Trip Spike Batch no./Expiry		
Field Blank ID		
Field Blank Collected From		

SAMPLE CONTAINERS					
Containers	Analytes	Number of Containers	Filtered (F) or Unfiltered (UF)?	Preserved (P) or Unpreserved (UP)?	Comments

Photos

Surface Water Sampling

PROJECT INFORMATION

Sampling Location	SW04

Project Number: PS224394
Client:
Site Name: McCrae landslide
Project Name: McCrae Landslide
Monitoring Round:
Sampled By (initials): SB
Date: 06/18/2025

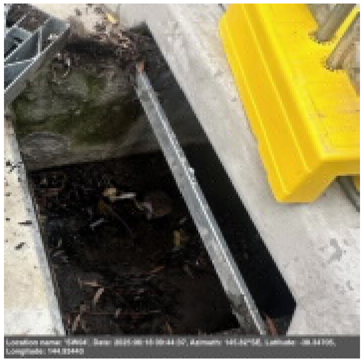
Weather Conditions	Sampling Method	WATER QUALITY PARAMETER READINGS						Location Type	Estimated Depth (m)	Estimated Width of SW Body (m)	Water Flow (L/Sec)	Comments
		pH	EC (uS/cm)	Temp. (°C)	Redox (mV)	DO (mg/L)	Turbidity (NTU)					
Partly Cloudy| Partly Sunny	Direct to Bottle	8.08	520	12.6	35.8	90.9		Pit				Clear, colourless, low turn, odourless

WATER QUALITY METER RECORDS	
Make:	Ysi pro
Serial Number:	18G103115
Calibration Date:	06/18/2025
Calibration Certificate:	Sb.18.6.25

Samples Collected	Yes/No	Sample ID
Primary Sample ID	Yes	
Primary Duplicate ID		
Secondary Duplicate ID		
Rinsate ID		
Rinsate Collected From		
Trip Blank ID		
Trip Blank Batch no./Expiry		
Trip Spike ID		
Trip Spike Batch no./Expiry		
Field Blank ID		
Field Blank Collected From		

SAMPLE CONTAINERS					
Containers	Analytes	Number of Containers	Filtered (F) or Unfiltered (UF)?	Preserved (P) or Unpreserved (UP)?	Comments

Photos



Surface Water Sampling

PROJECT INFORMATION

Sampling Location	SW08

Project Number: PS224394
Client:
Site Name: McCrae landslide
Project Name: McCrae Landslide
Monitoring Round:
Sampled By (initials): SB
Date: 06/20/2025

Weather Conditions	Sampling Method	WATER QUALITY PARAMETER READINGS						Location Type	Estimated Depth (m)	Estimated Width of SW Body (m)	Water Flow (L/Sec)	Comments
		pH	EC (uS/cm)	Temp. (°C)	Redox (mV)	DO (mg/L)	Turbidity (NTU)					
Partly Cloudy| Partly Sunny	Direct to Bottle	7.31	329.2	15.4	52.8	75.0		Tank				Clear/slight brown colour, low turb, odourless

WATER QUALITY METER RECORDS	
Make:	Ysi pro
Serial Number:	18g103112
Calibration Date:	
Calibration Certificate:	Airmet

Samples Collected	Yes/No	Sample ID
Primary Sample ID	Yes	SW08/25200625
Primary Duplicate ID	Yes	SW08/28200625
Secondary Duplicate ID	Yes	SW08/29200625
Rinsate ID		
Rinsate Collected From		
Trip Blank ID		
Trip Blank Batch no./Expiry		
Trip Spike ID		
Trip Spike Batch no./Expiry		
Field Blank ID		
Field Blank Collected From		

SAMPLE CONTAINERS					
Containers	Analytes	Number of Containers	Filtered (F) or Unfiltered (UF)?	Preserved (P) or Unpreserved (UP)?	Comments

Photos

Surface Water Sampling

PROJECT INFORMATION

Sampling Location	SW09

Project Number: PS224394
Client:
Site Name: McCrae landslide
Project Name: McCrae Landslide
Monitoring Round:
Sampled By (initials): SB
Date: 06/22/2025

Weather Conditions	Sampling Method	WATER QUALITY PARAMETER READINGS						Location Type	Estimated Depth (m)	Estimated Width of SW Body (m)	Water Flow (L/Sec)	Comments
		pH	EC (uS/cm)	Temp. (°C)	Redox (mV)	DO (mg/L)	Turbidity (NTU)					
Partly Cloudy| Partly Sunny	Direct to Bottle	4.50	287.0	17.1	127.7	80.0		Tank				Brown, odourless, low turb

WATER QUALITY METER RECORDS	
Make:	Ysi pro
Serial Number:	18G103112
Calibration Date:	
Calibration Certificate:	Airmet

Samples Collected	Yes/No	Sample ID
Primary Sample ID	Yes	
Primary Duplicate ID		
Secondary Duplicate ID		
Rinsate ID		
Rinsate Collected From		
Trip Blank ID		
Trip Blank Batch no./Expiry		
Trip Spike ID		
Trip Spike Batch no./Expiry		
Field Blank ID		
Field Blank Collected From		

SAMPLE CONTAINERS					
Containers	Analytes	Number of Containers	Filtered (F) or Unfiltered (UF)?	Preserved (P) or Unpreserved (UP)?	Comments

Photos

Water Quality Meter
Calibration Form

PROJECT INFORMATION

Client	
Site Name	Mccrae landslide
Project Number	PS224394
Project Name	McCrae Landslide
Date and Time	06/22/2025 11:04

WATER QUALITY METER INFORMATION

Supplier	Air-Met
WQM make and model	Ysi pro
WQM serial number	18g103115
Calibration certificate number	Sb.18.6.25
Check performed by	SB

Parameter	Standard Solution	Pre-calibrating reading	Acceptable Range	Calibration Required (Y/N)	Post Calibration Reading
Temperature	°C	13.2	-	-	-
pH	4	3.98	3.9 - 4.1	YES	
	7	7.16	6.9 - 7.1	NO	7.02
	10		9.9 - 10.1		
Conductivity	0	1987	0.0 - 0.1 mS/cm	NO	2699
	@ 13.2 °C		± 5%		
	NA @ 13.2 °C		± 5%		
Dissoved Oxygen	0% Saturation Solution	0.0	± 0.1 ppm	YES	
			± 0.5 ppm of value on Table A		
Redox	233.3 mV	232.1	± 10 mV	YES	

Table A - Change in Dissolved Oxygen with Temperature at 100% Relative Humidity (Altitude: sea level)

Temperature (°C)	DO (100%, ppm, mg/L)	Temperature (°C)	DO (100%, ppm, mg/L)
0	14.6	17	9.65
1	14.19	18	9.45
2	13.81	19	9.26
3	13.44	20	9.07
4	13.09	21	8.9
5	12.75	22	8.72
6	12.43	23	8.56
7	12.12	24	8.4
8	11.83	25	8.24
9	11.55	26	8.09
10	11.27	27	7.95
11	11.01	28	7.81
12	10.76	29	7.67
13	10.52	30	7.54
14	10.29	31	7.41
15	10.07	32	7.28
16	9.85		

Values are for pressure = 760 mm Hg for measurements at sea level

For a given temperature, the concentration of dissolved oxygen decreases by 3 mg/L with every 152.4 m (500 ft) increase in altitude

Comments	

Water Quality Meter Calibration Form

PROJECT INFORMATION

Client	
Site Name	McCrae landslide
Project Number	PS224394
Project Name	McCrae Landslide
Date and Time	06/19/2025 12:59

WATER QUALITY METER INFORMATION

Supplier	Air-Met
WQM make and model	Ysi pro
WQM serial number	18G103115
Calibration certificate number	Sb.17.6.25
Check performed by	Sb

Parameter	Standard Solution	Pre-calibrating reading	Acceptable Range	Calibration Required (Y/N)	Post Calibration Reading
Temperature	°C	14.5	-	-	-
pH	4	4.02	3.9 - 4.1	NO	
	7	7.08	6.9 - 7.1	NO	
	10		9.9 - 10.1		
Conductivity	0	2678	0.0 - 0.1 mS/cm	NO	
	@ 14.5 °C		± 5%		
	NA @ 14.5 °C		± 5%		
Dissoved Oxygen	0% Saturation Solution	0.01	± 0.1 ppm		
			± 0.5 ppm of value on Table A		
Redox	238.7 mV	236.5	± 10 mV	NO	

Table A - Change in Dissolved Oxygen with Temperature at 100% Relative Humidity (Altitude: sea level)

Temperature (°C)	DO (100%, ppm, mg/L)	Temperature (°C)	DO (100%, ppm, mg/L)
0	14.6	17	9.65
1	14.19	18	9.45
2	13.81	19	9.26
3	13.44	20	9.07
4	13.09	21	8.9
5	12.75	22	8.72
6	12.43	23	8.56
7	12.12	24	8.4
8	11.83	25	8.24
9	11.55	26	8.09
10	11.27	27	7.95
11	11.01	28	7.81
12	10.76	29	7.67
13	10.52	30	7.54
14	10.29	31	7.41
15	10.07	32	7.28
16	9.85		

Values are for pressure = 760 mm Hg for measurements at sea level

For a given temperature, the concentration of dissolved oxygen decreases by 3 mg/L with every 152.4 m (500 ft) increase in altitude

Comments	

Multi Parameter Water Meter 157.0 1262025M

Instrument YSI Pro Plus
Serial No. 18G103115

airmet
Air-Met Scientific Pty Ltd
1800 000 744

Item	Test	Pass	Comments
Battery	Charge Condition	✓	
	Fuses	✓	
	Capacity	✓	
Switch/keypad	Operation	✓	
Display	Intensity	✓	
	Operation (segments)	✓	
Grill Filter	Condition	✓	
	Seal	✓	
PCB	Condition	✓	
Connectors	Condition	✓	
Sensor	1. pH	✓	
	2. mV	✓	
	3. EC	✓	
	4. D.O	✓	
	5. Temp	✓	
Alarms	Beeper		
	Settings		
Software	Version		
Data logger	Operation		
Download	Operation		
Other tests:			

Certificate of Calibration

This is to certify that the aboveinstrument has been calibrated to the following specifications:

Sensor	Serial no	Standard Solutions	Certified	Solution Bottle Number	Instrument Reading
1. D.O		0%		391223	0%
2. Conductivity		2760µS		401089	2760µS
3. pH7		pH 7		399304	pH 7
4. pH4		pH 4		399527	pH 4
5. Temp °C		15°C		MultTherm	15°C
6. ORP mV		245mV		MultTherm	245mV

Calibrated by: Harrison Meers

Calibration date: 12-Jun-25

Next calibration due: 09-Dec-25

Multi Parameter Water Meter 190.0 1662025M

Instrument **YSI Pro Plus**
Serial No. **18G103112**

airmet
Air-Met Scientific Pty Ltd
1800 000 744

Item	Test	Pass	Comments
Battery	Charge Condition	✓	
	Fuses	✓	
	Capacity	✓	
Switch/keypad	Operation	✓	
Display	Intensity	✓	
	Operation (segments)	✓	
Grill Filter	Condition	✓	
	Seal	✓	
PCB	Condition	✓	
Connectors	Condition	✓	
Sensor	1. pH	✓	
	2. mV	✓	
	3. EC	✓	
	4. D.O	✓	
	5. Temp	✓	
Alarms	Beeper		
	Settings		
Software	Version		
Data logger	Operation		
Download	Operation		
Other tests:			

Certificate of Calibration

This is to certify that the above instrument has been calibrated to the following specifications:

Sensor	Serial no	Standard Solutions	Certified	Solution Bottle Number	Instrument Reading
1. D.O		0ppm		391223	0ppm
2. Conductivity		2760µS		401089	2760µS
3. pH7		pH 7		399304	pH 7
4. pH4		pH 4		399527	pH 4
5. Temp °C		19.4°C		MultTherm	19.4°C
6. ORP mV		235.32mV		MultTherm	235.32mV

Calibrated by: Rebecca Massoud

Calibration date: **16-Jun-25**

Next calibration due: **13-Dec-25**

Appendix E

Water Sampling Results

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Certificate of Analysis

WSP Australia P/L MELB
Level 11, 567 Collins Street
Melbourne
VIC 3000

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025 – Testing
NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates.

Attention: **Hong Vu**

Report **1235266-W**
Project name McCrae Landslide
Project ID PS224394
Received Date Jun 23, 2025

Client Sample ID			**SW08/29200625**
Sample Matrix			**Water**
Eurofins Sample No.			**M25-Jn0058408**
Date Sampled			**Jun 20, 2025**
Test/Reference	LOR	Unit	
Bromide	1	mg/L	< 1
Chloride	1	mg/L	260
Conductivity (at 25 °C)	10	uS/cm	310
Cyanide (total)	0.005	mg/L	0.011
Fluoride	0.5	mg/L	< 0.5
Nitrate (as N)	0.02	mg/L	2.0
pH (at 25 °C)	0.1	pH Units	4.2
Phosphorus reactive (as P)	0.01	mg/L	0.02
Sulphate (as SO4)	5	mg/L	15
Total Dissolved Solids Dried at 180 °C ± 2 °C	10	mg/L	170
Total Organic Carbon	5	mg/L	< 5
Phosphate total (as P)	0.01	mg/L	0.02
Silica (calculation from Si as SiO2)	0.5	mg/L	< 0.5
Alkalinity (speciated)			
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	< 20
Heavy Metals			
Aluminium	0.05	mg/L	< 0.05
Arsenic (filtered)	0.001	mg/L	0.029
Beryllium (filtered)	0.001	mg/L	< 0.001
Boron (filtered)	0.05	mg/L	< 0.05
Cadmium (filtered)	0.0002	mg/L	< 0.0002
Chromium (filtered)	0.001	mg/L	0.013
Cobalt (filtered)	0.001	mg/L	< 0.001
Copper (filtered)	0.001	mg/L	0.002
Iron	0.05	mg/L	< 0.05
Lead (filtered)	0.001	mg/L	0.010
Manganese	0.005	mg/L	0.044
Manganese (filtered)	0.005	mg/L	0.043
Mercury (filtered)	0.0001	mg/L	< 0.0001
Molybdenum (filtered)	0.005	mg/L	< 0.005
Nickel (filtered)	0.001	mg/L	< 0.001
Selenium (filtered)	0.001	mg/L	< 0.001
Silver (filtered)	0.005	mg/L	< 0.005
Tin (filtered)	0.005	mg/L	< 0.005

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Client Sample ID			SW08/2920062 5
Sample Matrix			Water
Eurofins Sample No.			M25-Jn0058408
Date Sampled			Jun 20, 2025
Test/Reference	LOR	Unit	
Heavy Metals			
Vanadium (filtered)	0.005	mg/L	< 0.005
Zinc (filtered)	0.005	mg/L	0.26
Alkali Metals			
Calcium	0.5	mg/L	4.3
Magnesium	0.5	mg/L	5.1
Potassium	0.5	mg/L	2.9
Sodium	0.5	mg/L	41

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Sample History

Where samples are submitted/analysed over several days, the last date of extraction is reported.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Bromide	Melbourne	Jun 24, 2025	28 Days
- Method: LTM-INO-4270 Anions by Ion Chromatography			
Chloride	Melbourne	Jun 24, 2025	28 Days
- Method: LTM-INO-4090 Chloride by Discrete Analyser			
Conductivity (at 25 °C)	Melbourne	Jun 24, 2025	28 Days
- Method: LTM-INO-4030 Conductivity			
Cyanide (total)	Melbourne	Jun 24, 2025	14 Days
- Method: LTM-INO-4020 Total Free WAD Cyanide by CFA			
Fluoride	Melbourne	Jun 24, 2025	28 Days
- Method: LTM-INO-4270 Anions by Ion Chromatography			
Nitrate (as N)	Melbourne	Jun 24, 2025	28 Days
- Method: LTM-INO-4450 Nitrogens by Discrete Analyser			
pH (at 25 °C)	Melbourne	Jun 24, 2025	6 Hours
- Method: LTM-GEN-7090 pH in water by ISE			
Phosphorus reactive (as P)	Melbourne	Jun 24, 2025	2 Days
- Method: APHA 4500-P			
Sulphate (as SO4)	Melbourne	Jun 24, 2025	28 Days
- Method: LTM-INO-4110 Sulfate by Discrete Analyser			
Total Organic Carbon	Melbourne	Jun 24, 2025	28 Days
- Method: LTM-INO-4060 Total Organic Carbon in water and soil			
Phosphate total (as P)	Melbourne	Jun 24, 2025	28 Days
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Silica (calculation from Si as SiO2)	Melbourne	Jun 24, 2025	28 Days
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Alkalinity (speciated)	Melbourne	Jun 24, 2025	14 Days
- Method: LTM-INO-4250 Alkalinity by Electrometric Titration			
Heavy Metals	Melbourne	Jun 24, 2025	28 Days
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Heavy Metals (filtered)	Melbourne	Jun 24, 2025	180 Days
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Mobil Metals : Metals M15	Melbourne	Jun 24, 2025	28 Days
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Alkali Metals	Melbourne	Jun 24, 2025	180 Days
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Total Dissolved Solids Dried at 180 °C ± 2 °C	Melbourne	Jun 24, 2025	28 Days
- Method: LTM-INO-4170 Total Dissolved Solids in Water			

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web: www.eurofins.com.au
email: EnviroSales@eurofinsanz.com

Eurofins Environment Testing Australia Pty Ltd
ABN: 50 005 085 521

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Brisbane 1/21 Smallwood Place Murarrie QLD 4172 +61 7 3902 4600 NATA# 1261 Site# 20794 & 2780
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Tauranga 1277 Cameron Road Gate Pa Tauranga 3112 +64 9 525 0568 IANZ# 1402

Company Name: WSP Australia P/L MELB
Address: Level 11, 567 Collins Street
Melbourne
VIC 3000

Project Name: McCrae Landslide
Project ID: PS224394

Order No.:
Report #: 1235266
Phone: 9861 1111
Fax: 9861 1144

Received: Jun 23, 2025 1:28 PM
Due: Jun 30, 2025
Priority: 5 Day
Contact Name: Hong Vu

Eurofins Analytical Services Manager : Harry Bacalis

Sample Detail						Aluminium	Arsenic (filtered)	Beryllium (filtered)	Bicarbonate Alkalinity (as CaCO3)	Boron (filtered)	Bromide	Cadmium (filtered)	Calcium	Chloride	Chromium (filtered)	Cobalt (filtered)	Conductivity (at 25 °C)	Copper (filtered)	Cyanide (total)	Fluoride	Iron	Lead (filtered)	Magnesium	Manganese	Manganese (filtered)	Mercury (filtered)	Molybdenum (filtered)	Nickel (filtered)	Nitrate (as N)	pH (at 25 °C)	Phosphate total (as P)	Phosphorus reactive (as P)	Potassium	Selenium (filtered)	Silica (calculation from Si as SiO2)	Silver (filtered)	Sodium	Sulphate (as SO4)	Tin (filtered)	Total Organic Carbon	Vanadium (filtered)	Zinc (filtered)	Total Dissolved Solids Dried at 180 °C ± 2 °C
Melbourne Laboratory - NATA # 1261 Site # 1254						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
External Laboratory																																											
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**																																						
1	SW08/29200625	Jun 20, 2025	11:45AM	Water	M25-Jn0058408	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Test Counts						1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

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Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follow guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013. They are included in this QC report where applicable. Additional QC data may be available on request.
2. Unless otherwise stated, all soil/sediment/solid results are reported on a dry weight basis.
3. Unless otherwise stated, all biota/food results are reported on a wet weight basis on the edible portion.
4. For CEC results where the sample's origin is unknown or environmentally contaminated, the results should be used advisedly.
5. Actual LORs are matrix dependent. Quoted LORs may be raised where sample extracts are diluted due to interferences.
6. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds where annotated.
7. SVOC analysis on waters is performed on homogenised, unfiltered samples unless noted otherwise.
8. Samples were analysed on an 'as received' basis.
9. Information identified in this report with blue colour indicates data provided by customers that may have an impact on the results.
10. This report replaces any interim results previously issued.

Holding Times

Please refer to the 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours before sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and despite any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the sampling date; therefore, compliance with these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether, the holding time is seven days; however, for all other VOCs, such as BTEX or C6-10 TRH, the holding time is 14 days.

Units

mg/kg: milligrams per kilogram	**mg/L:** milligrams per litre	**ppm:** parts per million
µg/L: micrograms per litre	**ppb:** parts per billion	**%:** Percentage
org/100 mL: Organisms per 100 millilitres	**NTU:** Nephelometric Turbidity Units	**MPN/100 mL:** Most Probable Number of organisms per 100 millilitres
CFU: Colony Forming Unit	**Colour:** Pt-Co Units (CU)	

Terms

APHA	American Public Health Association
CEC	Cation Exchange Capacity
COC	Chain of Custody
CP	Client Parent - QC was performed on samples pertaining to this report
CRM	Certified Reference Material (ISO17034) - reported as percent recovery.
Dry	Where moisture has been determined on a solid sample, the result is expressed on a dry weight basis.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
LOR	Limit of Reporting.
LCS	Laboratory Control Sample - reported as percent recovery.
Method Blank	In the case of solid samples, these are performed on laboratory-certified clean sands and in the case of water samples, these are performed on de-ionised water.
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC represents the sequence or batch that client samples were analysed within.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
SRA	Sample Receipt Advice
Surr - Surrogate	The addition of a similar compound to the analyte target is reported as percentage recovery. See below for acceptance criteria.
TBTO	Tributyltin oxide (*bis*-tributyltin oxide) - individual tributyltin compounds cannot be identified separately in the environment; however, free tributyltin was measured, and its values were converted stoichiometrically into tributyltin oxide for comparison with regulatory limits.
TCLP	Toxicity Characteristic Leaching Procedure
TEQ	Toxic Equivalency Quotient or Total Equivalence
QSM	US Department of Defense Quality Systems Manual Version 6.0
US EPA	United States Environmental Protection Agency
WA DWER	Sum of PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC - Acceptance Criteria

The acceptance criteria should only be used as a guide and may be different when site-specific Sampling Analysis and Quality Plan (SAQP) have been implemented.

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is ≤30%; however, the following acceptance guidelines are equally applicable:

Results <10 times the LOR:	No Limit
Results between 10-20 times the LOR:	RPD must lie between 0-50%
Results >20 times the LOR:	RPD must lie between 0-30%

NOTE: pH duplicates are reported as a range, not as RPD

Surrogate Recoveries: Recoveries must lie between 20-130% for Speciated Phenols & 50-150% for PFAS. SVOCs recoveries 20 – 150%, VOC recoveries 50 – 150%

PFAS field samples containing surrogate recoveries above the QC limit designated in QSM 6.0, where no positive PFAS results have been reported or reviewed, and no data was affected.

QC Data General Comments

1. Where a result is reported as less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown are not data from your samples.
3. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling. Therefore, laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
4. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of recovery, the term "INT" appears against that analyte.
5. For Matrix Spikes and LCS results, a dash "-" in the report means that the specific analyte was not added to the QC sample.
6. Duplicate RPDs are calculated from raw analytical data; thus, it is possible to have two sets of data.

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Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Bromide	mg/L	< 1			1	Pass	
Chloride	mg/L	< 1			1	Pass	
Conductivity (at 25 °C)	uS/cm	< 10			10	Pass	
Cyanide (total)	mg/L	< 0.005			0.005	Pass	
Fluoride	mg/L	< 0.5			0.5	Pass	
Nitrate (as N)	mg/L	< 0.02			0.02	Pass	
Phosphorus reactive (as P)	mg/L	< 0.01			0.01	Pass	
Sulphate (as SO4)	mg/L	< 5			5	Pass	
Total Dissolved Solids Dried at 180 °C ± 2 °C	mg/L	< 10			10	Pass	
Total Organic Carbon	mg/L	< 5			5	Pass	
Phosphate total (as P)	mg/L	< 0.01			0.01	Pass	
Method Blank							
Heavy Metals							
Aluminium	mg/L	< 0.05			0.05	Pass	
Arsenic (filtered)	mg/L	< 0.001			0.001	Pass	
Beryllium (filtered)	mg/L	< 0.001			0.001	Pass	
Boron (filtered)	mg/L	< 0.05			0.05	Pass	
Cadmium (filtered)	mg/L	< 0.0002			0.0002	Pass	
Chromium (filtered)	mg/L	< 0.001			0.001	Pass	
Cobalt (filtered)	mg/L	< 0.001			0.001	Pass	
Copper (filtered)	mg/L	< 0.001			0.001	Pass	
Iron	mg/L	< 0.05			0.05	Pass	
Lead (filtered)	mg/L	< 0.001			0.001	Pass	
Manganese	mg/L	< 0.005			0.005	Pass	
Manganese (filtered)	mg/L	< 0.005			0.005	Pass	
Mercury (filtered)	mg/L	< 0.0001			0.0001	Pass	
Molybdenum (filtered)	mg/L	< 0.005			0.005	Pass	
Nickel (filtered)	mg/L	< 0.001			0.001	Pass	
Selenium (filtered)	mg/L	< 0.001			0.001	Pass	
Silver (filtered)	mg/L	< 0.005			0.005	Pass	
Tin (filtered)	mg/L	< 0.005			0.005	Pass	
Vanadium (filtered)	mg/L	< 0.005			0.005	Pass	
Zinc (filtered)	mg/L	< 0.005			0.005	Pass	
Method Blank							
Alkali Metals							
Calcium	mg/L	< 0.5			0.5	Pass	
Magnesium	mg/L	< 0.5			0.5	Pass	
Potassium	mg/L	< 0.5			0.5	Pass	
Sodium	mg/L	< 0.5			0.5	Pass	
LCS - % Recovery							
Bromide	%	101			70-130	Pass	
Chloride	%	96			70-130	Pass	
Conductivity (at 25 °C)	%	95			70-130	Pass	
Cyanide (total)	%	98			70-130	Pass	
Fluoride	%	83			70-130	Pass	
Phosphorus reactive (as P)	%	95			70-130	Pass	
Sulphate (as SO4)	%	107			70-130	Pass	
Total Dissolved Solids Dried at 180 °C ± 2 °C	%	93			70-130	Pass	
Total Organic Carbon	%	94			70-130	Pass	
Phosphate total (as P)	%	94			70-130	Pass	
LCS - % Recovery							

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Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Heavy Metals									
Aluminium			%	115			80-120	Pass	
Iron			%	113			80-120	Pass	
Manganese			%	113			80-120	Pass	
LCS - % Recovery									
Alkali Metals									
Calcium			%	96			80-120	Pass	
Magnesium			%	95			80-120	Pass	
Potassium			%	98			80-120	Pass	
Sodium			%	94			80-120	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Spike - % Recovery									
				Result 1					
Chloride	M25-Jn0063409	NCP	%	96			70-130	Pass	
Sulphate (as SO4)	M25-Jn0056808	NCP	%	73			70-130	Pass	
Total Organic Carbon	L25-Jn0061078	NCP	%	98			70-130	Pass	
Phosphate total (as P)	M25-Jn0058585	NCP	%	108			70-130	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Aluminium	M25-Jn0069640	NCP	%	99			75-125	Pass	
Iron	M25-Jn0069640	NCP	%	95			75-125	Pass	
Manganese	M25-Jn0069640	NCP	%	98			75-125	Pass	
Spike - % Recovery									
Alkali Metals				Result 1					
Calcium	M25-Jn0057571	NCP	%	108			75-125	Pass	
Magnesium	M25-Jn0057571	NCP	%	109			75-125	Pass	
Potassium	M25-Jn0062742	NCP	%	115			75-125	Pass	
Sodium	M25-Jn0057571	NCP	%	105			75-125	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
				Result 1	Result 2	RPD			
Chloride	M25-Jn0063421	NCP	mg/L	810	72	11	30%	Pass	
Conductivity (at 25 °C)	M25-Jn0065116	NCP	uS/cm	74	74	1.0	30%	Pass	
Cyanide (total)	M25-Jn0056611	NCP	mg/L	0.021	0.020	2.0	30%	Pass	
pH (at 25 °C)	M25-Jn0065116	NCP	pH Units	7.4	7.4	PASS	30%	Pass	
Sulphate (as SO4)	M25-Jn0063421	NCP	mg/L	490	50	2.0	30%	Pass	
Total Dissolved Solids Dried at 180 °C ± 2 °C	M25-Jn0060584	NCP	mg/L	130	120	4.0	30%	Pass	
Total Organic Carbon	L25-Jn0061077	NCP	mg/L	< 5	< 5	<1	30%	Pass	
Phosphate total (as P)	M25-Jn0062729	NCP	mg/L	0.02	0.02	5.0	30%	Pass	
Duplicate									
Alkalinity (speciated)				Result 1	Result 2	RPD			
Bicarbonate Alkalinity (as CaCO3)	M25-Jn0059532	NCP	mg/L	820	780	4.0	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Aluminium	M25-Jn0069640	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Iron	M25-Jn0069640	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Manganese	M25-Jn0069640	NCP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Duplicate									
Alkali Metals				Result 1	Result 2	RPD			
Calcium	M25-Jn0062742	NCP	mg/L	270	270	<1	30%	Pass	
Magnesium	M25-Jn0062742	NCP	mg/L	730	720	<1	30%	Pass	
Potassium	M25-Jn0062742	NCP	mg/L	58	57	<1	30%	Pass	
Sodium	M25-Jn0062742	NCP	mg/L	3900	3900	1.0	30%	Pass	

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Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
Q08	The matrix spike recovery is outside of the recommended acceptance criteria. An acceptable recovery was obtained for the laboratory control sample indicating a sample matrix interference.

Authorised by:

Catherine Wilson	Analytical Services Manager
Emily Rosenberg	Senior Analyst-Metal
Luke Holt	Senior Analyst-Inorganic
Mary Makarios	Senior Analyst-Inorganic
Mary Makarios	Senior Analyst-Metal

Irrelevant & Sensitive

Glenn Jackson
Managing Director

Final Report – this report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

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Certificate of Analysis

WSP Australia P/L MELB
Level 11, 567 Collins Street
Melbourne
VIC 3000

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025 – Testing
NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates.

Attention:	**Hong Vu**
Report	**1235266-W-V2**
Project name	McCrae Landslide
Project ID	PS224394
Received Date	Jun 23, 2025

Client Sample ID			**SW08/29200625**
Sample Matrix			**Water**
Eurofins Sample No.			**M25-Jn0058408**
Date Sampled			**Jun 20, 2025**
Test/Reference	LOR	Unit	
Bromide	1	mg/L	< 1
Chloride	1	mg/L	56
Conductivity (at 25 °C)	10	uS/cm	310
Cyanide (total)	0.005	mg/L	0.011
Fluoride	0.5	mg/L	< 0.5
Nitrate (as N)	0.02	mg/L	2.0
pH (at 25 °C)	0.1	pH Units	4.2
Phosphorus reactive (as P)	0.01	mg/L	0.02
Sulphate (as SO4)	5	mg/L	15
Total Dissolved Solids Dried at 180 °C ± 2 °C	10	mg/L	170
Total Organic Carbon	5	mg/L	< 5
Phosphate total (as P)	0.01	mg/L	0.02
Silica (calculation from Si)	0.1	mg/L	0.5
Alkalinity (speciated)			
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	< 20
Heavy Metals			
Aluminium	0.05	mg/L	< 0.05
Arsenic (filtered)	0.001	mg/L	0.029
Beryllium (filtered)	0.001	mg/L	< 0.001
Boron (filtered)	0.05	mg/L	< 0.05
Cadmium (filtered)	0.0002	mg/L	< 0.0002
Chromium (filtered)	0.001	mg/L	0.013
Cobalt (filtered)	0.001	mg/L	< 0.001
Copper (filtered)	0.001	mg/L	0.002
Iron	0.05	mg/L	< 0.05
Lead (filtered)	0.001	mg/L	0.010
Manganese	0.005	mg/L	0.044
Manganese (filtered)	0.005	mg/L	0.043
Mercury (filtered)	0.0001	mg/L	< 0.0001
Molybdenum (filtered)	0.005	mg/L	< 0.005
Nickel (filtered)	0.001	mg/L	< 0.001
Selenium (filtered)	0.001	mg/L	< 0.001
Silver (filtered)	0.005	mg/L	< 0.005
Tin (filtered)	0.005	mg/L	< 0.005

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Client Sample ID			SW08/29200625
Sample Matrix			Water
Eurofins Sample No.			M25-Jn0058408
Date Sampled			Jun 20, 2025
Test/Reference	LOR	Unit	
Heavy Metals			
Vanadium (filtered)	0.005	mg/L	< 0.005
Zinc (filtered)	0.005	mg/L	0.26
Alkali Metals			
Calcium	0.5	mg/L	4.3
Magnesium	0.5	mg/L	5.1
Potassium	0.5	mg/L	2.9
Sodium	0.5	mg/L	41

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Sample History

Where samples are submitted/analysed over several days, the last date of extraction is reported.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Bromide	Melbourne	Jun 24, 2025	28 Days
- Method: LTM-INO-4270 Anions by Ion Chromatography			
Chloride	Melbourne	Jun 24, 2025	28 Days
- Method: LTM-INO-4090 Chloride by Discrete Analyser			
Conductivity (at 25 °C)	Melbourne	Jun 24, 2025	28 Days
- Method: LTM-INO-4030 Conductivity			
Cyanide (total)	Melbourne	Jun 24, 2025	14 Days
- Method: LTM-INO-4020 Total Free WAD Cyanide by CFA			
Fluoride	Melbourne	Jun 24, 2025	28 Days
- Method: LTM-INO-4270 Anions by Ion Chromatography			
Nitrate (as N)	Melbourne	Jun 24, 2025	28 Days
- Method: LTM-INO-4450 Nitrogens by Discrete Analyser			
pH (at 25 °C)	Melbourne	Jun 24, 2025	6 Hours
- Method: LTM-GEN-7090 pH in water by ISE			
Phosphorus reactive (as P)	Melbourne	Jun 24, 2025	2 Days
- Method: APHA 4500-P			
Sulphate (as SO4)	Melbourne	Jun 24, 2025	28 Days
- Method: LTM-INO-4110 Sulfate by Discrete Analyser			
Total Organic Carbon	Melbourne	Jun 24, 2025	28 Days
- Method: LTM-INO-4060 Total Organic Carbon in water and soil			
Phosphate total (as P)	Melbourne	Jun 24, 2025	28 Days
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Silica (calculation from Si)	Melbourne	Jul 15, 2025	28 Days
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Alkalinity (speciated)	Melbourne	Jun 24, 2025	14 Days
- Method: LTM-INO-4250 Alkalinity by Electrometric Titration			
Heavy Metals	Melbourne	Jun 24, 2025	28 Days
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Heavy Metals (filtered)	Melbourne	Jun 24, 2025	180 Days
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Mobil Metals : Metals M15	Melbourne	Jun 24, 2025	28 Days
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Alkali Metals	Melbourne	Jun 24, 2025	180 Days
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Total Dissolved Solids Dried at 180 °C ± 2 °C	Melbourne	Jun 24, 2025	28 Days
- Method: LTM-INO-4170 Total Dissolved Solids in Water			

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Canberra Unit 1,2 Dacre Street Mitchell ACT 2911 +61 2 6113 8091 NATA# 1261 Site# 25466
Brisbane 1/21 Smallwood Place Murarrie QLD 4172 +61 7 3902 4600 NATA# 1261 Site# 20794 & 2780
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Tauranga 1277 Cameron Road Gate Pa Tauranga 3112 +64 9 525 0568 IANZ# 1402

Company Name: WSP Australia P/L MELB
Address: Level 11, 567 Collins Street
Melbourne
VIC 3000

Project Name: McCrae Landslide
Project ID: PS224394

Order No.:
Report #: 1235266
Phone: 9861 1111
Fax: 9861 1144

Received: Jun 23, 2025 1:28 PM
Due: Jun 30, 2025
Priority: 5 Day
Contact Name: Hong Vu

Eurofins Analytical Services Manager : Harry Bacalis

Sample Detail

No	Sample ID	Sample Date	Sampling Time	Matrix	LAB ID
1	SW08/29200625	Jun 20, 2025	11:45AM	Water	M25-Jn0058408

Analyte	Melbourne Laboratory - NATA # 1261 Site # 1254	External Laboratory	1 (M25-Jn0058408)	Test Counts
Aluminium	X		X	1
Arsenic (filtered)	X		X	1
Beryllium (filtered)	X		X	1
Bicarbonate Alkalinity (as CaCO3)	X		X	1
Boron (filtered)	X		X	1
Bromide	X		X	1
Cadmium (filtered)	X		X	1
Calcium	X		X	1
Chloride	X		X	1
Chromium (filtered)	X		X	1
Cobalt (filtered)	X		X	1
Conductivity (at 25 °C)	X		X	1
Copper (filtered)	X		X	1
Cyanide (total)	X		X	1
Fluoride	X		X	1
Iron	X		X	1
Lead (filtered)	X		X	1
Magnesium	X		X	1
Manganese	X		X	1
Manganese (filtered)	X		X	1
Mercury (filtered)	X		X	1
Molybdenum (filtered)	X		X	1
Nickel (filtered)	X		X	1
Nitrate (as N)	X		X	1
pH (at 25 °C)	X		X	1
Phosphate total (as P)	X		X	1
Phosphorus reactive (as P)	X		X	1
Potassium	X		X	1
Selenium (filtered)	X		X	1
Silica (calculation from Si)	X		X	1
Silver (filtered)	X		X	1
Sodium	X		X	1
Sulphate (as SO4)	X		X	1
Tin (filtered)	X		X	1
Total Organic Carbon	X		X	1
Vanadium (filtered)	X		X	1
Zinc (filtered)	X		X	1
Total Dissolved Solids Dried at 180 °C ± 2 °C	X		X	1

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COC	Chain of Custody
CP	Client Parent - QC was performed on samples pertaining to this report
CRM	Certified Reference Material (ISO17034) - reported as percent recovery.
Dry	Where moisture has been determined on a solid sample, the result is expressed on a dry weight basis.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
LOR	Limit of Reporting.
LCS	Laboratory Control Sample - reported as percent recovery.
Method Blank	In the case of solid samples, these are performed on laboratory-certified clean sands and in the case of water samples, these are performed on de-ionised water.
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC represents the sequence or batch that client samples were analysed within.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
SRA	Sample Receipt Advice
Surr - Surrogate	The addition of a similar compound to the analyte target is reported as percentage recovery. See below for acceptance criteria.
TBTO	Tributyltin oxide (*bis*-tributyltin oxide) - individual tributyltin compounds cannot be identified separately in the environment; however, free tributyltin was measured, and its values were converted stoichiometrically into tributyltin oxide for comparison with regulatory limits.
TCLP	Toxicity Characteristic Leaching Procedure
TEQ	Toxic Equivalency Quotient or Total Equivalence
QSM	US Department of Defense Quality Systems Manual Version 6.0
US EPA	United States Environmental Protection Agency
WA DWER	Sum of PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC - Acceptance Criteria

The acceptance criteria should only be used as a guide and may be different when site-specific Sampling Analysis and Quality Plan (SAQP) have been implemented.

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is ≤30%; however, the following acceptance guidelines are equally applicable:

Results <10 times the LOR:	No Limit
Results between 10-20 times the LOR:	RPD must lie between 0-50%
Results >20 times the LOR:	RPD must lie between 0-30%

NOTE: pH duplicates are reported as a range, not as RPD

Surrogate Recoveries: Recoveries must lie between 20-130% for Speciated Phenols & 50-150% for PFAS. SVOCs recoveries 20 – 150%, VOC recoveries 50 – 150%

PFAS field samples containing surrogate recoveries above the QC limit designated in QSM 6.0, where no positive PFAS results have been reported or reviewed, and no data was affected.

QC Data General Comments

1. Where a result is reported as less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown are not data from your samples.
3. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling. Therefore, laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
4. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of recovery, the term "INT" appears against that analyte.
5. For Matrix Spikes and LCS results, a dash "-" in the report means that the specific analyte was not added to the QC sample.
6. Duplicate RPDs are calculated from raw analytical data; thus, it is possible to have two sets of data.

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Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Bromide	mg/L	< 1			1	Pass	
Chloride	mg/L	< 1			1	Pass	
Conductivity (at 25 °C)	uS/cm	< 10			10	Pass	
Cyanide (total)	mg/L	< 0.005			0.005	Pass	
Fluoride	mg/L	< 0.5			0.5	Pass	
Nitrate (as N)	mg/L	< 0.02			0.02	Pass	
Phosphorus reactive (as P)	mg/L	< 0.01			0.01	Pass	
Sulphate (as SO4)	mg/L	< 5			5	Pass	
Total Dissolved Solids Dried at 180 °C ± 2 °C	mg/L	< 10			10	Pass	
Total Organic Carbon	mg/L	< 5			5	Pass	
Phosphate total (as P)	mg/L	< 0.01			0.01	Pass	
Method Blank							
Heavy Metals							
Aluminium	mg/L	< 0.05			0.05	Pass	
Arsenic (filtered)	mg/L	< 0.001			0.001	Pass	
Beryllium (filtered)	mg/L	< 0.001			0.001	Pass	
Boron (filtered)	mg/L	< 0.05			0.05	Pass	
Cadmium (filtered)	mg/L	< 0.0002			0.0002	Pass	
Chromium (filtered)	mg/L	< 0.001			0.001	Pass	
Cobalt (filtered)	mg/L	< 0.001			0.001	Pass	
Copper (filtered)	mg/L	< 0.001			0.001	Pass	
Iron	mg/L	< 0.05			0.05	Pass	
Lead (filtered)	mg/L	< 0.001			0.001	Pass	
Manganese	mg/L	< 0.005			0.005	Pass	
Manganese (filtered)	mg/L	< 0.005			0.005	Pass	
Mercury (filtered)	mg/L	< 0.0001			0.0001	Pass	
Molybdenum (filtered)	mg/L	< 0.005			0.005	Pass	
Nickel (filtered)	mg/L	< 0.001			0.001	Pass	
Selenium (filtered)	mg/L	< 0.001			0.001	Pass	
Silver (filtered)	mg/L	< 0.005			0.005	Pass	
Tin (filtered)	mg/L	< 0.005			0.005	Pass	
Vanadium (filtered)	mg/L	< 0.005			0.005	Pass	
Zinc (filtered)	mg/L	< 0.005			0.005	Pass	
Method Blank							
Alkali Metals							
Calcium	mg/L	< 0.5			0.5	Pass	
Magnesium	mg/L	< 0.5			0.5	Pass	
Potassium	mg/L	< 0.5			0.5	Pass	
Sodium	mg/L	< 0.5			0.5	Pass	
LCS - % Recovery							
Bromide	%	101			70-130	Pass	
Chloride	%	96			70-130	Pass	
Conductivity (at 25 °C)	%	95			70-130	Pass	
Cyanide (total)	%	98			70-130	Pass	
Fluoride	%	83			70-130	Pass	
Phosphorus reactive (as P)	%	95			70-130	Pass	
Sulphate (as SO4)	%	107			70-130	Pass	
Total Dissolved Solids Dried at 180 °C ± 2 °C	%	93			70-130	Pass	
Total Organic Carbon	%	94			70-130	Pass	
Phosphate total (as P)	%	94			70-130	Pass	
LCS - % Recovery							

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Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Heavy Metals									
Aluminium			%	115			80-120	Pass	
Iron			%	113			80-120	Pass	
Manganese			%	113			80-120	Pass	
LCS - % Recovery									
Alkali Metals									
Calcium			%	96			80-120	Pass	
Magnesium			%	95			80-120	Pass	
Potassium			%	98			80-120	Pass	
Sodium			%	94			80-120	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Spike - % Recovery									
				Result 1					
Chloride	M25-Jn0063409	NCP	%	96			70-130	Pass	
Sulphate (as SO4)	M25-Jn0056808	NCP	%	73			70-130	Pass	
Total Organic Carbon	L25-Jn0061078	NCP	%	98			70-130	Pass	
Phosphate total (as P)	M25-Jn0058585	NCP	%	108			70-130	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Aluminium	M25-Jn0069640	NCP	%	99			75-125	Pass	
Iron	M25-Jn0069640	NCP	%	95			75-125	Pass	
Manganese	M25-Jn0069640	NCP	%	98			75-125	Pass	
Spike - % Recovery									
Alkali Metals				Result 1					
Calcium	M25-Jn0057571	NCP	%	108			75-125	Pass	
Magnesium	M25-Jn0057571	NCP	%	109			75-125	Pass	
Potassium	M25-Jn0062742	NCP	%	115			75-125	Pass	
Sodium	M25-Jn0057571	NCP	%	105			75-125	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
				Result 1	Result 2	RPD			
Chloride	M25-Jn0063421	NCP	mg/L	810	72	11	30%	Pass	
Conductivity (at 25 °C)	M25-Jn0065116	NCP	uS/cm	74	74	1.0	30%	Pass	
Cyanide (total)	M25-Jn0056611	NCP	mg/L	0.021	0.020	2.0	30%	Pass	
pH (at 25 °C)	M25-Jn0065116	NCP	pH Units	7.4	7.4	PASS	30%	Pass	
Sulphate (as SO4)	M25-Jn0063421	NCP	mg/L	490	50	2.0	30%	Pass	
Total Dissolved Solids Dried at 180 °C ± 2 °C	M25-Jn0060584	NCP	mg/L	130	120	4.0	30%	Pass	
Total Organic Carbon	L25-Jn0061077	NCP	mg/L	< 5	< 5	<1	30%	Pass	
Phosphate total (as P)	M25-Jn0062729	NCP	mg/L	0.02	0.02	5.0	30%	Pass	
Duplicate									
Alkalinity (speciated)				Result 1	Result 2	RPD			
Bicarbonate Alkalinity (as CaCO3)	M25-Jn0059532	NCP	mg/L	820	780	4.0	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Aluminium	M25-Jn0069640	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Iron	M25-Jn0069640	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Manganese	M25-Jn0069640	NCP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Duplicate									
Alkali Metals				Result 1	Result 2	RPD			
Calcium	M25-Jn0062742	NCP	mg/L	270	270	<1	30%	Pass	
Magnesium	M25-Jn0062742	NCP	mg/L	730	720	<1	30%	Pass	
Potassium	M25-Jn0062742	NCP	mg/L	58	57	<1	30%	Pass	
Sodium	M25-Jn0062742	NCP	mg/L	3900	3900	1.0	30%	Pass	

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Comments

Report 1235266-W-V2 (amendment to report 1235266-W) has been issued with revised results for Chloride following repeat analysis.

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
Q08	The matrix spike recovery is outside of the recommended acceptance criteria. An acceptable recovery was obtained for the laboratory control sample indicating a sample matrix interference.

Authorised by:

Harry Bacalis	Analytical Services Manager
Emily Rosenberg	Senior Analyst-Metal
Luke Holt	Senior Analyst-Inorganic
Mary Makarios	Senior Analyst-Inorganic
Mary Makarios	Senior Analyst-Metal

Irrelevant & Sensitive

Glenn Jackson
Managing Director

Final Report – this report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

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CERTIFICATE OF ANALYSIS

Work Order	: **EM2510716**	Page	: 1 of 4
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: Hong Phuc Vu	Contact	: Josh Alexander
Address	: Level 11 567 Collins Street Melbourne VIC, AUSTRALIA 3000	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: +61 3 8862 3573	Telephone	: +61-3-8549 9600
Project	: PS224394	Date Samples Received	: 17-Jun-2025 10:50
Order number	: PS224394	Date Analysis Commenced	: 18-Jun-2025
C-O-C number	: ----	Issue Date	: 25-Jun-2025 17:36
Sampler	: ----		
Site	: McCrae Landslide		
Quote number	: WSP MSA 2025		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Dilani Fernando	Laboratory Coordinator	Melbourne Inorganics, Springvale, VIC
Eric Chau	Metals Team Leader	Melbourne Inorganics, Springvale, VIC

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	Pit01/25160625	Pit03/25160625	Pit04/25160625	----	----
			Sampling date / time	16-Jun-2025 14:45	16-Jun-2025 15:15	16-Jun-2025 15:45	----	----
Compound	CAS Number	LOR	Unit	EM2510716-001	EM2510716-002	EM2510716-003	--------	--------
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**6.77**	**7.67**	**7.78**	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**515**	**520**	**579**	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**305**	**290**	**294**	----	----
ED009: Anions								
Bromide	24959-67-9	0.02	mg/L	**0.29**	**0.27**	**0.28**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**14**	**14**	**14**	----	----
Magnesium	7439-95-4	1	mg/L	**18**	**18**	**19**	----	----
Sodium	7440-23-5	1	mg/L	**63**	**64**	**70**	----	----
Potassium	7440-09-7	1	mg/L	**4**	**4**	**5**	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.01**	<0.01	**0.01**	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	**0.002**	**0.005**	**0.002**	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L	**0.015**	**0.015**	**0.019**	----	----
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	Pit01/25160625	Pit03/25160625	Pit04/25160625	----	----
			Sampling date / time	16-Jun-2025 14:45	16-Jun-2025 15:15	16-Jun-2025 15:45	----	----
Compound	CAS Number	LOR	Unit	EM2510716-001	EM2510716-002	EM2510716-003	--------	--------
				Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	**0.012**	**0.415**	----	----
Boron	7440-42-8	0.05	mg/L	**0.06**	**0.05**	**0.06**	----	----
Iron	7439-89-6	0.05	mg/L	**0.35**	**0.17**	**0.06**	----	----
EK026SF: Total CN by Segmented Flow Analyser								
Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	<0.004	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	<0.1	<0.1	<0.1	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	**0.01**	<0.01	<0.01	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**1.25**	**1.18**	**1.20**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**1.26**	**1.18**	**1.20**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	**0.06**	**0.06**	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**6**	**9**	**6**	----	----

Inter-Laboratory Testing

Analysis conducted by ALS Sydney, NATA accreditation no. 825, site no. 10911 (Chemistry / Biology).

(WATER) ED009: Anions

QUALITY CONTROL REPORT

Work Order	: **EM2510716**	Page	: 1 of 7
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: Hong Phuc Vu	Contact	: Josh Alexander
Address	: Level 11 567 Collins Street Melbourne VIC, AUSTRALIA 3000	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: +61 3 8862 3573	Telephone	: +61-3-8549 9600
Project	: PS224394	Date Samples Received	: 17-Jun-2025
Order number	: PS224394	Date Analysis Commenced	: 18-Jun-2025
C-O-C number	: ----	Issue Date	: 25-Jun-2025
Sampler	: ----		
Site	: McCrae Landslide		
Quote number	: WSP MSA 2025		
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No. of samples analysed	: 3		

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This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Dilani Fernando	Laboratory Coordinator	Melbourne Inorganics, Springvale, VIC
Eric Chau	Metals Team Leader	Melbourne Inorganics, Springvale, VIC

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Key :
- Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
- CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
- LOR = Limit of reporting
- RPD = Relative Percentage Difference
- # = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
ED009: Anions (QC Lot: 6668776)									
EM2510703-001	Anonymous	ED009: Bromide	24959-67-9	0.02	mg/L	3.73	3.60	3.6	0% - 20%
EP2509465-001	Anonymous	ED009: Bromide	24959-67-9	0.02	mg/L	0.66	0.58	13.1	0% - 20%
EA005P: pH by PC Titrator (QC Lot: 6656742)									
EM2510710-004	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	6.61	6.64	0.5	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 6656744)									
EM2510710-004	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	2500	2480	0.6	0% - 20%
EM2510743-003	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	3680	3700	0.6	0% - 20%
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 6661872)									
EM2510710-003	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	1060	1050	0.2	0% - 20%
EM2510734-010	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	852	863	1.4	0% - 20%
EM2510744-002	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	1100	988	11.1	0% - 20%
EM2510768-005	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	1640	1730	5.2	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 6671280)									
EM2510716-002	Pit03/25160625	ED093F: Calcium	7440-70-2	1	mg/L	14	15	0.0	0% - 50%
		ED093F: Magnesium	7439-95-4	1	mg/L	18	18	0.0	0% - 50%
		ED093F: Sodium	7440-23-5	1	mg/L	64	65	0.0	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	4	4	0.0	No Limit
EM2510812-001	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	109	110	1.1	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	523	545	4.1	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	2580	2650	3.0	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	39	40	3.1	0% - 20%
EG020F: Dissolved Metals by ICP-MS (QC Lot: 6671281)									

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
EG020F: Dissolved Metals by ICP-MS (QC Lot: 6671281) - continued									
EM2510812-002	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.429	0.422	1.6	0% - 20%
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.129	0.128	1.0	0% - 20%
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	0.001	0.001	0.0	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.005	0.005	0.0	No Limit
		EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.0	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	0.07	0.06	0.0	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	1.01	0.99	1.4	0% - 20%
EM2510716-001	Pit01/25160625	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.002	0.002	0.0	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.015	0.015	0.0	0% - 50%
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.0	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	0.01	0.01	0.0	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	0.06	0.06	0.0	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	0.35	0.35	0.0	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 6671282)									
EM2510936-005	Anonymous	EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
EM2510716-001	Pit01/25160625	EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
				Laboratory Duplicate (DUP) Report					
EK026SF: Total CN by Segmented Flow Analyser (QC Lot: 6658195)									
EM2510703-001	Anonymous	EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	0.0	No Limit
EM2510710-004	Anonymous	EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	0.0	No Limit
EK040P: Fluoride by PC Titrator (QC Lot: 6656737)									
EM2510625-002	Anonymous	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.1	0.1	0.0	No Limit
EM2510482-002	Anonymous	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.9	0.8	0.0	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 6655889)									
EM2510659-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 6667591)									
EM2510716-001	Pit01/25160625	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	1.26	1.23	2.1	0% - 20%
EM2510809-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	1.15	1.12	2.5	0% - 20%
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 6668035)									
EM2510625-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.05	0.05	0.0	No Limit
EM2510807-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.09	0.08	0.0	No Limit
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 6655892)									
EM2510700-001	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	14.4	14.8	3.1	0% - 20%
EP005: Total Organic Carbon (TOC) (QC Lot: 6670692)									
EM2510664-001	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	20	22	7.2	0% - 20%
EM2510921-006	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	7	10	28.9	No Limit

Method Blank (MB) and Laboratory Control Sample (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Acceptable Limits (%)	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
ED009: Anions (QCLot: 6668776)								
ED009: Bromide	24959-67-9	0.02	mg/L	<0.02	2 mg/L	104	84.0	118
EA005P: pH by PC Titrator (QCLot: 6656742)								
EA005-P: pH Value	----	----	pH Unit	----	4 pH Unit	99.5	98.8	101
				----	7 pH Unit	100	99.3	101
EA010P: Conductivity by PC Titrator (QCLot: 6656744)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	1412 µS/cm	100	85.0	119
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 6661872)								
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	2000 mg/L	94.0	91.0	110
				<10	2330 mg/L	110	80.7	119
				<10	293 mg/L	97.3	91.0	110
ED093F: Dissolved Major Cations (QCLot: 6671280)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	112	80.0	120
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	105	80.0	120
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	102	80.0	120
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	100	80.0	120
EG020F: Dissolved Metals by ICP-MS (QCLot: 6671281)								
EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	98.7	90.4	111
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	101	89.0	111
EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	106	85.0	112
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	96.7	83.5	111
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	99.3	83.2	109
EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	94.4	84.3	110
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	95.9	83.1	107
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	100	84.6	108
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	99.0	84.8	110
EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	98.2	88.3	112
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	95.7	84.3	110
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	105	82.3	113
EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	0.1 mg/L	100	86.7	113
EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	102	83.7	110

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Acceptable Limits (%) Low	Acceptable Limits (%) High
EG020F: Dissolved Metals by ICP-MS (QCLot: 6671281) - continued								
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	100	86.3	112
EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	99.8	85.4	115
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	102	91.8	112
EG020F: Dissolved Metals by ICP-MS (QCLot: 6671282)								
EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	0.02 mg/L	102	83.2	119
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 6658195)								
EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.004	0.2 mg/L	93.0	77.7	116
EK040P: Fluoride by PC Titrator (QCLot: 6656737)								
EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	5 mg/L	96.3	80.8	118
EK057G: Nitrite as N by Discrete Analyser (QCLot: 6655889)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	100	90.0	110
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 6667591)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	101	90.0	110
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 6668035)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	2.21 mg/L	89.9	71.9	114
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 6655892)								
EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	0.5 mg/L	105	90.0	110
EP005: Total Organic Carbon (TOC) (QCLot: 6670692)								
EP005: Total Organic Carbon	----	1	mg/L	<1	100 mg/L	93.4	81.2	110

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects or analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report Spike Concentration	SpikeRecovery(%) MS	Acceptable Limits (%) Low	Acceptable Limits (%) High
ED009: Anions (QCLot: 6668776)							
EM2510703-001	Anonymous	ED009: Bromide	24959-67-9	0.2 mg/L	# Not Determined	70.0	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 6671281)							
EM2510716-001	Pit01/25160625	EG020A-F: Arsenic	7440-38-2	0.2 mg/L	97.8	76.6	124
		EG020A-F: Beryllium	7440-41-7	0.2 mg/L	118	73.0	120
		EG020A-F: Cadmium	7440-43-9	0.05 mg/L	94.2	74.6	118
		EG020A-F: Chromium	7440-47-3	0.2 mg/L	99.6	71.0	135

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Acceptable Limits (%)	
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 6671281) - continued							
EM2510716-001	Pit01/25160625	EG020A-F: Cobalt	7440-48-4	0.2 mg/L	97.5	78.0	132
		EG020A-F: Copper	7440-50-8	0.2 mg/L	96.5	76.0	130
		EG020A-F: Lead	7439-92-1	0.2 mg/L	101	75.0	133
		EG020A-F: Manganese	7439-96-5	0.2 mg/L	99.8	64.0	134
		EG020A-F: Nickel	7440-02-0	0.2 mg/L	95.5	73.0	131
		EG020A-F: Vanadium	7440-62-2	0.2 mg/L	98.8	73.0	131
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	98.5	75.0	131
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 6658195)							
EM2510705-001	Anonymous	EK026SF: Total Cyanide	57-12-5	2 mg/L	122	70.0	130
EK040P: Fluoride by PC Titrator (QCLot: 6656737)							
EM2510482-003	Anonymous	EK040P: Fluoride	16984-48-8	25 mg/L	90.6	70.0	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 6655889)							
EM2510659-002	Anonymous	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	101	80.0	114
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 6667591)							
EM2510716-001	Pit01/25160625	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	87.5	70.0	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 6668035)							
EM2510787-001	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	85.3	70.0	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 6655892)							
EM2510700-002	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	5 mg/L	104	79.0	123
EP005: Total Organic Carbon (TOC) (QCLot: 6670692)							
EM2510716-001	Pit01/25160625	EP005: Total Organic Carbon	----	100 mg/L	119	76.6	125

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EM2510716**	Page	: 1 of 8
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: Hong Phuc Vu	Telephone	: +61-3-8549 9600
Project	: PS224394	Date Samples Received	: 17-Jun-2025
Site	: McCrae Landslide	Issue Date	: 25-Jun-2025
Sampler	: ----	No. of samples received	: 3
Order number	: PS224394	No. of samples analysed	: 3

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, where applicable to the methodology, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
ED009: Anions	EM2510703--001	Anonymous	**Bromide**	24959-67-9	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method	*Extraction / Preparation*			*Analysis*		
Container / Client Sample ID(s)	*Date extracted*	*Due for extraction*	***Days overdue***	*Date analysed*	*Due for analysis*	***Days overdue***
EA005P: pH by PC Titrator						
Clear Plastic Bottle - Natural Pit01/25160625, Pit03/25160625, Pit04/25160625	----	----	----	19-Jun-2025	16-Jun-2025	**3**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type		Count		Rate (%)		Quality Control Specification
Analytical Methods	Method	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)						
pH by Auto Titrator	EA005-P	1	20	5.00	10.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
***Container** / Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural (EA005-P) Pit01/25160625, Pit03/25160625, Pit04/25160625	**16-Jun-2025**	**----**	----	----	**19-Jun-2025**	16-Jun-2025	×
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P) Pit01/25160625, Pit03/25160625, Pit04/25160625	**16-Jun-2025**	**----**	----	----	**19-Jun-2025**	14-Jul-2025	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Clear Plastic Bottle - Natural (EA015H)								
Pit01/25160625, Pit04/25160625	Pit03/25160625,	**16-Jun-2025**	**----**	----	----	**19-Jun-2025**	23-Jun-2025	✓
ED009: Anions								
Clear Plastic Bottle - Natural (ED009)								
Pit01/25160625, Pit04/25160625	Pit03/25160625,	**16-Jun-2025**	**----**	----	----	**23-Jun-2025**	14-Jul-2025	✓
ED093F: Dissolved Major Cations								
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)								
Pit01/25160625, Pit04/25160625	Pit03/25160625,	**16-Jun-2025**	**----**	----	----	**24-Jun-2025**	14-Jul-2025	✓
EG020F: Dissolved Metals by ICP-MS								
Clear Plastic Bottle - Nitric Acid; Filtered (EG020B-F)								
Pit01/25160625, Pit04/25160625	Pit03/25160625,	**16-Jun-2025**	**----**	----	----	**24-Jun-2025**	13-Dec-2025	✓
EK026SF: Total CN by Segmented Flow Analyser								
Black Opaque Plastic Bottle - NaOH (EK026SF)								
Pit01/25160625, Pit04/25160625	Pit03/25160625,	**16-Jun-2025**	**----**	----	----	**19-Jun-2025**	30-Jun-2025	✓
EK040P: Fluoride by PC Titrator								
Clear Plastic Bottle - Natural (EK040P)								
Pit01/25160625, Pit04/25160625	Pit03/25160625,	**16-Jun-2025**	**----**	----	----	**19-Jun-2025**	14-Jul-2025	✓
EK057G: Nitrite as N by Discrete Analyser								
Clear Plastic Bottle - Natural (EK057G)								
Pit01/25160625, Pit04/25160625	Pit03/25160625,	**16-Jun-2025**	**----**	----	----	**18-Jun-2025**	18-Jun-2025	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK059G)								
Pit01/25160625, Pit04/25160625	Pit03/25160625,	**16-Jun-2025**	**----**	----	----	**24-Jun-2025**	14-Jul-2025	✓
EK067G: Total Phosphorus as P by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK067G)								
Pit01/25160625, Pit04/25160625	Pit03/25160625,	**16-Jun-2025**	**24-Jun-2025**	14-Jul-2025	✓	**25-Jun-2025**	14-Jul-2025	✓
EK071G: Reactive Phosphorus as P by discrete analyser								
Clear Plastic Bottle - Natural (EK071G)								
Pit01/25160625, Pit04/25160625	Pit03/25160625,	**16-Jun-2025**	**----**	----	----	**18-Jun-2025**	18-Jun-2025	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP005: Total Organic Carbon (TOC)							
Amber TOC Vial - Sulfuric Acid (EP005) Pit01/25160625, Pit03/25160625, Pit04/25160625	**16-Jun-2025**	**----**	----	----	**24-Jun-2025**	14-Jul-2025	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	*Actual*	*Expected*	*Evaluation*	
Laboratory Duplicates (DUP)							
Conductivity by Auto Titrator	EA010-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by Auto Titrator	EK040P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	8	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by Auto Titrator	EA005-P	1	20	**5.00**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	6	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions - by IC	ED009	2	4	**50.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	4	32	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Conductivity by Auto Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by Auto Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by Auto Titrator	EA005-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions - by IC	ED009	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	3	32	**9.38**	**7.50**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Conductivity by Auto Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by Auto Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Nitrite as N by Discrete Analyser	EK057G	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions - by IC	ED009	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	32	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by Auto Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions - by IC	ED009	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
pH by Auto Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM Schedule B(3)
Conductivity by Auto Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM Schedule B(3)
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of `filterable` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM Schedule B(3)
Standard Anions - by IC	ED009	WATER	In house: Referenced to APHA 4110. This method is compliant with NEPM Schedule B(3)
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Metals by ICP-MS - Suite B	EG020B-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Cyanide by Segmented Flow Analyser	EK026SF	WATER	In house: Referenced to APHA 4500-CN C&O / ASTM D7511 / ISO 14403. Sodium hydroxide preserved samples are introduced into an automated segmented flow analyser. Complex bound cyanide is decomposed in a continuously flowing stream, at a pH of 3.8, by the effect of UV light. A UV-B lamp (312 nm) and a decomposition spiral of borosilicate glass are used to filter out UV light with a wavelength of less than 290 nm thus preventing the conversion of thiocyanate into cyanide. The hydrogen cyanide present at a pH of 3.8 is separated by gas dialysis. The hydrogen cyanide is then determined photometrically, based on the reaction of cyanide with chloramine-T to form cyanogen chloride. This then reacts with 4-pyridine carboxylic acid and 1,3-dimethylbarbituric acid to give a red colour which is measured at 600 nm. This method is compliant with NEPM Schedule B(3)
Fluoride by Auto Titrator	EK040P	WATER	In house: Referenced to APHA 4500-F C: CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al, Zhang et al. This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Total Organic Carbon	EP005	WATER	In house: Referenced to APHA 5310 B, The automated TOC analyzer determines Total and Inorganic Carbon by IR cell. TOC is calculated as the difference. This method is compliant with NEPM Schedule B(3)

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM Schedule B(3)

CERTIFICATE OF ANALYSIS

Work Order	: **EM2510957**	Page	: 1 of 4
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: Hong Phuc Vu	Contact	: Josh Alexander
Address	: Level 11 567 Collins Street Melbourne VIC, AUSTRALIA 3000	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: +61 3 8862 3573	Telephone	: +61-3-8549 9600
Project	: PS224394	Date Samples Received	: 19-Jun-2025 12:05
Order number	: PS224394	Date Analysis Commenced	: 19-Jun-2025
C-O-C number	: ----	Issue Date	: 29-Jun-2025 17:39
Sampler	: ----		
Site	: ----		
Quote number	: WSP MSA 2025		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Dilani Fernando	Laboratory Coordinator	Melbourne Inorganics, Springvale, VIC
Eric Chau	Metals Team Leader	Melbourne Inorganics, Springvale, VIC

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EA015H: EM2510957 # 3 TDS by method EA-015 may bias high due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW02 / 25180625	SW03 / 25180625	BH04 / 50180625	----	----
			Sampling date / time	18-Jun-2025 11:30	18-Jun-2025 11:00	18-Jun-2025 09:30	----	----
Compound	CAS Number	LOR	Unit	EM2510957-001	EM2510957-002	EM2510957-003	--------	--------
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.10**	**7.59**	**6.65**	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**744**	**754**	**9800**	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**360**	**381**	**5800**	----	----
ED009: Anions								
Bromide	24959-67-9	0.02	mg/L	**0.35**	**0.36**	**5.91**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**18**	**19**	**118**	----	----
Magnesium	7439-95-4	1	mg/L	**17**	**17**	**330**	----	----
Sodium	7440-23-5	1	mg/L	**109**	**109**	**1460**	----	----
Potassium	7440-09-7	1	mg/L	**5**	**5**	**21**	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.02**	**0.01**	**0.01**	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	**0.009**	----	----
Copper	7440-50-8	0.001	mg/L	**0.004**	**0.004**	**0.002**	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L	**0.004**	**0.004**	**0.200**	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.001**	<0.001	**0.002**	----	----
Nickel	7440-02-0	0.001	mg/L	**0.001**	**0.001**	**0.017**	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	**0.002**	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----

Analytical Results

Sub-Matrix: WATER
(Matrix: WATER)

Compound	CAS Number	LOR	Unit	SW02 / 25180625	SW03 / 25180625	BH04 / 50180625	----	----
Sampling date / time				18-Jun-2025 11:30	18-Jun-2025 11:00	18-Jun-2025 09:30	----	----
				EM2510957-001	EM2510957-002	EM2510957-003	--------	--------
				Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L	**0.006**	**0.007**	**0.051**	----	----
Boron	7440-42-8	0.05	mg/L	**0.07**	**0.08**	**0.06**	----	----
Iron	7439-89-6	0.05	mg/L	**0.07**	**0.06**	<0.05	----	----
EK026SF: Total CN by Segmented Flow Analyser								
Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	<0.004	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.1**	**0.1**	**0.3**	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	**0.01**	<0.01	**0.02**	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.53**	**0.52**	**2.42**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.54**	**0.52**	**2.44**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.04**	**0.01**	**0.02**	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**6**	**6**	**7**	----	----

Inter-Laboratory Testing

Analysis conducted by ALS Sydney, NATA accreditation no. 825, site no. 10911 (Chemistry / Biology).

(WATER) ED009: Anions

QUALITY CONTROL REPORT

Work Order	: **EM2510957**	Page	: 1 of 7
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: Hong Phuc Vu	Contact	: Josh Alexander
Address	: Level 11 567 Collins Street Melbourne VIC, AUSTRALIA 3000	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: +61 3 8862 3573	Telephone	: +61-3-8549 9600
Project	: PS224394	Date Samples Received	: 19-Jun-2025
Order number	: PS224394	Date Analysis Commenced	: 19-Jun-2025
C-O-C number	: ----	Issue Date	: 29-Jun-2025
Sampler	: ----		
Site	: ----		
Quote number	: WSP MSA 2025		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 825
Accredited for compliance with
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This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
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General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC
* = The final LOR has been raised due to dilution or other sample specific cause; adjusted LOR is shown in brackets. The duplicate ranges for Acceptable RPD% are applied to the final LOR where applicable.

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
ED009: Anions (QC Lot: 6675569)									
EM2510811-001	Anonymous	ED009: Bromide	24959-67-9	0.02 (4.00)*	mg/L	13.6	16.9	21.7	No Limit
EA005P: pH by PC Titrator (QC Lot: 6664745)									
EM2511011-002	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	6.59	6.65	0.9	0% - 20%
EM2510957-001	SW02 / 25180625	EA005-P: pH Value	----	0.01	pH Unit	7.10	7.16	0.8	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 6664747)									
EM2510957-001	SW02 / 25180625	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	744	746	0.4	0% - 20%
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 6668192)									
EM2510957-001	SW02 / 25180625	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	360	380	5.3	0% - 20%
EM2510965-001	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	348	327	6.0	0% - 20%
EM2510993-002	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	9140	7600	18.4	0% - 20%
EM2510993-012	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	<10	0.0	No Limit
ED093F: Dissolved Major Cations (QC Lot: 6675035)									
EM2510957-002	SW03 / 25180625	ED093F: Calcium	7440-70-2	1	mg/L	19	19	0.0	0% - 50%
		ED093F: Magnesium	7439-95-4	1	mg/L	17	18	0.0	0% - 50%
		ED093F: Sodium	7440-23-5	1	mg/L	109	110	1.7	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	5	5	0.0	No Limit
EM2511124-003	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	85	83	2.3	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	239	234	2.4	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	919	916	0.3	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	156	155	0.0	0% - 20%

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
EG020F: Dissolved Metals by ICP-MS (QC Lot: 6675033)									
EM2510779-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	0.0003	0.0003	0.0	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.002	0.002	0.0	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.009	0.009	0.0	No Limit
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.302	0.298	1.3	0% - 20%
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	0.02	0.02	0.0	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.0	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	0.06	0.06	0.0	No Limit
EM2511054-002	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	0.0222	0.0230	3.4	0% - 20%
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.398	0.400	0.5	0% - 20%
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	0.002	0.002	0.0	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	0.233	0.236	1.3	0% - 20%
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.007	0.007	0.0	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	0.194	0.194	0.0	0% - 20%
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	26.6	27.2	2.1	0% - 20%
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.188	0.193	2.5	0% - 20%
		EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	78.1	79.1	1.3	0% - 20%
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	1.01	1.02	0.0	0% - 20%
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.0	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	364	362	0.7	0% - 20%
EG020F: Dissolved Metals by ICP-MS (QC Lot: 6675034)									
EM2510910-001	Anonymous	EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
EM2511118-003	Anonymous	EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Acceptable RPD (%)*
EK026SF: Total CN by Segmented Flow Analyser (QC Lot: 6664219)									
EM2510905-001	Anonymous	EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	0.0	No Limit
EM2510957-003	BH04 / 50180625	EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	0.0	No Limit
EK040P: Fluoride by PC Titrator (QC Lot: 6664746)									
EM2511005-005	Anonymous	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.3	0.3	0.0	No Limit
EM2510957-001	SW02 / 25180625	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.1	0.1	0.0	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 6662654)									
EM2510937-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EM2510937-009	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 6671863)									
EM2510910-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.13	0.13	0.0	0% - 50%
EM2511045-005	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 6675011)									
EM2510957-002	SW03 / 25180625	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.01	0.04	86.3	No Limit
EM2510494-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.02	0.02	0.0	No Limit
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 6662653)									
EM2510937-001	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EM2510937-009	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	0.02	0.02	0.0	No Limit
EP005: Total Organic Carbon (TOC) (QC Lot: 6678522)									
EM2510890-001	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	6	8	37.2	No Limit
EM2510957-003	BH04 / 50180625	EP005: Total Organic Carbon	----	1	mg/L	7	6	23.9	No Limit

Method Blank (MB) and Laboratory Control Sample (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Acceptable Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
ED009: Anions (QCLot: 6675569)								
ED009: Bromide	24959-67-9	0.02	mg/L	<0.02	2 mg/L	101	84.0	118
EA005P: pH by PC Titrator (QCLot: 6664745)								
EA005-P: pH Value	----	----	pH Unit	----	4 pH Unit	99.5	98.8	101
				----	7 pH Unit	100	99.3	101
EA010P: Conductivity by PC Titrator (QCLot: 6664747)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	1412 µS/cm	96.6	85.0	119
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 6668192)								
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	2000 mg/L	99.4	91.0	110
				<10	2330 mg/L	110	80.7	119
				<10	293 mg/L	102	91.0	110
ED093F: Dissolved Major Cations (QCLot: 6675035)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	107	80.0	120
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	109	80.0	120
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	107	80.0	120
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	105	80.0	120
EG020F: Dissolved Metals by ICP-MS (QCLot: 6675033)								
EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	103	90.4	111
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	106	89.0	111
EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	99.1	85.0	112
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	97.4	83.5	111
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	104	83.2	109
EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	101	84.3	110
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	99.9	83.1	107
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	102	84.6	108
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	103	84.8	110
EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	101	88.3	112
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	96.5	84.3	110
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	103	82.3	113
EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	0.1 mg/L	108	86.7	113
EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	106	83.7	110

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Acceptable Limits (%) Low	Acceptable Limits (%) High
EG020F: Dissolved Metals by ICP-MS (QCLot: 6675033) - continued								
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	102	86.3	112
EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	95.5	85.4	115
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	105	91.8	112
EG020F: Dissolved Metals by ICP-MS (QCLot: 6675034)								
EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	0.02 mg/L	105	83.2	119
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 6664219)								
EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.004	0.2 mg/L	108	77.7	116
EK040P: Fluoride by PC Titrator (QCLot: 6664746)								
EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	5 mg/L	98.6	80.8	118
EK057G: Nitrite as N by Discrete Analyser (QCLot: 6662654)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	94.3	90.0	110
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 6671863)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	94.4	90.0	110
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 6675011)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	2.21 mg/L	94.2	71.9	114
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 6662653)								
EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	0.5 mg/L	99.3	90.0	110
EP005: Total Organic Carbon (TOC) (QCLot: 6678522)								
EP005: Total Organic Carbon	----	1	mg/L	<1	100 mg/L	95.0	81.2	110

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects or analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report Spike Concentration	SpikeRecovery(%) MS	Acceptable Limits (%) Low	Acceptable Limits (%) High
ED009: Anions (QCLot: 6675569)							
EM2510811-001	Anonymous	ED009: Bromide	24959-67-9	0.2 mg/L	# Not Determined	70.0	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 6675033)							
EM2510779-001	Anonymous	EG020A-F: Arsenic	7440-38-2	0.2 mg/L	103	76.6	124
		EG020A-F: Beryllium	7440-41-7	0.2 mg/L	106	73.0	120
		EG020A-F: Cadmium	7440-43-9	0.05 mg/L	99.0	74.6	118
		EG020A-F: Chromium	7440-47-3	0.2 mg/L	102	71.0	135

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Acceptable Limits (%)	
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 6675033) - continued							
EM2510779-001	Anonymous	EG020A-F: Cobalt	7440-48-4	0.2 mg/L	102	78.0	132
		EG020A-F: Copper	7440-50-8	0.2 mg/L	102	76.0	130
		EG020A-F: Lead	7439-92-1	0.2 mg/L	101	75.0	133
		EG020A-F: Manganese	7439-96-5	0.2 mg/L	104	64.0	134
		EG020A-F: Nickel	7440-02-0	0.2 mg/L	99.8	73.0	131
		EG020A-F: Vanadium	7440-62-2	0.2 mg/L	102	73.0	131
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	114	75.0	131
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 6664219)							
EM2510905-002	Anonymous	EK026SF: Total Cyanide	57-12-5	0.2 mg/L	73.2	70.0	130
EK040P: Fluoride by PC Titrator (QCLot: 6664746)							
EM2510910-004	Anonymous	EK040P: Fluoride	16984-48-8	5 mg/L	96.0	70.0	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 6662654)							
EM2510937-002	Anonymous	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	99.8	80.0	114
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 6675011)							
EM2510494-002	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	91.6	70.0	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 6662653)							
EM2510937-002	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.5 mg/L	110	79.0	123

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EM2510957**	Page	: 1 of 8
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: Hong Phuc Vu	Telephone	: +61-3-8549 9600
Project	: PS224394	Date Samples Received	: 19-Jun-2025
Site	: ----	Issue Date	: 29-Jun-2025
Sampler	: ----	No. of samples received	: 3
Order number	: PS224394	No. of samples analysed	: 3

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, where applicable to the methodology, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
ED009: Anions	EM2510811--001	Anonymous	**Bromide**	24959-67-9	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)	*Date extracted*	*Due for extraction*	***Days overdue***	*Date analysed*	*Due for analysis*	***Days overdue***
EA005P: pH by PC Titrator						
Clear Plastic Bottle - Natural SW02 / 25180625, SW03 / 25180625, BH04 / 50180625	----	----	----	23-Jun-2025	18-Jun-2025	**5**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type		Count		Rate (%)		Quality Control Specification
Analytical Methods	Method	QC	Regular	Actual	Expected	
Matrix Spikes (MS)						
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	0	13	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	0	12	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	Extraction / Preparation			Analysis		
Container */ Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural (EA005-P) SW02 / 25180625, SW03 / 25180625, BH04 / 50180625	**18-Jun-2025**	**----**	----	----	**23-Jun-2025**	18-Jun-2025	×

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P) SW02 / 25180625, SW03 / 25180625, BH04 / 50180625	18-Jun-2025	----	----	----	23-Jun-2025	16-Jul-2025	✓
EA015: Total Dissolved Solids dried at 180 ± 5 °C							
Clear Plastic Bottle - Natural (EA015H) SW02 / 25180625, SW03 / 25180625, BH04 / 50180625	18-Jun-2025	----	----	----	23-Jun-2025	25-Jun-2025	✓
ED009: Anions							
Clear Plastic Bottle - Natural (ED009) SW02 / 25180625, SW03 / 25180625, BH04 / 50180625	18-Jun-2025	----	----	----	26-Jun-2025	16-Jul-2025	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) SW02 / 25180625, SW03 / 25180625, BH04 / 50180625	18-Jun-2025	----	----	----	25-Jun-2025	16-Jul-2025	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020B-F) SW02 / 25180625, SW03 / 25180625, BH04 / 50180625	18-Jun-2025	----	----	----	25-Jun-2025	15-Dec-2025	✓
EK026SF: Total CN by Segmented Flow Analyser							
Opaque plastic bottle - NaOH (EK026SF) SW02 / 25180625, SW03 / 25180625, BH04 / 50180625	18-Jun-2025	----	----	----	23-Jun-2025	02-Jul-2025	✓
EK040P: Fluoride by PC Titrator							
Clear Plastic Bottle - Natural (EK040P) SW02 / 25180625, SW03 / 25180625, BH04 / 50180625	18-Jun-2025	----	----	----	23-Jun-2025	16-Jul-2025	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G) SW02 / 25180625, SW03 / 25180625, BH04 / 50180625	18-Jun-2025	----	----	----	20-Jun-2025	20-Jun-2025	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G) SW02 / 25180625, SW03 / 25180625, BH04 / 50180625	18-Jun-2025	----	----	----	28-Jun-2025	16-Jul-2025	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G) SW02 / 25180625, SW03 / 25180625, BH04 / 50180625	18-Jun-2025	28-Jun-2025	16-Jul-2025	✓	28-Jun-2025	16-Jul-2025	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK071G: Reactive Phosphorus as P by discrete analyser								
Clear Plastic Bottle - Natural (EK071G) SW02 / 25180625, BH04 / 50180625	SW03 / 25180625,	**18-Jun-2025**	**----**	----	----	**20-Jun-2025**	20-Jun-2025	✓
EP005: Total Organic Carbon (TOC)								
Amber TOC Vial - Sulfuric Acid (EP005) SW02 / 25180625, BH04 / 50180625	SW03 / 25180625,	**18-Jun-2025**	**----**	----	----	**26-Jun-2025**	16-Jul-2025	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Conductivity by Auto Titrator	EA010-P	1	3	**33.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	2	7	**28.57**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by Auto Titrator	EK040P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	13	**15.38**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by Auto Titrator	EA005-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions - by IC	ED009	1	3	**33.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	4	31	**12.90**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Conductivity by Auto Titrator	EA010-P	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by Auto Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by Auto Titrator	EA005-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions - by IC	ED009	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	3	31	**9.68**	**7.50**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Conductivity by Auto Titrator	EA010-P	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by Auto Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type / *Analytical Methods*	*Method*	*Count* QC	*Count* Regular	*Rate (%)* Actual	*Rate (%)* Expected	*Rate (%)* Evaluation	*Quality Control Specification*
Method Blanks (MB) - Continued							
Nitrite as N by Discrete Analyser	EK057G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions - by IC	ED009	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	31	**6.45**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by Auto Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	0	13	**0.00**	**5.00**	✗	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions - by IC	ED009	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	0	12	**0.00**	**5.00**	✗	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH by Auto Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM Schedule B(3)
Conductivity by Auto Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM Schedule B(3)
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of `filterable` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM Schedule B(3)
Standard Anions - by IC	ED009	WATER	In house: Referenced to APHA 4110. This method is compliant with NEPM Schedule B(3)
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Metals by ICP-MS - Suite B	EG020B-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Cyanide by Segmented Flow Analyser	EK026SF	WATER	In house: Referenced to APHA 4500-CN C&O / ASTM D7511 / ISO 14403. Sodium hydroxide preserved samples are introduced into an automated segmented flow analyser. Complex bound cyanide is decomposed in a continuously flowing stream, at a pH of 3.8, by the effect of UV light. A UV-B lamp (312 nm) and a decomposition spiral of borosilicate glass are used to filter out UV light with a wavelength of less than 290 nm thus preventing the conversion of thiocyanate into cyanide. The hydrogen cyanide present at a pH of 3.8 is separated by gas dialysis. The hydrogen cyanide is then determined photometrically, based on the reaction of cyanide with chloramine-T to form cyanogen chloride. This then reacts with 4-pyridine carboxylic acid and 1,3-dimethylbarbituric acid to give a red colour which is measured at 600 nm. This method is compliant with NEPM Schedule B(3)
Fluoride by Auto Titrator	EK040P	WATER	In house: Referenced to APHA 4500-F C: CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al, Zhang et al. This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Total Organic Carbon	EP005	WATER	In house: Referenced to APHA 5310 B, The automated TOC analyzer determines Total and Inorganic Carbon by IR cell. TOC is calculated as the difference. This method is compliant with NEPM Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM Schedule B(3)

CERTIFICATE OF ANALYSIS

Work Order	: **EM2511120**	Page	: 1 of 4
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: Hong Phuc Vu	Contact	: Josh Alexander
Address	: Level 11 567 Collins Street Melbourne VIC, AUSTRALIA 3000	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: +61 3 8862 3573	Telephone	: +61-3-8549 9600
Project	: PS224394	Date Samples Received	: 20-Jun-2025 15:30
Order number	: PS224394	Date Analysis Commenced	: 21-Jun-2025
C-O-C number	: ----	Issue Date	: 01-Jul-2025 17:08
Sampler	: ----		
Site	: ----		
Quote number	: WSP MSA 2025		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Dilani Fernando	Laboratory Coordinator	Melbourne Inorganics, Springvale, VIC
Eric Chau	Metals Team Leader	Melbourne Inorganics, Springvale, VIC
Jarwis Nheu	Non-Metals Team Leader	Melbourne Inorganics, Springvale, VIC
Nikki Stepniewski	Senior Inorganic Instrument Chemist	Melbourne Inorganics, Springvale, VIC

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EK026SF: EM2511107 #1, poor matrix spike recovery for TCN due to sample matrix. Confirmed by re-preparation and re-analysis.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW08/25200625	SW08/28200625	SW09/25200625	----	----
			Sampling date / time	20-Jun-2025 11:45	20-Jun-2025 11:45	20-Jun-2025 12:15	----	----
Compound	CAS Number	LOR	Unit	EM2511120-001	EM2511120-002	EM2511120-003	--------	--------
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**5.75**	**5.62**	**5.87**	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**297**	**318**	**45**	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**191**	**178**	**72**	----	----
ED009: Anions								
Bromide	24959-67-9	0.02	mg/L	**0.14**	**0.14**	**0.02**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**5**	**4**	**2**	----	----
Magnesium	7439-95-4	1	mg/L	**5**	**5**	<1	----	----
Sodium	7440-23-5	1	mg/L	**40**	**39**	**5**	----	----
Potassium	7440-09-7	1	mg/L	**2**	**2**	<1	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.02**	**0.02**	**0.02**	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.031**	**0.030**	<0.001	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L	**0.014**	**0.014**	**0.013**	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	**0.002**	**0.002**	**0.002**	----	----
Lead	7439-92-1	0.001	mg/L	**0.011**	**0.011**	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L	**0.047**	**0.046**	**0.002**	----	----
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW08/25200625	SW08/28200625	SW09/25200625	----	----
			Sampling date / time	20-Jun-2025 11:45	20-Jun-2025 11:45	20-Jun-2025 12:15	----	----
Compound	CAS Number	LOR	Unit	EM2511120-001	EM2511120-002	EM2511120-003	--------	--------
				Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L	**0.261**	**0.266**	**0.372**	----	----
Boron	7440-42-8	0.05	mg/L	**0.06**	**0.06**	<0.05	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	----	----
EK026SF: Total CN by Segmented Flow Analyser								
Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	<0.004	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	<0.1	<0.1	<0.1	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.27**	**0.30**	**0.19**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.27**	**0.30**	**0.19**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.02**	**0.04**	**0.02**	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**0.02**	**0.01**	<0.01	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**3**	**2**	**2**	----	----

Inter-Laboratory Testing

Analysis conducted by ALS Sydney, NATA accreditation no. 825, site no. 10911 (Chemistry / Biology).

(WATER) ED009: Anions

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EM2511120**	Page	: 1 of 8
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: Hong Phuc Vu	Telephone	: +61-3-8549 9600
Project	: PS224394	Date Samples Received	: 20-Jun-2025
Site	: ----	Issue Date	: 01-Jul-2025
Sampler	: ----	No. of samples received	: 3
Order number	: PS224394	No. of samples analysed	: 3

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, where applicable to the methodology, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
EK026SF: Total CN by Segmented Flow Analyser	EM2511107--001	Anonymous	**Total Cyanide**	57-12-5	60.9 %	70.0-130%	**Recovery less than lower data quality objective**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method		Extraction / Preparation			Analysis		
Container / Client Sample ID(s)		Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural							
SW08/25200625, SW09/25200625	SW08/28200625,	----	----	----	25-Jun-2025	20-Jun-2025	**5**
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural							
SW08/25200625, SW09/25200625	SW08/28200625,	----	----	----	23-Jun-2025	22-Jun-2025	**1**
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural							
SW08/25200625, SW09/25200625	SW08/28200625,	----	----	----	23-Jun-2025	22-Jun-2025	**1**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type		Count		Rate (%)		Quality Control Specification
Analytical Methods	Method	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)						
pH by Auto Titrator	EA005-P	1	18	5.56	10.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation: Date extracted	Extraction / Preparation: Due for extraction	Extraction / Preparation: Evaluation	Analysis: Date analysed	Analysis: Due for analysis	Analysis: Evaluation
EA005P: pH by PC Titrator								
Clear Plastic Bottle - Natural (EA005-P) SW08/25200625, SW09/25200625	SW08/28200625,	**20-Jun-2025**	**----**	----	----	**25-Jun-2025**	20-Jun-2025	×
EA010P: Conductivity by PC Titrator								
Clear Plastic Bottle - Natural (EA010-P) SW08/25200625, SW09/25200625	SW08/28200625,	**20-Jun-2025**	**----**	----	----	**25-Jun-2025**	18-Jul-2025	✓
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Clear Plastic Bottle - Natural (EA015H) SW08/25200625, SW09/25200625	SW08/28200625,	**20-Jun-2025**	**----**	----	----	**25-Jun-2025**	27-Jun-2025	✓
ED009: Anions								
Clear Plastic Bottle - Natural (ED009) SW08/25200625, SW09/25200625	SW08/28200625,	**20-Jun-2025**	**----**	----	----	**29-Jun-2025**	18-Jul-2025	✓
ED093F: Dissolved Major Cations								
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) SW08/25200625, SW09/25200625	SW08/28200625,	**20-Jun-2025**	**----**	----	----	**25-Jun-2025**	18-Jul-2025	✓
EG020F: Dissolved Metals by ICP-MS								
Clear Plastic Bottle - Nitric Acid; Filtered (EG020B-F) SW08/25200625, SW09/25200625	SW08/28200625,	**20-Jun-2025**	**----**	----	----	**25-Jun-2025**	17-Dec-2025	✓
EK026SF: Total CN by Segmented Flow Analyser								
Opaque plastic bottle - NaOH (EK026SF) SW08/25200625, SW09/25200625	SW08/28200625,	**20-Jun-2025**	**----**	----	----	**25-Jun-2025**	04-Jul-2025	✓
EK040P: Fluoride by PC Titrator								
Clear Plastic Bottle - Natural (EK040P) SW08/25200625, SW09/25200625	SW08/28200625,	**20-Jun-2025**	**----**	----	----	**25-Jun-2025**	18-Jul-2025	✓
EK057G: Nitrite as N by Discrete Analyser								
Clear Plastic Bottle - Natural (EK057G) SW08/25200625, SW09/25200625	SW08/28200625,	**20-Jun-2025**	**----**	----	----	**23-Jun-2025**	22-Jun-2025	×
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK059G) SW08/25200625, SW09/25200625	SW08/28200625,	**20-Jun-2025**	**----**	----	----	**30-Jun-2025**	18-Jul-2025	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK067G: Total Phosphorus as P by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK067G)								
SW08/25200625, SW09/25200625	SW08/28200625,	**20-Jun-2025**	**30-Jun-2025**	18-Jul-2025	✓	**30-Jun-2025**	18-Jul-2025	✓
EK071G: Reactive Phosphorus as P by discrete analyser								
Clear Plastic Bottle - Natural (EK071G)								
SW08/25200625, SW09/25200625	SW08/28200625,	**20-Jun-2025**	----	----	----	**23-Jun-2025**	22-Jun-2025	×
EP005: Total Organic Carbon (TOC)								
Amber TOC Vial - Sulfuric Acid (EP005)								
SW08/25200625, SW09/25200625	SW08/28200625,	**20-Jun-2025**	----	----	----	**30-Jun-2025**	18-Jul-2025	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Conductivity by Auto Titrator	EA010-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by Auto Titrator	EK040P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	13	**15.38**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by Auto Titrator	EA005-P	1	18	**5.56**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	10	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions - by IC	ED009	1	4	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	4	40	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Conductivity by Auto Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by Auto Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by Auto Titrator	EA005-P	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions - by IC	ED009	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	3	40	**7.50**	**7.50**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Conductivity by Auto Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by Auto Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Nitrite as N by Discrete Analyser	EK057G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions - by IC	ED009	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by Auto Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions - by IC	ED009	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
pH by Auto Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM Schedule B(3)
Conductivity by Auto Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM Schedule B(3)
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of `filterable` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM Schedule B(3)
Standard Anions - by IC	ED009	WATER	In house: Referenced to APHA 4110. This method is compliant with NEPM Schedule B(3)
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Metals by ICP-MS - Suite B	EG020B-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Cyanide by Segmented Flow Analyser	EK026SF	WATER	In house: Referenced to APHA 4500-CN C&O / ASTM D7511 / ISO 14403. Sodium hydroxide preserved samples are introduced into an automated segmented flow analyser. Complex bound cyanide is decomposed in a continuously flowing stream, at a pH of 3.8, by the effect of UV light. A UV-B lamp (312 nm) and a decomposition spiral of borosilicate glass are used to filter out UV light with a wavelength of less than 290 nm thus preventing the conversion of thiocyanate into cyanide. The hydrogen cyanide present at a pH of 3.8 is separated by gas dialysis. The hydrogen cyanide is then determined photometrically, based on the reaction of cyanide with chloramine-T to form cyanogen chloride. This then reacts with 4-pyridine carboxylic acid and 1,3-dimethylbarbituric acid to give a red colour which is measured at 600 nm. This method is compliant with NEPM Schedule B(3)
Fluoride by Auto Titrator	EK040P	WATER	In house: Referenced to APHA 4500-F C: CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al, Zhang et al. This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Total Organic Carbon	EP005	WATER	In house: Referenced to APHA 5310 B, The automated TOC analyzer determines Total and Inorganic Carbon by IR cell. TOC is calculated as the difference. This method is compliant with NEPM Schedule B(3)

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM Schedule B(3)

CERTIFICATE OF ANALYSIS

Work Order	: **EM2512392**	Page	: 1 of 4
Amendment	: **(Partial Report)**		
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: Hong Phuc Vu	Contact	: Josh Alexander
Address	: Level 11 567 Collins Street Melbourne VIC, AUSTRALIA 3000	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: +61 3 8862 3573	Telephone	: +61-3-8549 9600
Project	: PS224394	Date Samples Received	: 17-Jun-2025 10:50
Order number	: PS224394	Date Analysis Commenced	: 11-Jul-2025
C-O-C number	: ----	Issue Date	: 14-Jul-2025 11:02
Sampler	: ----		
Site	: McCrae Landslide		
Quote number	: WSP MSA 2025		
No. of samples received	: 8		
No. of samples analysed	: 8		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Dilani Fernando	Laboratory Coordinator	Melbourne Inorganics, Springvale, VIC

(Partial Report)

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

This report contains preliminary authorised results. The report may contain semi-quantitative results. Any result presented in this preliminary report may be subject to change in the final report.

- This is a rebatch of EM2510716, EM2510957 and EM2511120.
- ED045G: The presence of Thiocyanate, Thiosulfate and Sulfite can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.

(Partial Report)

Work Order : EM2512392
Client : WSP Australia Pty Ltd
Project : PS224394

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	Pit01/25160625	Pit03/25160625	Pit04/25160625	SW02/25180625	SW03/25180625
			Sampling date / time	16-Jun-2025 14:45	16-Jun-2025 15:15	16-Jun-2025 15:45	18-Jun-2025 11:30	18-Jun-2025 11:00
Compound	CAS Number	LOR	Unit	EM2512392-001	EM2512392-002	EM2512392-003	EM2512392-004	EM2512392-005
				Result	Result	Result	Result	Result
ED040F: Dissolved Major Anions								
Silicon	7440-21-3	0.05	mg/L	**7.18**	**7.25**	**6.74**	**7.92**	**7.90**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**26**	**28**	**42**	**39**	**39**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**65**	**66**	**102**	**152**	**154**

(Partial Report)

Analytical Results

Sub-Matrix: WATER
(Matrix: WATER)

			Sample ID	BH04/50180625	SW08/25200625	SW08/28200625	----	----
			Sampling date / time	18-Jun-2025 09:30	20-Jun-2025 11:45	20-Jun-2025 11:45	----	----
Compound	CAS Number	LOR	Unit	EM2512392-006	EM2512392-007	EM2512392-008	--------	--------
				Result	Result	Result	----	----
ED040F: Dissolved Major Anions								
Silicon	7440-21-3	0.05	mg/L	**24.7**	**0.22**	**0.25**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**343**	**11**	**11**	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**3260**	**71**	**78**	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **EM2512392**	Page	: 1 of 4
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: Hong Phuc Vu	Contact	: Josh Alexander
Address	: Level 11 567 Collins Street Melbourne VIC, AUSTRALIA 3000	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: +61 3 8862 3573	Telephone	: +61-3-8549 9600
Project	: PS224394	Date Samples Received	: 17-Jun-2025 10:50
Order number	: PS224394	Date Analysis Commenced	: 11-Jul-2025
C-O-C number	: ----	Issue Date	: 15-Jul-2025 10:36
Sampler	: ----		
Site	: McCrae Landslide		
Quote number	: WSP MSA 2025		
No. of samples received	: 8		
No. of samples analysed	: 8		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Dilani Fernando	Laboratory Coordinator	Melbourne Inorganics, Springvale, VIC
Jarwis Nheu	Non-Metals Team Leader	Melbourne Inorganics, Springvale, VIC

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- This is a rebatch of EM2510716, EM2510957 and EM2511120.
- ED045G: The presence of Thiocyanate, Thiosulfate and Sulfite can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			*Sample ID*	Pit01/25160625	Pit03/25160625	Pit04/25160625	SW02/25180625	SW03/25180625
			Sampling date / time	16-Jun-2025 14:45	16-Jun-2025 15:15	16-Jun-2025 15:45	18-Jun-2025 11:30	18-Jun-2025 11:00
Compound	*CAS Number*	*LOR*	*Unit*	EM2512392-001	EM2512392-002	EM2512392-003	EM2512392-004	EM2512392-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**6.61**	**7.34**	**7.26**	**7.13**	**7.44**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**120**	**121**	**103**	**98**	**100**
Total Alkalinity as CaCO3	----	1	mg/L	**120**	**121**	**103**	**98**	**100**
ED040F: Dissolved Major Anions								
Silicon	7440-21-3	0.05	mg/L	**7.18**	**7.25**	**6.74**	**7.92**	**7.90**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**26**	**28**	**42**	**39**	**39**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**65**	**66**	**102**	**152**	**154**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	BH04/50180625	SW08/25200625	SW08/28200625	----	----
			Sampling date / time	18-Jun-2025 09:30	20-Jun-2025 11:45	20-Jun-2025 11:45	----	----
Compound	CAS Number	LOR	Unit	EM2512392-006	EM2512392-007	EM2512392-008	--------	--------
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**6.74**	**5.74**	**5.84**	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**158**	**9**	**4**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**158**	**9**	**4**	----	----
ED040F: Dissolved Major Anions								
Silicon	7440-21-3	0.05	mg/L	**24.7**	**0.22**	**0.25**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**343**	**11**	**11**	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**3260**	**71**	**78**	----	----

QUALITY CONTROL REPORT

Work Order	: **EM2512392**	Page	: 1 of 3
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: Hong Phuc Vu	Contact	: Josh Alexander
Address	: Level 11 567 Collins Street Melbourne VIC, AUSTRALIA 3000	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: +61 3 8862 3573	Telephone	: +61-3-8549 9600
Project	: PS224394	Date Samples Received	: 17-Jun-2025
Order number	: PS224394	Date Analysis Commenced	: 11-Jul-2025
C-O-C number	: ----	Issue Date	: 15-Jul-2025
Sampler	: ----		
Site	: McCrae Landslide		
Quote number	: WSP MSA 2025		
No. of samples received	: 8		
No. of samples analysed	: 8		

Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Dilani Fernando	Laboratory Coordinator	Melbourne Inorganics, Springvale, VIC
Jarwis Nheu	Non-Metals Team Leader	Melbourne Inorganics, Springvale, VIC

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	***Sample ID***	***Method: Compound***	***CAS Number***	***LOR***	***Unit***	***Original Result***	***Duplicate Result***	***RPD (%)***	***Acceptable RPD (%)***
EA005P: pH by PC Titrator (QC Lot: 6716659)									
EM2512383-023	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	7.46	7.55	1.2	0% - 20%
EM2512384-005	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	3.02	3.01	0.3	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 6716661)									
EM2512384-005	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	<1	<1	0.0	No Limit
EM2512397-004	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	<1	<1	0.0	No Limit
ED040F: Dissolved Major Anions (QC Lot: 6714846)									
EM2512345-001	Anonymous	ED040F: Silicon	7440-21-3	0.05	mg/L	1.67	1.68	0.0	0% - 20%
EM2512392-008	SW08/28200625	ED040F: Silicon	7440-21-3	0.05	mg/L	0.25	0.33	25.7	No Limit
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 6714848)									
EM2512383-019	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	1470	1470	0.0	0% - 20%
EM2512392-008	SW08/28200625	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	11	12	0.0	0% - 50%
ED045G: Chloride by Discrete Analyser (QC Lot: 6714849)									
EM2512392-008	SW08/28200625	ED045G: Chloride	16887-00-6	1	mg/L	78	78	0.0	0% - 20%

Method Blank (MB) and Laboratory Control Sample (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
				Result	Spike Concentration	Spike Recovery (%) LCS	Acceptable Limits (%) Low	Acceptable Limits (%) High
EA005P: pH by PC Titrator (QCLot: 6716659)								
EA005-P: pH Value	----	----	pH Unit	----	4 pH Unit	100	98.8	101
				----	7 pH Unit	100	99.3	101
ED037P: Alkalinity by PC Titrator (QCLot: 6716661)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	# 2.6	85.0	116
ED040F: Dissolved Major Anions (QCLot: 6714846)								
ED040F: Silicon	7440-21-3	0.05	mg/L	<0.05	5 mg/L	100	80.0	120
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 6714848)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	500 mg/L	100	90.0	110
				<1	25 mg/L	107	90.0	110
ED045G: Chloride by Discrete Analyser (QCLot: 6714849)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	1000 mg/L	106	90.0	110
				<1	10 mg/L	102	90.0	110

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects or analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report			
				Spike Concentration	SpikeRecovery(%) MS	Acceptable Limits (%) Low	Acceptable Limits (%) High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 6714848)							
EM2512392-002	Pit03/25160625	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	100 mg/L	79.4	70.0	130
ED045G: Chloride by Discrete Analyser (QCLot: 6714849)							
EM2512392-002	Pit03/25160625	ED045G: Chloride	16887-00-6	400 mg/L	83.4	70.0	142

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EM2512392**	Page	: 1 of 6
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: Hong Phuc Vu	Telephone	: +61-3-8549 9600
Project	: PS224394	Date Samples Received	: 17-Jun-2025
Site	: McCrae Landslide	Issue Date	: 15-Jul-2025
Sampler	: ----	No. of samples received	: 8
Order number	: PS224394	No. of samples analysed	: 8

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Matrix Spike outliers occur.**
- **Laboratory Control outliers exist - please see following pages for full details.**
- **For all regular sample matrices, where applicable to the methodology, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Laboratory Control Spike (LCS) Recoveries							
ED037P: Alkalinity by PC Titrator	QC-6716661-001	----	**Total Alkalinity as CaCO3**	----	2.6 %	85.0-116%	**Recovery less than lower control limit**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)		Extraction / Preparation: Date extracted	Due for extraction	Days overdue	Analysis: Date analysed	Due for analysis	Days overdue
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural							
Pit01/25160625, Pit04/25160625	Pit03/25160625,	----	----	----	15-Jul-2025	16-Jun-2025	**29**
Clear Plastic Bottle - Natural							
SW02/25180625, BH04/50180625	SW03/25180625,	----	----	----	15-Jul-2025	18-Jun-2025	**27**
Clear Plastic Bottle - Natural							
SW08/25200625,	SW08/28200625	----	----	----	15-Jul-2025	20-Jun-2025	**25**
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural							
Pit01/25160625, Pit04/25160625	Pit03/25160625,	----	----	----	15-Jul-2025	30-Jun-2025	**15**
Clear Plastic Bottle - Natural							
SW02/25180625, BH04/50180625	SW03/25180625,	----	----	----	15-Jul-2025	02-Jul-2025	**13**
Clear Plastic Bottle - Natural							
SW08/25200625,	SW08/28200625	----	----	----	15-Jul-2025	04-Jul-2025	**11**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Extraction / Preparation: Due for extraction	Extraction / Preparation: Evaluation	Analysis: Date analysed	Analysis: Due for analysis	Analysis: Evaluation
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural (EA005-P) Pit01/25160625, Pit03/25160625, Pit04/25160625	**16-Jun-2025**	**----**	----	----	**15-Jul-2025**	16-Jun-2025	×
Clear Plastic Bottle - Natural (EA005-P) SW02/25180625, SW03/25180625, BH04/50180625	**18-Jun-2025**	**----**	----	----	**15-Jul-2025**	18-Jun-2025	×
Clear Plastic Bottle - Natural (EA005-P) SW08/25200625, SW08/28200625	**20-Jun-2025**	**----**	----	----	**15-Jul-2025**	20-Jun-2025	×
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P) Pit01/25160625, Pit03/25160625, Pit04/25160625	**16-Jun-2025**	**----**	----	----	**15-Jul-2025**	30-Jun-2025	×
Clear Plastic Bottle - Natural (ED037-P) SW02/25180625, SW03/25180625, BH04/50180625	**18-Jun-2025**	**----**	----	----	**15-Jul-2025**	02-Jul-2025	×
Clear Plastic Bottle - Natural (ED037-P) SW08/25200625, SW08/28200625	**20-Jun-2025**	**----**	----	----	**15-Jul-2025**	04-Jul-2025	×
ED040F: Dissolved Major Anions							
Clear Plastic Bottle - Natural (ED040F) Pit01/25160625, Pit03/25160625, Pit04/25160625	**16-Jun-2025**	**----**	----	----	**11-Jul-2025**	14-Jul-2025	✓
Clear Plastic Bottle - Natural (ED040F) SW02/25180625, SW03/25180625, BH04/50180625	**18-Jun-2025**	**----**	----	----	**11-Jul-2025**	16-Jul-2025	✓
Clear Plastic Bottle - Natural (ED040F) SW08/25200625, SW08/28200625	**20-Jun-2025**	**----**	----	----	**11-Jul-2025**	18-Jul-2025	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G) Pit01/25160625, Pit03/25160625, Pit04/25160625	**16-Jun-2025**	**----**	----	----	**11-Jul-2025**	14-Jul-2025	✓
Clear Plastic Bottle - Natural (ED041G) SW02/25180625, SW03/25180625, BH04/50180625	**18-Jun-2025**	**----**	----	----	**11-Jul-2025**	16-Jul-2025	✓
Clear Plastic Bottle - Natural (ED041G) SW08/25200625, SW08/28200625	**20-Jun-2025**	**----**	----	----	**11-Jul-2025**	18-Jul-2025	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED045G: Chloride by Discrete Analyser								
Clear Plastic Bottle - Natural (ED045G)								
Pit01/25160625, Pit04/25160625	Pit03/25160625,	**16-Jun-2025**	----	----	----	**11-Jul-2025**	14-Jul-2025	✓
Clear Plastic Bottle - Natural (ED045G)								
SW02/25180625, BH04/50180625	SW03/25180625,	**18-Jun-2025**	----	----	----	**11-Jul-2025**	16-Jul-2025	✓
Clear Plastic Bottle - Natural (ED045G)								
SW08/25200625,	SW08/28200625	**20-Jun-2025**	----	----	----	**11-Jul-2025**	18-Jul-2025	✓

Work Order : EM2512392
Client : WSP Australia Pty Ltd
Project : PS224394

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by Auto Titrator	ED037-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	8	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Anions - Dissolved	ED040F	2	8	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by Auto Titrator	EA005-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	10	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by Auto Titrator	ED037-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	8	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Anions - Dissolved	ED040F	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by Auto Titrator	EA005-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	10	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chloride by Discrete Analyser	ED045G	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Anions - Dissolved	ED040F	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Chloride by Discrete Analyser	ED045G	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
pH by Auto Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM Schedule B(3)
Alkalinity by Auto Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) on a settled supernatant aliquot of the sample using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM Schedule B(3)
Major Anions - Dissolved	ED040F	WATER	In house: Referenced to APHA 3120. The 0.45µm filtered samples are determined by ICP/AES for Sulfur and/or Silicon content and reported as Sulfate and/or Silica after conversion by gravimetric factor.
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride. In the presence of ferric ions the liberated thiocyanate forms highly-coloured ferric thiocyanate which is measured at 480 nm.

REBATCH REQUEST

Workorder / Client code / Project:	ALS Workorder EM2510716, EM2510957 & EM2511120, Client PARBRIVIC, Project PS224394, McCrae Landslide		**CS Contact: Josh Alexander**
			Additional Information:
Project Manager:	Hong Phuc Vu ***Please include this rebatch PM plus all report recipients as per original workorder***		
Date samples rec'd:	17/06/2025 10:50		
Date Instructions rec'd:	Fri 11/07/2025 10:21 AM		analyse for alkalinity ASAP - holding time
Rebatch due date:	18/07/2025	FTAT approved?	
Due date surcharge:	N/A		

New Lab ID	Client ID	Sampling Date / Time	Previous Work Order Reference	Previous ALS ID	Tray Number(s)	Container	Managed Moisture	Standard: **NT-02**: Major Anions	Standard: **ED040F**: Silicon			Leachate						Shortest Holding time expiry
1	Pit01/25160625	16/06/2025 14:45	EM2510716	1	MG1496-97	500 mL Green/ Natural	NO	X	X									30-Jun-25
2	Pit03/25160625	16/06/2025 15:15	EM2510716	2	MG1496-97		NO	X	X									30-Jun-25
3	Pit04/25160625	16/06/2025 15:45	EM2510716	3	MG1496-97		NO	X	X									30-Jun-25
4	SW02 / 25180625	18/06/2025 11:30	EM2510957	1	MG 1535-36		NO	X	X									02-Jul-25
5	SW03 / 25180625	18/06/2025 11:00	EM2510957	2	MG 1535-36		NO	X	X									02-Jul-25
6	BH04 / 50180625	18/06/2025 9:30	EM2510957	3	MG 1535-36		NO	X	X									02-Jul-25
7	SW08/25200625	20/06/2025 11:45	EM2511120	1	MG 1558		NO	X	X									04-Jul-25
8	SW08/28200625	20/06/2025 11:45	EM2511120	2	MG 1558		NO	X	X									04-Jul-25
X	SW09/25200625	20/06/2025 12:15	EM2511120	3	MG 1558		NO	X	X									04-Jul-25
							TOTAL											

X = No volume.

Environmental Division
Melbourne
Work Order Reference
EM2512392
Telephone : + 61-3-8549 9600

Ciara Barr

From: Vu, Hong Phuc <hong.vu@wsp.com>
Friday, 11 July 2025 10:21 AM
To: Josh Alexander
Cc: Paul, Darren; Dubowik, Alana; Verburg, Rens
Subject: RE: [EXTERNAL] - FW: RESULTS & EDD for ALS Workorder : EM2511120 | Overall Description: McCrae Landslide

Hi Josh,

They were requested initially and our field engineers made it short as per your quote below. HCO3 /alkalinity is one of our important parameters. Is there a chance to test the remaining/residual samples?

RE: [EXTERNAL] - McCrae Landslide

JA Josh Alexander <josh.alexander@ALSGlobal.com>
To Vu, Hong Phuc
Cc Paul, Darren

Business Confidential\Internal and External

This sender josh.alexander@ALSGlobal.com is from outside your organization.

You replied to this message on 13/06/2025 9:40 AM.

See below suites/method codes to use, pricing and the bottle requirements. Note we do not offer to su
able to supply again in the future

MATRIX	TEST PARAMETER	ALS Code	TECHNIQUE / METHOD REFERENCE
WATER	Cations & Anions: Major (Ca, Mg, Na, K, Cl, SO_4, Alkalinity) + Fluoride	NT-1 & NT-2A	Various
WATER	Conductivity (EC)	EA010P	APHA 2510 B
WATER	pH	EA005P	APHA 4500 H+ -
WATER	Total Dissolved Solids (TDS)	EA015H	APHA 2540 C
WATER	Nitrate as N	EK058G	APHA VCl3 reducti 4500 NO_3^- + NO_2^-

Many thanks,
HOng

My workdays are Monday, Tuesday, Thursday and Friday

Hong Phuc Vu, PhD
Senior Associate Geochemist/Geochemical Modeller
He/Him

T +61 3 8862 3573
Irrelevant & Sensitive

WSP
Level 11, 567 Collins Street
Melbourne, 3000
Australia

DPA.0004.0001.0001_0260

#1235266
LS 20/6

wsp

Chain of Custody Form

P Project No.	PS224394	Delivery Method *	Courier	
Location	McCrae Landslide		WSP	
oratory	EUROFINS			
oratory / Quote	WSP standard	Turnaround Time Required		5 days
P Workorder No.		Sampled By	(initials)	
WSP Job Contact		Chilled		x
WSP Email (1)	HongLuu@wsp.com	Security Sealed		x
WSP Email (2)				
WSP Email (3)	au_esdat_labsync@golderassociates.onmicrosoft.com			

Samples likely to be highly contaminated marked # below

Sample Receipt 1				Sample Receipt 2			
Relinquished By	S, B	Received By	Vinmi?	Relinquished By		Received By	
Organisation	WSP	Organisation	EF	Organisation		Organisation	
Date	20/6	Date	20/6	Date		Date	
Time	2:30	Time	5:29	Time		Time	
Sec. Seal Intact	Yes	Temperature	7.5 °C ice	Sec. Seal Intact	Yes/No	Temperature	°C

#	SAMPLE DATE & TIME	SAMPLE ID	SAMPLE TYPE	SAMPLE CONTAINERS	TOC	Dissolved Metals & Cations	pH, EC, TDS, Reactive P, Nitrate, Fluoride	Bromide	Total P, Nitrate	Cyanide (total)
1	20/6 11:45	SW08/29 200625	W	5	x	x	x	x	x	x

eurofins Environment Testing

www.eurofins.com.au EnviroSales@eurofinsanz.com

Eurofins Environment Testing Australia Pty Ltd
ABN: 50 005 085 521

Melbourne	Geelong	Sydney	Canberra	Brisbane	Newcastle
6 Monterey Road	19/8 Lewalan Street	179 Magowar Road	Unit 1,2 Dacre Street	1/21 Smallwood Place	1/2 Frost Drive
Dandenong South	Grovedale	Girraween	Mitchell	Murarrie	Mayfield West
VIC 3175	VIC 3216	NSW 2145	ACT 2911	QLD 4172	NSW 2304
+61 3 8564 5000	+61 3 8564 5000	+61 2 9900 8400	+61 2 6113 8091	+61 7 3902 4600	+61 2 4968 8448
NATA# 1261	NATA# 1261	NATA# 1261	NATA# 1261	NATA# 1261	NATA# 1261
Site# 1254	Site# 25403	Site# 18217	Site# 25466	Site# 20794 & 2780	Site# 25079

Eurofins ARL Pty Ltd
ABN: 91 05 0159 898

Perth
46-48 Banksia Road
Welshpool
WA 6106
+61 8 6253 4444
NATA# 2377
Site# 2370 & 2554

Eurofins Environment Testing NZ Ltd
NZBN: 9429046024954

Auckland	Auckland (Focus)	Christchurch	Tauranga
35 O'Rorke Road	Unit C1/4 Pacific Rise	43 Detroit Drive	1277 Cameron Road
Penrose	Mount Wellington	Rolleston	Gate Pa
Auckland 1061	Auckland 1061	Christchurch 7675	Tauranga 3112
+64 9 526 4551	+64 9 525 0568	+64 3 343 5201	+64 9 525 0568
IANZ# 1327	IANZ# 1308	IANZ# 1290	IANZ# 1402

Sample Receipt Advice

Company name:	WSP Australia P/L MELB
Contact name:	Hong Vu
Project name:	McCrae Landslide
Project ID:	PS224394
Turnaround time:	5 Day
Date/Time received	Jun 23, 2025 1:28 PM
Eurofins reference	1235266

Sample Information

- ✓ A detailed list of analytes logged into our LIMS, is included in the attached summary table.
- ✓ All samples have been received as described on the above COC.
- ✓ COC has been completed correctly.
- ✓ Attempt to chill was evident.
- ✓ Appropriately preserved sample containers have been used.
- ✓ All samples were received in good condition.
- ✓ Samples have been provided with adequate time to commence analysis in accordance with the relevant holding times.
- ✓ Appropriate sample containers have been used.
- ✓ Sample containers for volatile analysis received with zero headspace.
- ✗ Split sample sent to requested external lab.
- ✗ Some samples have been subcontracted.
- N/A Custody Seals intact (if used).

Notes

Contact

If you have any questions with respect to these samples, please contact your Analytical Services Manager:

Harry Bacalis on phone : +61 3 8564 5064 or by email: Harry.Bacalis@eurofinsanz.com

Results will be delivered electronically via email to Hong Vu - hong.vu@wsp.com.

Note: A copy of these results will also be delivered to the general WSP Australia P/L MELB email address.

Global Leader - Results you can trust

eurofins

web: www.eurofins.com.au
email: EnviroSales@eurofinsanz.com

Eurofins Environment Testing Australia Pty Ltd
ABN: 50 005 085 521

Melbourne	Geelong	Sydney	Canberra	Brisbane	Newcastle
6 Monterey Road	19/8 Lewalan Street	179 Magowar Road	Unit 1,2 Dacre Street	1/21 Smallwood Place	1/2 Frost Drive
Dandenong South	Grovedale	Girraween	Mitchell	Murarrie	Mayfield West
VIC 3175	VIC 3216	NSW 2145	ACT 2911	QLD 4172	NSW 2304
+61 3 8564 5000	+61 3 8564 5000	+61 2 9900 8400	+61 2 6113 8091	+61 7 3902 4600	+61 2 4968 8448
NATA# 1261	NATA# 1261	NATA# 1261	NATA# 1261	NATA# 1261	NATA# 1261
Site# 1254	Site# 25403	Site# 18217	Site# 25466	Site# 20794 & 2780	Site# 25079

Eurofins ARL Pty Ltd
ABN: 91 05 0159 898

Perth
46-48 Banksia Road
Welshpool
WA 6106
+61 8 6253 4444
NATA# 2377
Site# 2370 & 2554

Eurofins Environment Testing NZ Ltd
NZBN: 9429046024954

Auckland	Auckland (Focus)	Christchurch	Tauranga
35 O'Rorke Road	Unit C1/4 Pacific Rise	43 Detroit Drive	1277 Cameron Road
Penrose	Mount Wellington	Rolleston	Gate Pa
Auckland 1061	Auckland 1061	Christchurch 7675	Tauranga 3112
+64 9 526 4551	+64 9 525 0568	+64 3 343 5201	+64 9 525 0568
IANZ# 1327	IANZ# 1308	IANZ# 1290	IANZ# 1402

Company Name: WSP Australia P/L MELB
Address: Level 11, 567 Collins Street
Melbourne
VIC 3000

Project Name: McCrae Landslide
Project ID: PS224394

Order No.:
Report #: 1235266
Phone: 9861 1111
Fax: 9861 1144

Received: Jun 23, 2025 1:28 PM
Due: Jun 30, 2025
Priority: 5 Day
Contact Name: Hong Vu

Eurofins Analytical Services Manager : Harry Bacalis

Sample Detail

Melbourne Laboratory - NATA # 1261 Site # 1254

External Laboratory

No	Sample ID	Sample Date	Sampling Time	Matrix	LAB ID
1	SW08/29200625	Jun 20, 2025	11:45AM	Water	M25-Jn0058408

Analyte	Melbourne Laboratory - NATA # 1261 Site # 1254	External Laboratory	1 (M25-Jn0058408)	Test Counts
Aluminium	X		X	1
Arsenic (filtered)	X		X	1
Beryllium (filtered)	X		X	1
Bicarbonate Alkalinity (as CaCO3)	X		X	1
Boron (filtered)	X		X	1
Bromide	X		X	1
Cadmium (filtered)	X		X	1
Calcium	X		X	1
Chloride	X		X	1
Chromium (filtered)	X		X	1
Cobalt (filtered)	X		X	1
Conductivity (at 25 °C)	X		X	1
Copper (filtered)	X		X	1
Cyanide (total)	X		X	1
Fluoride	X		X	1
Iron	X		X	1
Lead (filtered)	X		X	1
Magnesium	X		X	1
Manganese	X		X	1
Manganese (filtered)	X		X	1
Mercury (filtered)	X		X	1
Molybdenum (filtered)	X		X	1
Nickel (filtered)	X		X	1
Nitrate (as N)	X		X	1
pH (at 25 °C)	X		X	1
Phosphate total (as P)	X		X	1
Phosphorus reactive (as P)	X		X	1
Potassium	X		X	1
Selenium (filtered)	X		X	1
Silica (calculation from Si as SiO2)	X		X	1
Silver (filtered)	X		X	1
Sodium	X		X	1
Sulphate (as SO4)	X		X	1
Tin (filtered)	X		X	1
Total Organic Carbon	X		X	1
Vanadium (filtered)	X		X	1
Zinc (filtered)	X		X	1
Total Dissolved Solids Dried at 180 °C ± 2 °C	X		X	1

McCrae Landslide - PS224394

Vu, Hong Phuc<hong.vu@wsp.com>
To: Harry Bacalis
Cc: Brennan, Sachin <Sachin.Brennan@wsp.com>; Paul, Darren <darren.paul@wsp.com>

Hi Harry,

Can you please send 4 bottle sets for water samples for: Al, Fe, Mn, Ca, Mg, HCO3, K, Na, Cl, silica (as SiO2), SO4, NO3, F, PO4, pH, EC, TDS, Total Organic Carbon, total Phosphorus, reactive phosphate, and filtered trace metals (Arsenic, Beryllium, Boron, Bromide, Cobalt, Cadmium, Calcium, Chloride, Chromium, Copper, Cyanide, Manganese, Lead, Mercury, Molybdenum, Nickel, Zinc, Silver, Tin, Vanadium, and Selenium).

filters (4 each) and 50 mL syringes (4 each).

Please send to our Richmond office today and Sachin (cc'ed here) is our contact person.

Many thanks,
Hong

My workdays are Monday, Tuesday, Thursday and Friday

Hong Phuc Vu, PhD
Senior Associate Geochemist/Geochemical Modeller
He/Him

T +61 3 8862 3573
Irrelevant & Sensitive

WSP
Level 11, 567 Collins Street
Melbourne, 3000
Australia

wsp.com

WSP acknowledges that every project we work on takes place on First Peoples lands. We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

Eurofins Sample Receipt Advice - Report 1235266 : Site McCrae Landslide (PS224394)

McCrae ...24394

Vu, Hong Phuc<hong.vu@wsp.com>
To: SH_AU_CAU001_EnviroSampleVic
Cc: Harry Bacalis; +2 others
Mon 23/6/25 1:28 PM

McCrae Landslide - PS224394
Outlook item

Unverified Sender: The sender of this email has not been verified. Review the content of the message carefully and verify the identity of the sender before acting on this email: replying, opening attachments or clicking links.

Hi Luke and Harry,

Can you please request the testing for this sample as per the attached email?

Many thanks,
Hong

My workdays are Monday, Tuesday, Thursday and Friday

Hong Phuc Vu, PhD
Senior Associate Geochemist/Geochemical Modeller
He/Him

T +61 3 8862 3573
Irrelevant & Sensitive

WSP
Level 11, 567 Collins Street
Melbourne, 3000
Australia

wsp.com

wsp

Chain of Custody Form

WSP Project No.	PS224394	Delivery Method	Courier
Job Location	McCrae Landslide		WSP
Laboratory	ALS		
Laboratory / Quote	WSP standard	Turnaround Time Required	5 days
WSP Workorder No.		Sampled By (initials)	
WSP Job Contact		Chilled	x
WSP Email (1)	Hong.vu@wsp.com	Security Sealed	x
WSP Email (2)			
WSP Email (3)	au_esdat_labsync@golderassociates.onmicrosoft.com		

Samples likely to be highly contaminated marked # below

Sample Receipt 1				Sample Receipt 2			
Relinquished By	S.B	Received By		Relinquished By		Received By	
Organisation	WSP	Organisation		Organisation		Organisation	
Date	17/6	Date		Date		Date	
Time	7:00	Time		Time		Time	
Sec. Seal Intact	Yes	Temperature	°C	Sec. Seal Intact	Yes/No	Temperature	°C

#	SAMPLE DATE & TIME		SAMPLE ID	SAMPLE TYPE	SAMPLE CONTAINERS	TOC	Dissolved Metals & Cations	pH, EC, TDS, Reactive P, Nitrate, Fluoride	Bromide	Total P, Nitrate	Cyanide (total)
1	16/6	14:45	Pit01/25160625	W	6	x	x	x	x	x	x
2	↓	15:15	Pit05/25160625	W	6	x	x	x	x	x	x
3	↓	15:45	Pit04/25160625	W	6	x	x	x	x	x	✓

Environmental Division
Melbourne
Work Order Reference
EM2510716

Telephone : + 61-3-8549 9600

[illegible] 17/6 10.50

wsp

Chain of Custody Form

WSP Project No.	P5224394	Delivery Method Courier	
Job Location	McCrae Landslide	WSP	
Laboratory	ALS		
Laboratory / Quote	WSP standard	Turnaround Time Required	5 days
WSP Workorder No.		Sampled By (initials)	
WSP Job Contact		Chilled	x
WSP Email (1)	Hong.vu@wsp.com	Security Sealed	x
WSP Email (2)			
WSP Email (3)	au_esdat_labsync@golderassociates.onmicrosoft.com		

Sample Receipt 1				Sample Receipt 2			
Relinquished By	S.B	Received By		Relinquished By		Received By	Monne
Organisation	14:50	Organisation		Organisation		Organisation	Cha
Date	18/6	Date		Date		Date	19/6 12:05
Time	W	Time		Time		Time	
Sec. Seal Intact	Yes	Temperature	°C	Sec. Seal Intact	Yes/No	Temperature	°C 7.8

Samples likely to be highly contaminated marked # below

#	SAMPLE DATE & TIME		SAMPLE ID	SAMPLE TYPE	SAMPLE CONTAINERS	TOC	Dissolved Metals & Cations	pH, EC, TDS, Reactive P, Nitrate, Fluoride	Bromide	Total P, Nitrate	Cyanide (total)
1	18/6	11:30	SW02 / 25180625	W	6	x	x	x	x	x	x
2	↓	11:00	SW03 / 25180625	W	6	x	x	x	x	x	x
3	↓	9:30	13H04 / 50180625	W	6	x	x	x	x	x	x

Environmental Division
Melbourne
Work Order Reference
EM2510957

Telephone : +61-3-8549 9600

wsp

Chain of Custody Form

WSP Project No.	PS224394	Delivery Method Courier	
Job Location	McCrae Landslide	WSP	
Laboratory	ALS		
Laboratory / Quote	WSP standard	Turnaround Time Required	5 days
WSP Workorder No.		Sampled By (initials)	
WSP Job Contact		Chilled	x
WSP Email (1)	Hong.vu@wsp.com	Security Sealed	x
WSP Email (2)			
WSP Email (3)	au_esdat_labsync@golderassociates.onmicrosoft.com		

Sample Receipt 1				Sample Receipt 2			
Relinquished By	SJB	Received By		Relinquished By		Received By	Morton
Organisation	WSP	Organisation		Organisation		Organisation	(ALS)
Date	20/6	Date		Date		Date	20/6 1530
Time	2:30	Time		Time		Time	
Sec. Seal Intact	Yes	Temperature	°C	Sec. Seal Intact	Yes/No	Temperature	°C

Samples likely to be highly contaminated marked # below

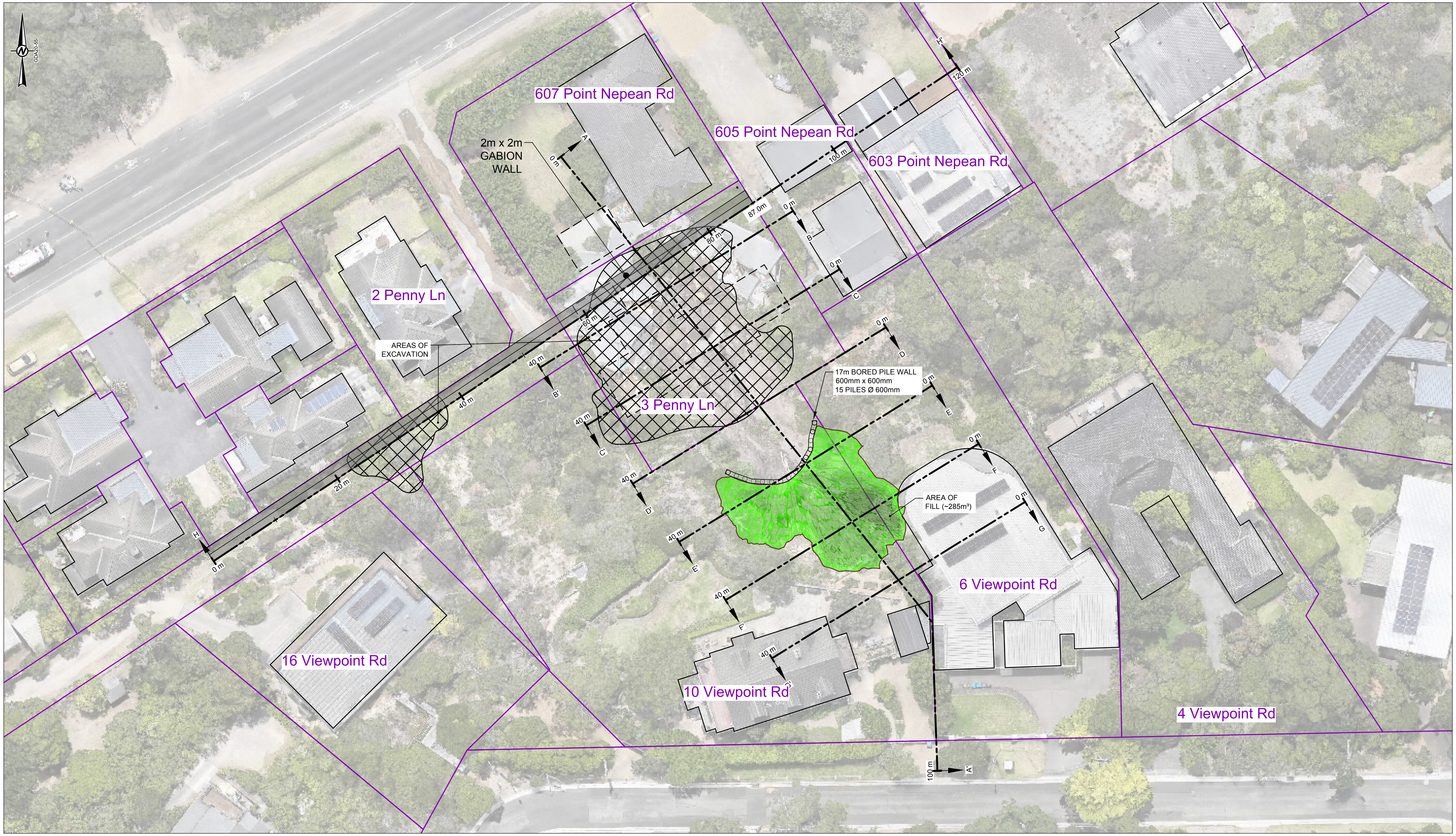
#	SAMPLE DATE & TIME	SAMPLE ID	SAMPLE TYPE	SAMPLE CONTAINERS	TOC	Dissolved Metals & Cations	pH, EC, TDS, Reactive P, Nitrate, Fluoride	Bromide	Total P, Nitrate	Cyanide (total)
1	20/6 11:45	SW08/25200625	W	6	x	x	x	x	x	x
2	20/6 11:45	SW08/28200625	W	6	x	x	x	x	x	x
3	20/6 12:15	SW09/25200625	W	6	x	x	x	x	x	x

Environmental Division
Melbourne
Work Order Reference
EM2511120

Telephone : +61-3-8549 9600

Appendix F

Concept Design for Remediation

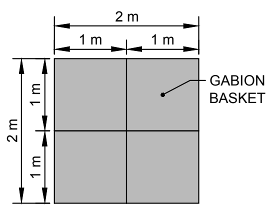


LEGEND

- CADASTRAL BOUNDARY (VICMAP)
- EXISTING SURFACE 2017-11-28 PROFILE
- EXISTING SURFACE 2025-02-05 PROFILE
- ROCKFILL
- GROUND GAINED BETWEEN 2017-2025
- INDICATIVE PROPERTY BOUNDARY
- INDICATIVE CURRENT AND PRE-LANDSLIP BUILDING
- INDICATES ROCK FILL REQUIRED

NOTE(S)

1. ALL LEVELS ARE REFERENCED IN METRES TO AHD.
2. ALL CO-ORDINATES ARE REFERENCED IN METRES TO MGA20-55.
3. AERIAL DATED 2025-01-16.
4. SECTIONS ON SHEET PS224394-001-SK-002b.



Gabion Wall
SCALE 1:100

0 5 10
1:250 METRES

0 5 10
1:250 METRES

NOT FOR CONSTRUCTION
INFORMATION ONLY

CLIENT
McCrae Landslide Board of Inquiry

PROJECT
McCrae Landslide Board of Inquiry

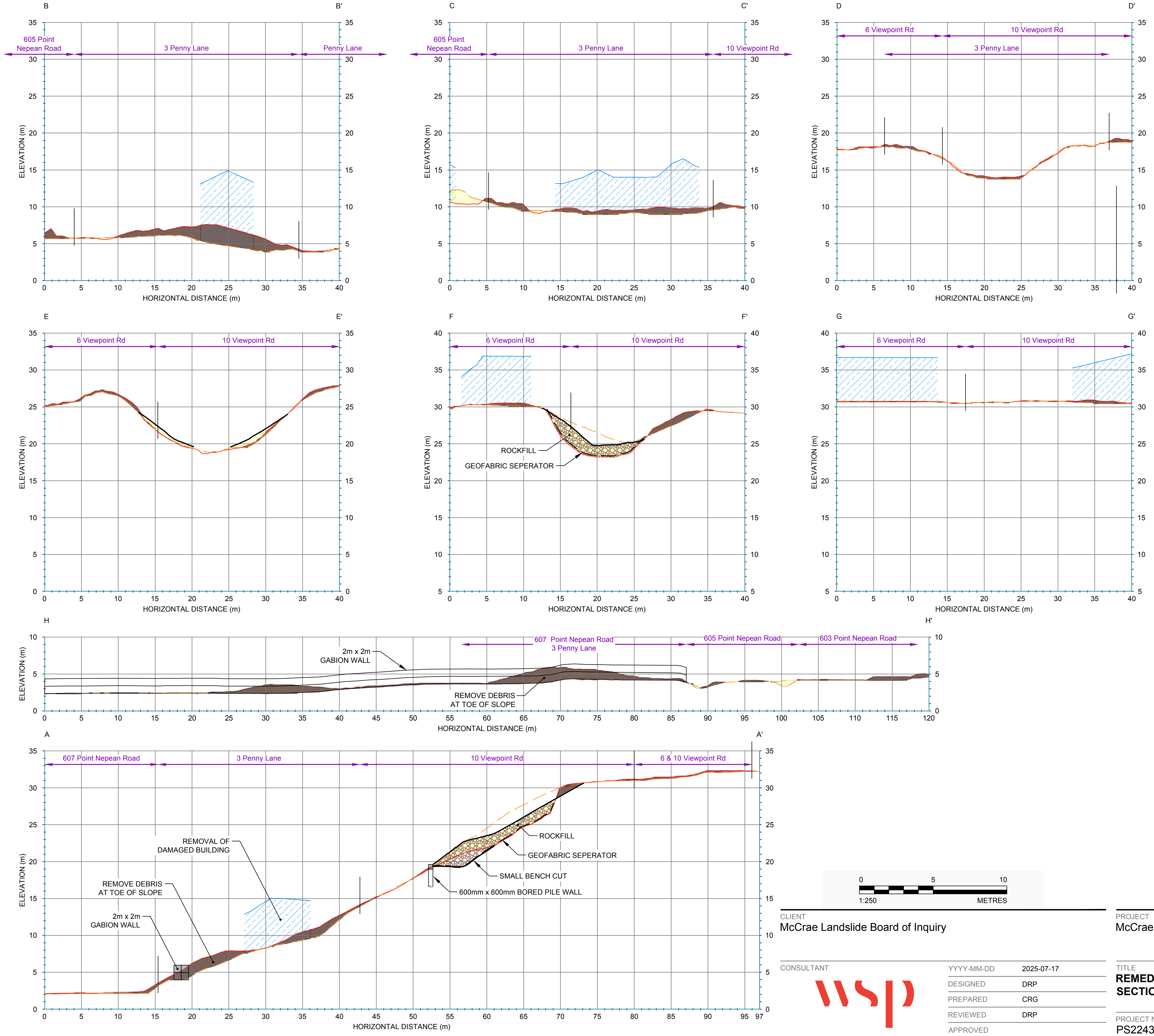
CONSULTANT
wsp

YYYY-MM-DD	2025-07-17
DESIGNED	DRP
PREPARED	CRG
REVIEWED	DRP
APPROVED	

TITLE
REMEDIATION CONCEPT USING ROCKFILL WITH WALL - PLAN VIEW

PROJECT NO.	CONTROL	REV.	FIGURE
PS224394	SK-001	A	003a

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3
0 25 mm



LEGEND

- CADASTRAL BOUNDARY (VICMAP)
- EXISTING SURFACE 2017-11-28 PROFILE
- EXISTING SURFACE 2025-02-05 PROFILE
- ROCKFILL
- GROUND GAINED BETWEEN 2017-2025
- INDICATIVE PROPERTY BOUNDARY
- INDICATIVE CURRENT AND PRE-LANDSLIP BUILDING

NOTE(S)

1. ALL LEVELS ARE REFERENCED IN METRES TO AHD.
2. ALL CO-ORDINATES ARE REFERENCED IN METRES TO MGA20-55.
3. AERIAL DATED 2025-01-16.
4. LOCATION OF SECTIONS ON SHEET PS224394-001-SK-002a.

NOT FOR CONSTRUCTION

INFORMATION ONLY

0 5 10
1:250 METRES

CLIENT	McCrae Landslide Board of Inquiry
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YYYY-MM-DD	2025-07-17
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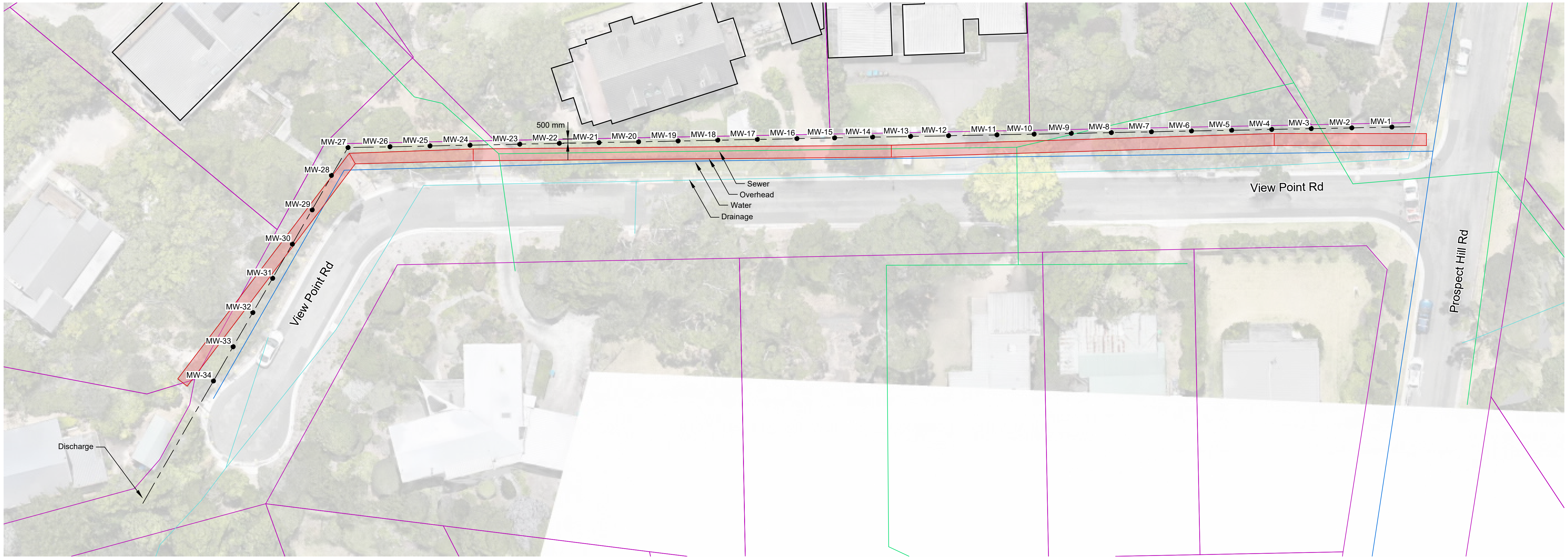
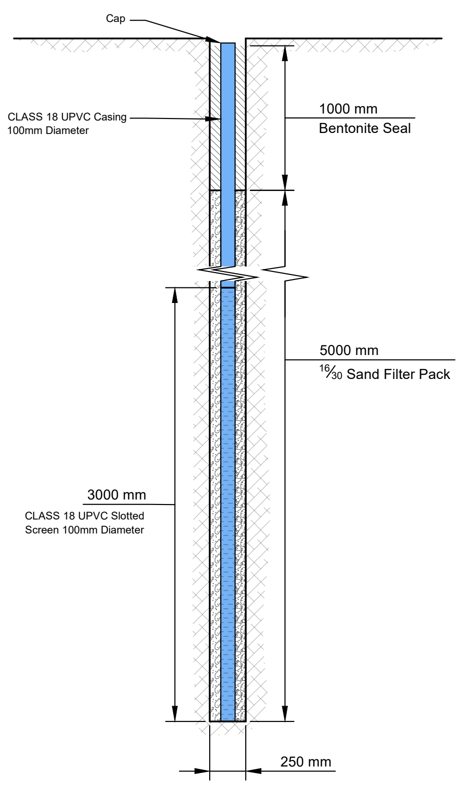
PREPARED	CRG
REVIEWED	DRP
APPROVED	
TITLE	REMEDIATION CONCEPT USING ROCKFILL WITH WALL - SECTIONS
PROJECT NO.	PS224394
CONTROL	SK-001
REV.	A
FIGURE	003b





GROUNDWATER MONITORING WELL

LEGEND

- CADASTRAL BOUNDARY (VICMAP)
- EXISTING BUILDING
- OVERHEAD ELECTRICITY
- WATER PIPE
- DRAINAGE PIPE
- SEWER PIPE

NOTE(S)

1. ALL LEVELS ARE REFERENCED IN METRES TO AHD.
2. ALL CO-ORDINATES ARE REFERENCED IN METRES TO MGA20-55.
3. AERIAL DATED 2025-01-16.
4. BASE SURVEY DATED 2017-11-28

NOT FOR CONSTRUCTION

INFORMATION ONLY

0 2.5 5
1:100 METRES

0 10 20
1:500 METRES

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PROJECT
McCrae Landslide Board of Inquiry

CONSULTANT

YYYY-MM-DD	2025-
DESIGNED	DRP
PREPARED	CRG
REVIEWED	DRP
APPROVED	

TITLE
groundwater extraction monitoring wells

PROJECT NO.	CONTROL	REV.	FIGURE
PS224394	SK-001	A	010

25 mm

Appendix G

Summary of Surface Water Observations

1st November 2024 to 30th November 2024

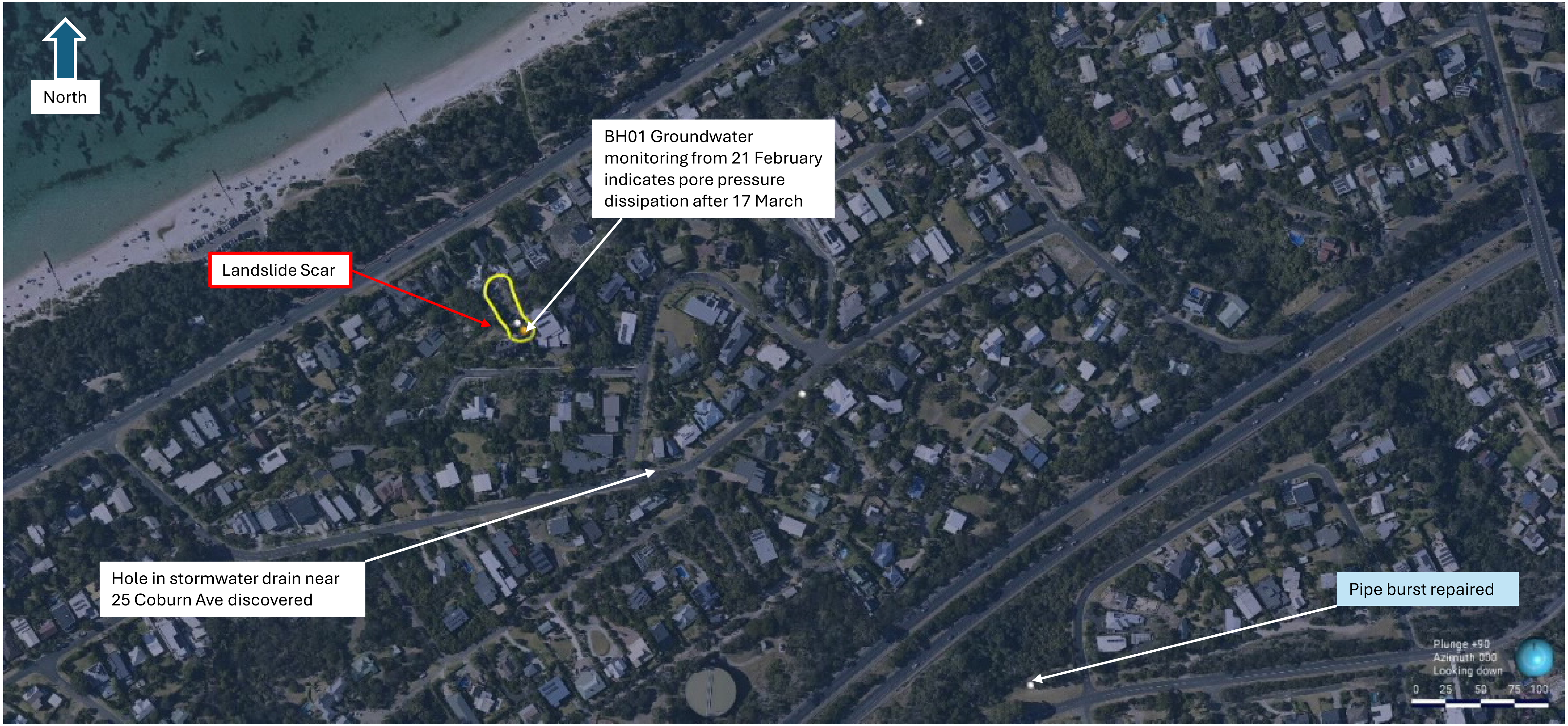
1st December 2024 to 16th December 2024

17th December 2024 to 24th December 2024

24th December 2024 to 31st December 2024

1st January 2025 to 19th January 2025

16 January 2025 to Mid March 2025



Appendix H

Information Referred to for this Assessment

Index of evidence referenced

Report Title		Prepared by	Commissioned by	Date	Document ID
Pre November 2022 Landslides					
1	Geotechnical Investigation of Stability of Gully between The Eyrie & Point Nepean Road, McCrae	Lane Piper	Mornington Peninsula Shire Council	12 September 2007	MSC.5012.0001.0123
2	Draft for Comment Landslide Susceptibility Assessment Stage 2	Cardno Lane Piper	Mornington Peninsula Shire Council	1 February 2012	MSC.5012.0001.4440
3	Geotechnical Assessment of Regional Landslide Susceptibility, Mornington Peninsula Shire	Cardno Lane Piper	Mornington Peninsula Shire Council	18 July 2012	MSC.5001.0001.6105
Post November 2022 Landslides					
2022					
4	Geotechnical assessment of 10-12 View Point Road, McCrae	CivilTest	Bronwyn and Gerry Borghesi	5 December 2022	MSC.5000.0001.1741
5	Technical memorandum regarding geotechnical assessment of Penny Land, McCrae	Cardno now Stantec	Mornington Peninsula Shire Council	7 December 2022	MSC.5000.0001.0292
2023					
6	Structural Engineering Investigation Report re 611-615 Point Nepean Road	Logocon	CHU	16 February 2023	MSC.5000.0001.0616
7	Land Stability Assessment at 10-12 View Point Road, McCrae 1222044-3	CivilTest	Bronwyn and Gerry Borghesi	24 March 2023	MSC.5000.0001.0001
8	Structural Computation for Proposed Land Stability Design at 10-	Rexicon	Bronwyn and Gerry Borghesi	20 June 2023	MSC.5000.0001.0361

	Report Title	Prepared by	Commissioned by	Date	Document ID
	12 View Point Road, McCrae				
9	Peer review response 1222044-5	CivilTest	Bronwyn and Gerry Borghesi	12 July 2023	MSC.5000.0001.0636
10	Land Stability Assessment at 10-12 View Point Road, McCrae 1222044-3 Issue 5	CivilTest	Bronwyn and Gerry Borghesi	2 August 2023	SUB.0015.0001.0345
11	Preliminary Comments Report No 122573	A.S.James	Denise and Paul Willigenburg	13 October 2023	BAB.0001.0001.0017
12	Risk Assessment of 10-12 View Point Road, McCrae	PSM	Mornington Peninsula Shire Council	3 November 2023	BAB.0001.0001.0018
13	10-12 View Point Road McCrase - Technical Memorandum 1222044-6	CivilTest	Bronwyn and Gerry Borghesi	21 December 2023	MSC.5000.0001.0246
2024					
14	Expert Opinion Report - Landslide Assessment 10-12 View Point Road, McCrae	PSM	Mornington Peninsula Shire Council	11 June 2024	MSC.5000.0001.0639
15	Expert Opinion Report - Rectification 10-12 View Point Road, McCrae	PSM	Mornington Peninsula Shire Council	11 June 2024	MSC.5000.0001.1565
16	Risk Assessment 10-12 View Point Road, McCrea	PSM	Mornington Peninsula Shire Council	11 June 2024	MSC.5000.0001.1706
17	Geotechincal Opinion - Collaborative Approach	A.S.James	Denise and Paul Willigenburg	24 July 2024	MSC.5000.0001.0631
18	Risk-to-Life Assessment Report 1222044-11	CivilTest	Bronwyn and Gerry Borghesi	26 August 2024	MSC.5000.0001.0715
19	Risk-to-Life Assessment Report 1222044-11 Issue 2	CivilTest	Bronwyn and Gerry Borghesi	26 September 2024	MSC.5000.0001.0628
20	McCrea Landslide - Meeting Prepartion	A.S.James	Denise and Paul Willigenburg	2 October 2024	MSC.5000.0001.1625
21	Minutes of experts meeting 122573/Prep2	A.S.James	Denise and Paul Willigenburg	8 October 2024	MSC.5000.0001.0358

	Report Title	Prepared by	Commissioned by	Date	Document ID
22	Minutes of experts meeting 122573/Prep2/Rev1	A.S.James	Denise and Paul Willigenburg	10 October 2024	BAB.0001.0001.0031
23	Correspondence from A S James Pty Ltd to Geobrugg Australia Pty Ltd	A.S.James	Denise and Paul Willigenburg	15 October 2024	BAB.0001.0001.0030
24	Shallslide Online Tool prepared by Geobrugg	Geobrugg	Denise and Paul Willigenburg	22 October 2024	MSC.5000.0001.0936
Post January 2025 Landslides					
25	Viewpoint Road Landslide, McCrae Landslide Risk Assessment	GHD	VicSES	22 January 2025	MSC.5003.0002.2627
26	[Draft] McCrae Landslide - Factual Geotechnical and Groundwater Investigation - Fee Proposal	PSM	Mornington Peninsula Shire Council	6 February 2025	MSC.5016.0001.1982
27	Preliminary Advice - Emergency orders for Select Dwellings	PSM	Mornington Peninsula Shire Council	11 February 2025	MSC.5016.0001.0792
28	McCrae Landslide Incident Temporary Works Proposal	PSM	Mornington Peninsula Shire Council	25 February 2025	MSC.5016.0001.0916
29	McCrae Landslide Incident Displacement Monitoring Update - 12/02 - 28/02/2025	PSM	Mornington Peninsula Shire Council	6 March 2025	MSC.5016.0001.0136
30	McCrae Landslide Incident Displacement Monitoring Update - 28/02 - 6/03/2025	PSM	Mornington Peninsula Shire Council	12 March 2025	MSC.5016.0001.0205
31	McCrae Landslide - Stormwater and Sewer Investigation Proposal - Reverse Brief	PSM	Mornington Peninsula Shire Council	17 March 2025	MSC.5016.0001.1844
32	McCrae Landslide Incident Displacement Monitoring Update - 7/03 - 13/03/2025	PSM	Mornington Peninsula Shire Council	20 March 2025	MSC.5020.0001.0385

	Report Title	Prepared by	Commissioned by	Date	Document ID
33	Pile Investigation - 6 Viewpoint Road, McCrae	Integrity Testing	Mornington Peninsula Shire Council	22 March 2025	MSC.5001.0001.3621
34	Risk-to-Life Assessment Report 1222044-16	CivilTest	Bronwyn and Gerry Borghesi	27 March 2025	MSC.5016.0001.0996
35	Potential Assistance	Fair Engineers	Kellie and Nick Moran	2 April 2025	RES.0009.0003.0001
36	Causation Report 1222044-15	CivilTest	Bronwyn and Gerry Borghesi	4 April 2025	RES.0001.0001.0001
37	McCrae Landslide Incident Displacement Monitoring Update - 14/03 - 27/03/2025	PSM	Mornington Peninsula Shire Council	8 April 2025	MSC.5020.0001.0453
38	McCrae Landslide Evacuation Order Area - Geotechnical Factual Report	PSM	Mornington Peninsula Shire Council	9 April 2025	MSC.5007.0004.0078
39	McCrae Landslip Project	SMEC	South East Water	5 May 2025	SEW.0001.0001.0142
40	Witness Statement of Brett Phillips Cooper	Brett Phillips Cooper	N/A	12 May 2025	RES.0004.0002.0008
41	Witness Statement of Gerard Raymond Borghesi	Gerard Raymond Borghesi	N/A	14 May 2025	RES.0001.0003.0002
42	PSM Risk to Life Assessment	PSM	Mornington Peninsula Shire Council	22 May 2025	MSC.5047.0001.0001
43	Documents received as part of NTP-PSM-001 Tranche 001	PSM		Package dated 29 May 2025	PSM.5000.0001.0001 through PSM.5000.0004.4636
44	Witness Statement of Jonathan Crook	Jonathan Crook	South East Water	4 June 2025	SEW.0001.0001.4914
45	McCrae Burst Volume – V4 250513	Jonathan Crook	South East Water	13 May 2024	SEW.0001.0001.0746
46	Witness Statement of Rob A'Vard	Rob A'Vard	N/A	3 April 2024	RES.0014.0001.0002
47	PSM McCrae Landslide – Stormwater and Sewer Investigation	PSM	Mornington Peninsula Shire Council	13 June 2025	MSC.5067.0001.0018

	Report Title	Prepared by	Commissioned by	Date	Document ID
	Geotechnical Factual Report (Draft)				
48	Dane Pope Working Notes (as of 22/05/2025)	PSM	Mornington Peninsula Shire Council	22 May 2025	PSM.5000.0004.4640
49	Photo of tension cracks at toe of retaining wall at 10-12 View Point Road	Unknown	Unknown	13 January 2025	MSC.5035.0001.0033
50	25 Coburn Avenue McCrae – Urgent Pipe Repair	Aidan Gallagher	Mornington Peninsula Shire Council	25 March 2025	MSC.5031.0001.4490
51	Photo of tension seepage on slope below 10-12 View Point Road	Unknown	Unknown	10 January 2025	MSC.5035.0001.0022
52	Annexures to Witness Statement of Gerard Borghesi	Gerard Raymond Borghesi	N/A	14 May 2025	RES.0001.0003.0001
53	Documents received as part of NTP-PSM-001 Tranche 001	PSM	Mornington Peninsula Shire Council	Package dated 6 June 2025	MSC.5056.0001.0001 to MSC.5056.0001.0003
54	Groundwater chemistry results	WSP	Board of Inquiry	Package dated 2 July 2025	DPA.0002.0001.0001 to DPA.0003.0001.0018
55	Plans showing water services in the McCrae are.	South East Water	South East Water	Undated	SME.0001.0001.0148
56	Witness Statement of David Simon	David Simon	Mornington Peninsula Shire Council	11 April 2025	MSC.9000.0001.0002_0001
57	Witness Statement of Julian Tully	Julian Tulley	South East Water	19 June 2025	SEW.0001.0001.5173
58	Water chemistry results provided to expert database	PSM	Mornington Peninsula Shire Council	16 July 2025	PSM.5004.0001.0001, PSM.5004.0001.0003, PSM.5004.0001.0005, PSM.5004.0001.0013, PSM.5004.0001.0020
59	Groundwater monitoring data	PSM	Mornington Peninsula Shire Council	16 July 2025	PSM.5004.0001.0002
60	Documents submitted to the expert database	SMEC	South East Water	26 June 2025	SME.0001.0001.0234 through SME.0001.0001.0327

Report Title		Prepared by	Commissioned by	Date	Document ID
61	Documents submitted to the expert database	SMEC	South East Water	15 July 2025	Various

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[i] Seep from the 2025 landslide (SW05 is one of PSM surface water locations, flowing water along east side of Penny Lane. Sample was collected and measured on 20 January 2025 by PSM).