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Our Ref: PSM5226-002L

3 November 2023

Associate
Harwood Andrews
79 Gheringhap St, Geelong VIC 3220
tcimino@ha.legal

Attention: Tanya Cimino

Dear Tanya

RE: RISK ASSESSMENT. 10-12 VIEW POINT ROAD, MCRAE

1. Introduction

PSM were commissioned by Harwood Andrews (**HA**) on behalf of Mornington Peninsula Shire (**MPS**) to carry out a Landslide Risk Assessment (**LRA**) at 10-12 View Point Road, McRae (the "**Site"**) in accordance with the requirements of the Australian Geomechanics Society (**AGS**) Guidelines on Landslide Risk Assessment (AGS, 2007). The scope of the LRA is restricted to the following:

1. Desktop methods only. i.e. PSM will outline reliance on the factual data set out in the provided documentation.
2. Risk to life at the following properties:
   a. 10-12 View Point Road (referred to herein as property "**P1**").
   b. 2 Penny Lane (referred to herein as property "**P2**").
   c. 3/613 Pt Nepean Road (referred to herein as property "**P3**").
3. The following modes of failure:
   a. Translational slide.
   b. Debris flow.

PSM has not been provided:

- A feature survey of the Site.
- Recent development plans.

2. Background documents

2.1 CivilTest Documents

PSM has considered a series of CivilTest Pty Ltd (**CivilTest**) documents.

The CivilTest report 1222044-1 Issue 2 (5 December 2022) provides:

- A cross section from a drone survey, Inset 1.

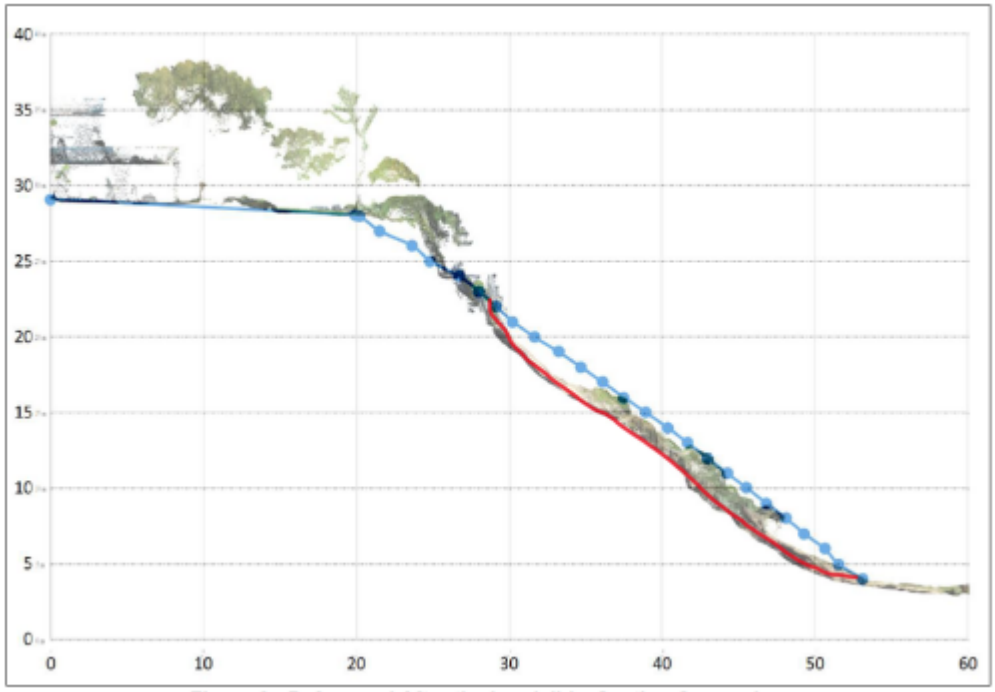


Figure 6 - Before and After the Landslide, Section Comparison

Inset 1: Excerpt from CivilTest report 1222044-1 Issue 2 (5 December 2022)

The CivilTest report 1222044-3 (24 March 2023) indicates:

- Boreholes drilled at the toe of the slope in Penny Lane encountered landslide debris, Inset 2 (Section 2.1 of 1222044-3 (24 March 2023)).
- Boreholes 1 and 2 encountered landslide debris 1.2 m and 0.7 m thick respectively (Appendix C of 1222044-3 (24 March 2023)). PSM has assumed that all fill reported at the toe of the slope is landslide debris.
- Geotechnical laboratory testing completed on borehole 1 indicates that all four samples (depths of 3m, are a Sandy CLAY of low plasticity with between 36 to 48% fines and fine to coarse sand (typically medium grained).
- The boreholes were drilled on 1 March 2023.
- Wet soils were reported in:
  - Borehole 1 at 2.6 m below ground level (**bgl**).
  - Borehole 2 at 2.8 m bgl.
  - Borehole 3 between 1.8 m and 5.2 m bgl.

2.1 Soil Profile

Three boreholes (BH) were drilled by a mechanical auger at the approximate locations shown on the attached plan. The two boreholes drilled at the toe of the slope on Penny Lane revealed that the soil profile consists of residual material from the landslip made up of silty SAND FILL and sandy CLAY FILL, overlying Colluvial material consisting of natural sandy CLAY, SAND and gravelly SAND. This is further underlain by Aeolian silty SAND.

The borehole drilled at the top of the slope revealed that the soil profile consists of silty SAND FILL, overlying natural Aeolian SAND followed by sandy CLAY and silty CLAY with sand.

Groundwater was encountered in the boreholes at depths of 2.6 metres in borehole 1 and 2.8 metres in borehole 2.

Inset 2: CivilTest description of debris flow as "fill"

The CivilTest report 1222044-3 Issue 5 (2 August 2023) indicates:

- A sub-surface model at the crest of the escarpment at the Site comprising:
  - A thin layer of sand FILL, overlying,
  - Aeolian Sands (slightly indurated), overlying
  - Residual granite (sandy/silty CLAY).
- A sub-surface model at the toe of escarpment at the Site comprising:
  - Debris from the landslide (logged as fill), overlying,
  - Colluvium (Sandy CLAY, SAND and Gravelly SAND) overlying
  - Aeolian Silty SAND.

2.2 Stantec Documents

The Stantec Geotechnical Assessment ((V220600Report01.1, 7/12/2022) referred to herein as the "**Stantec GA**") indicates that:

- The thickness of the landslide was possibly less than 0.5m.
- Seepage was observed in the head scarp, Inset 3.
- Probabilities of landslide hazards vary from 1 in 2 years to 1 in 20 years.
- The photographs of the debris flow zone indicate to PSM that the depth/thickness of material evacuated from the debris flow zone is inferred to be less than 0.5 m.

> Figure 4-2 shows the main scarp of the landslide where it has undermined the existing stairs. It can be seen that the failure surface of the landslide runs parallel to the ground surface. The weathered granite is exposed in the failure surface. Looking at the side flank it can be seen that the thickness of soil that would have overlain the weathered granite is relatively shallow, possibly less than 0.5m.
>
> Water was observed to be seeping from the head scarp at several locations more than 24 hours after the storm occurred. These seeps appear to be associated with natural springs further up slope.

Inset 3: Excerpt from Section 4.1 of the Stantec GA

2.3 Nearmap and Google Street View

PSM has considered the readily available Nearmap and Google Street view images which indicate:

- A series of trees were removed on property P1 between April 2021 and September 2021, Appendix A1. This is supported by street view images between February 2018 and October 2022, Appendix A2.
- The translational slide scarp has approximate dimensions of 8 m x 5 m, Appendix A3.
- The debris flow:
  - Initiated from an area approximately 12m southeast of the property P1 northwestern boundary and was approximately 4 m wide.
  - Run out was approximately 5 m into properties P2 and P3, Appendix A3.

2.4 Rainfall data

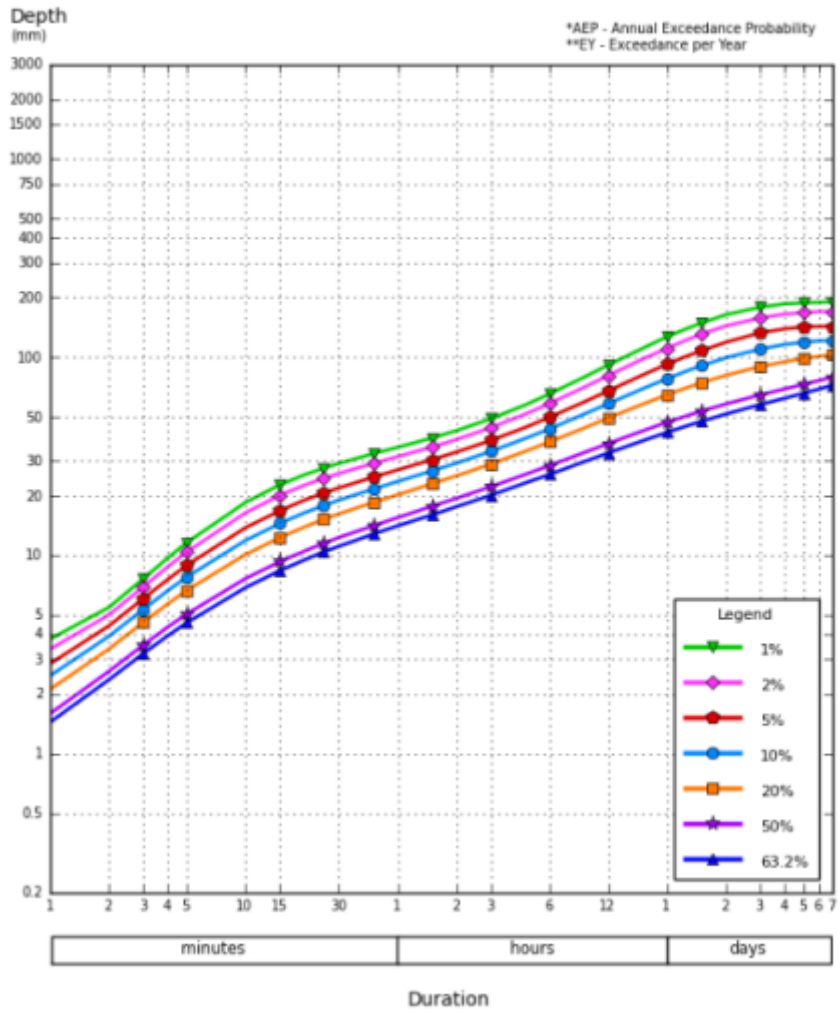
2.4.1 Rosebud weather station

The Rosebud weather station climate data (Station ID: 086213, Climate Data Online - Map search (bom.gov.au), accessed 31 October 2023) indicates:

- On 14 November 2022 approximately 80mm of rainfall was recorded and reported over a 24 hour period.
- The 30-day cumulative rainfall on the 14 November 2022 was 133 mm.
- The 30-day cumulative rainfall on the 1 March 2023, when the CivilTest boreholes were drilled, was 47 mm.
- The dataset commenced in 1927 (albeit is missing significant data) and there are at least 19 events where the 30-day cumulative rainfall has exceeded 150 mm.

2.4.2 Intensity Frequency Duration

The Intensity Frequency Duration (IFD) curve for the Site is presented in Inset 4. The table for rare events is presented in Inset 5.



Inset 4: IFD frequent and infrequent curve for the Site

	Annual Exceedance Probability (1 in x)				
Duration	**1 in 100**	**1 in 200**	**1 in 500**	**1 in 1000**	**1 in 2000**
1 min	3.78	4.30	5.04	5.65	6.31
2 min	5.47	6.18	7.17	7.98	8.84
3 min	7.63	8.64	10.1	11.2	12.4
4 min	9.71	11.0	12.8	14.4	16.0
5 min	11.6	13.2	15.4	17.2	19.2
10 min	18.5	21.1	24.8	27.8	31.1
15 min	22.7	25.9	30.4	34.1	38.1
20 min	25.5	29.1	34.1	38.2	42.7
25 min	27.5	31.4	36.7	41.2	46.0
30 min	29.1	33.2	38.8	43.5	48.6
45 min	32.6	37.0	43.3	48.4	54.0
1 hour	35.1	39.9	46.6	52.1	58.1
1.5 hour	39.1	44.4	51.9	58.1	64.7
2 hour	42.6	48.4	56.6	63.3	70.6
3 hour	48.9	55.7	65.2	73.0	81.5
4.5 hour	57.4	65.5	76.9	86.3	96.6
6 hour	65.3	74.6	87.6	98.4	110
8 hour	74.8	85.5	101	113	127

Inset 5: IFD rare table for the Site

2.4.3 Weather Chasers

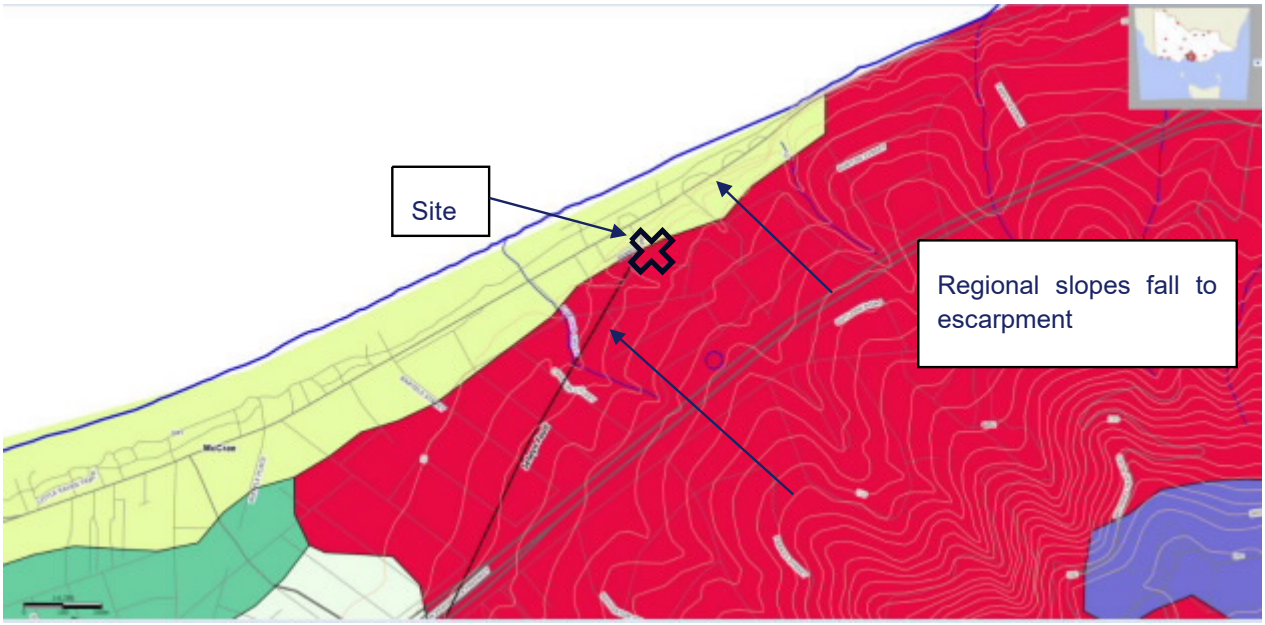
Review of the Melbourne radar archive (Melbourne Radar - 128km Rain Rate (theweatherchaser.com), accessed 31/10/2023) indicates that:

- The majority of moderate to heavy rainfall was observed between 11pm on 13/11/2023 and 7am on 14/11/2023, Figures A7 to A8 of Appendix A.
- Some showers were recorded for the remainder of the 14/11/2023, Figure A9 of Appendix A.

3. Geotechnical Model

3.1 Topography and drainage

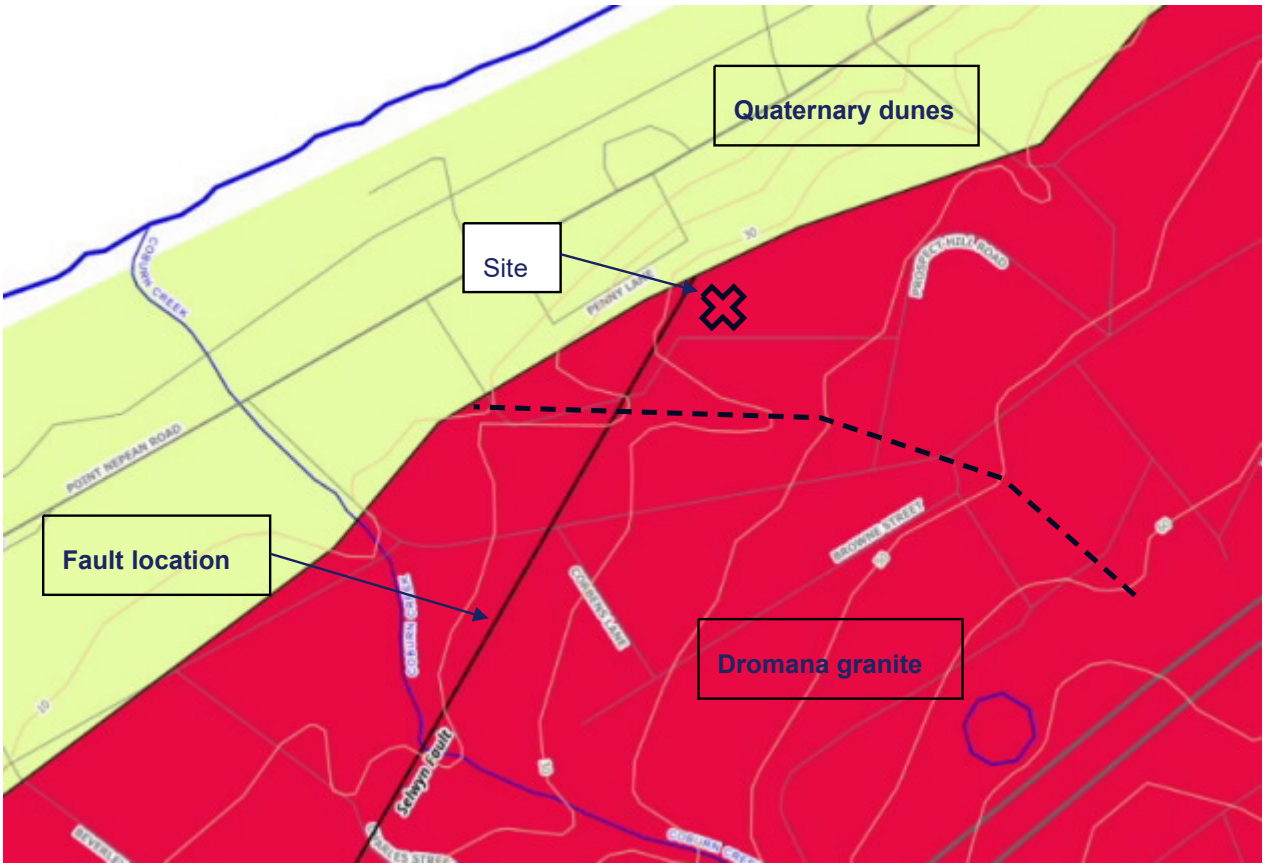
The Site is located at the lower escarpment of Arthurs Seat, Inset 6 (GeoVic Anonymous (gsv.vic.gov.au), accessed 1 November 2023) with approximately 270 of metres of relief measured in a south west direction from the summit of Arthurs Seat. Several drainage paths strike in a north to northwest direction.



Inset 6: Topography and drainage paths of Arthurs Seat

3.2 Geology

The Victoria Seamless Geology (Earth Resources publications (efirst.com.au) , (2014)) model indicates that the Site is close to the boundary of Quaternary aged dune deposits (with siliceous and calcareous sands) and Devonian aged Dromana granite. The Earth Resources mapping portal (GeoVic Anonymous (gsv.vic.gov.au), accessed 1 November 2023) indicates that the inferred location of the Selwyn Fault traverses the Site, Inset 7.



Inset 7: Earth Resources geological map with Selwyn Fault highlighted.

3.3 Sub-surface conditions

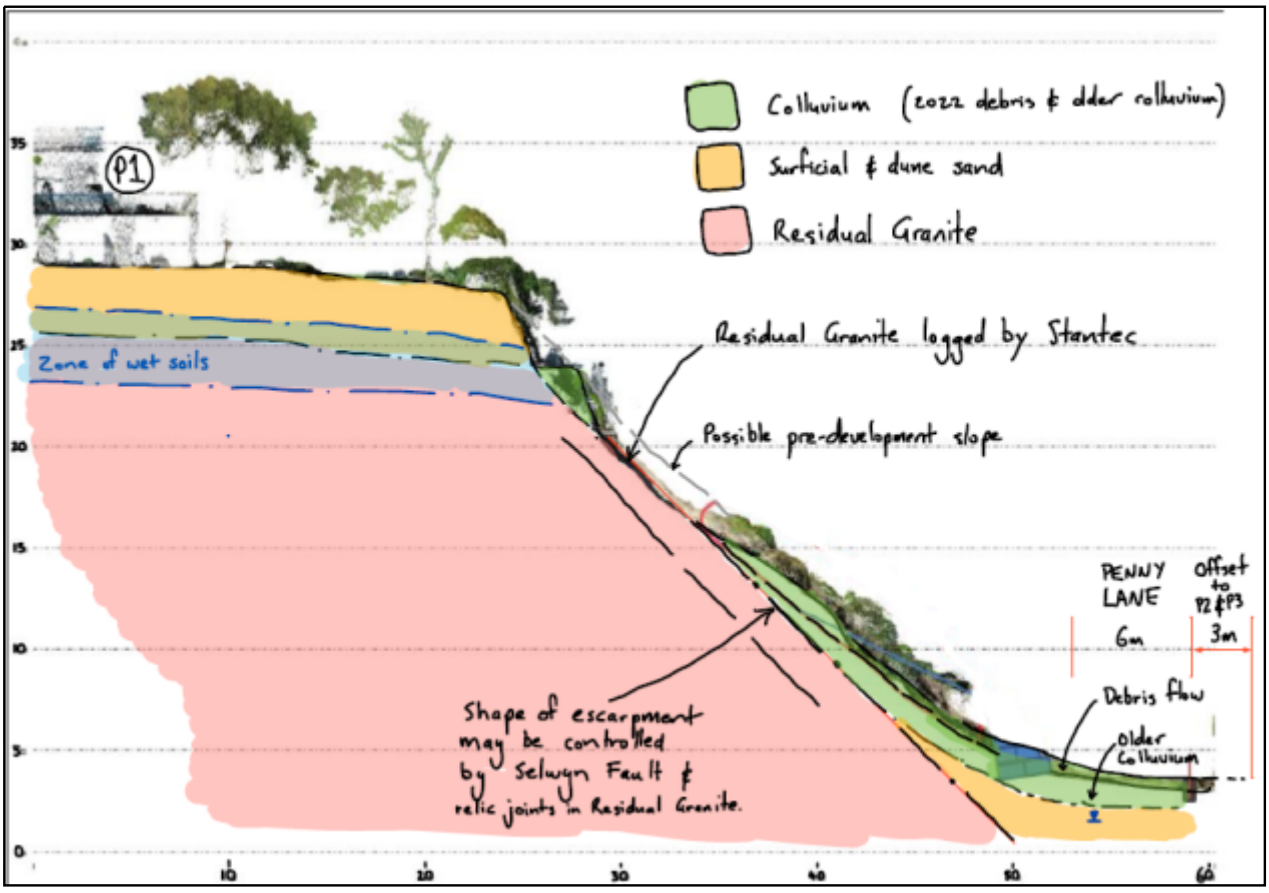
The conditions documented by others in the boreholes and slope exposures indicated subsurface conditions generally consistent with those described on the geological map. Table 1 presents the PSM interpretation of the geotechnical units.

Table 1 – Geotechnical units

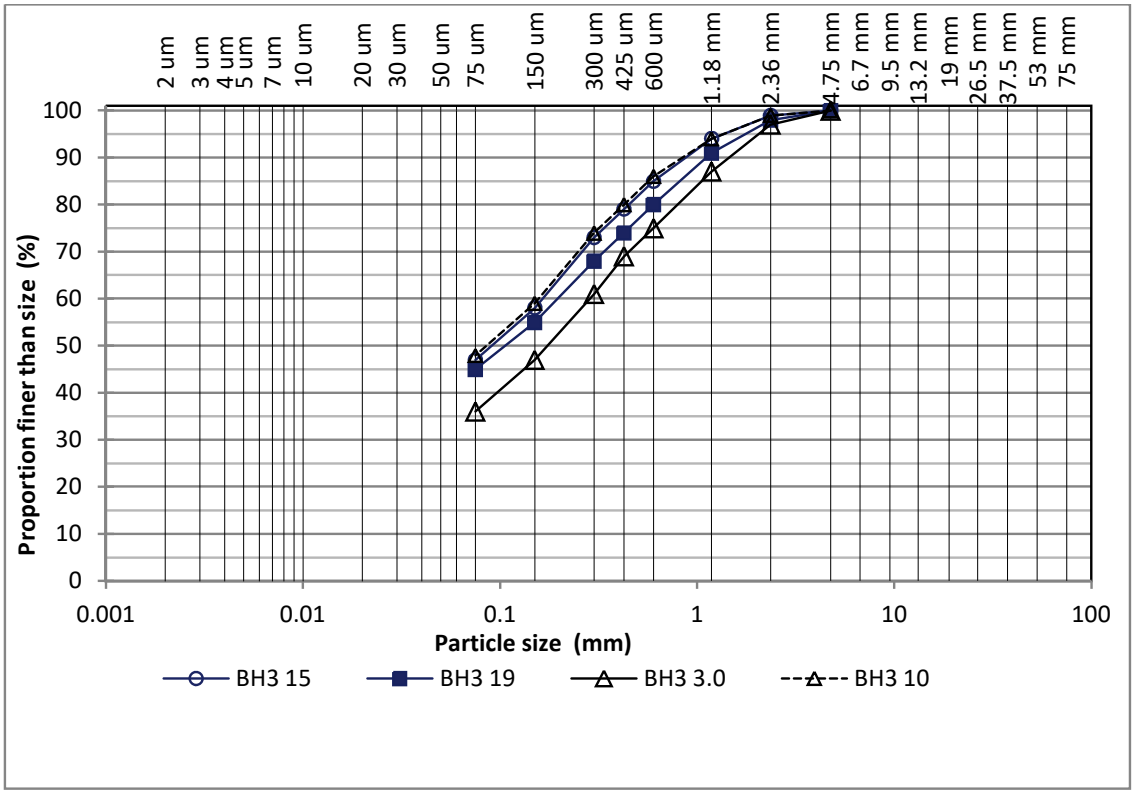
Unit	Description
DUNE DEPOSITS (1)	SAND and Silty/Gravelly SAND, fine to coarse grained, moist to wet, inferred medium dense. SPT N value of 10 at 1.5 m bgl. Contact with underlying Residual Granite (3) is difficult to define.
COLLUVIUM (2)	Inferred to be a mixture of Units 1 and 3. Recent Colluvium (the debris flow from 2022 landslide) is Silty SAND/Sandy CLAY. Old Colluvium buried by 2022 landslide is Sandy CLAY and SAND. This unit has no strength testing.
RESIDUAL GRANITE (3)	Sandy to Silty CLAY/Clayey SAND, low plasticity, fine to coarse grained, wet at contact with overlying dune deposits otherwise moist, typically medium dense to dense/stiff to very stiff. SPT N values vary from 12 to 34 with a mean of 25 from 3 m to 20 m bgl.

Our interpretation of the geological conditions is presented in Inset 8. With regards to the geological model PSM notes the following key observations:

- There is uncertainty regarding the contact between the DUNE DEPOSITS and the RESIDUAL GRANITE owing to the likelihood of some of the parent material of the DUNE DEPOSITS being from wind driven erosion of the Dromana Granite. PSM has assumed that the wet soils are an indicator of the contact between the two geotechnical units.
- The laboratory testing indicates that all samples between 3 m and 19 m bgl have very similar Particle Size Distributions, Inset 9, and Atterberg limits indicate low plasticity CLAY fines.



Inset 8: PSM geological model



Inset 9: CivilTest Particle Size Distributions

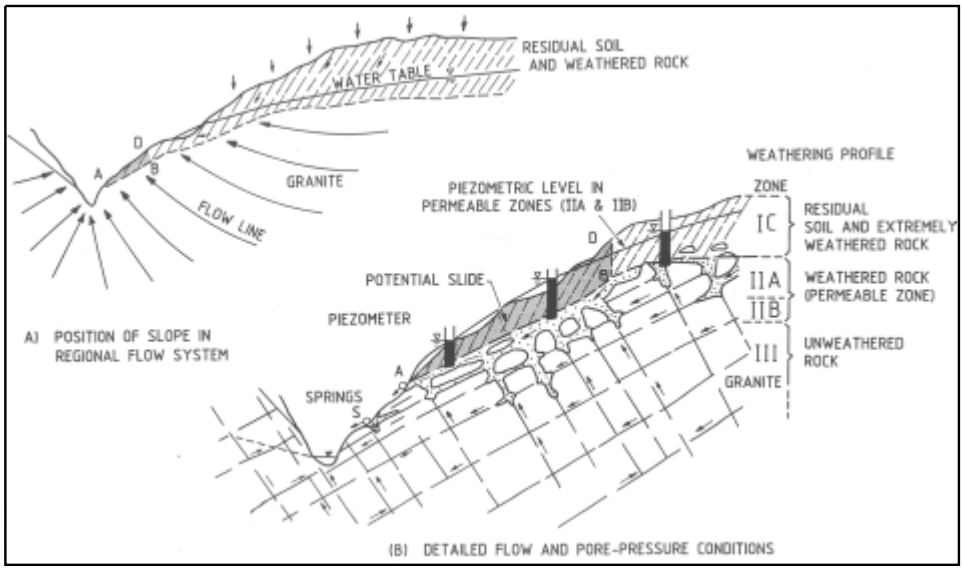
3.4 Groundwater

PSM notes that no groundwater monitoring has been conducted on the Site.

Perched water tables are inferred to exist at the contact of the DUNE DEPOSITS and the underlying RESIDUAL GRANITE and not necessarily limited to during periods of wet weather. This is inferred to be due to:

- The size of the catchment of Arthurs Seat and slopes and drainage paths that fall towards the northwest, the Site and the escarpment.
- Local sources of water related to residential development and subdivisions.

PSM notes that wet soils were encountered in borehole 3 between 1.8 m and 5.2 m bgl in March 2023 and this was not during or following a period of high rainfall, Section 2.4.1. This observation is consistent with published groundwater models in weathered granitic profiles, Inset 10.



Inset 10: Possible piezometric conditions in weathered granitic soils (Fell et al, 2004)[1].

Groundwater was observed on Penny Lane between 2.4 m to 2.6 m bgl. This is consistent with water levels of the adjacent Port Phillip Bay. These levels are anticipated to fluctuate with tidal levels.

4. Landslide Risk Assessment

4.1 Introduction

Fundamentally where a debris flow has entered a property, no control measures have adopted to remediate the source of the debris flow and dilated/disturbed ground is noted in a similar area as the previous landslide, the risk to life cannot improve. Due to the presence of a preferred flow path and an increase in the slope angle at the toe of the slope (due to deposition of debris) the risk is most likely higher. PSM notes that the selection of detachment probabilities is subjective and variations between authors of an order of magnitude are not uncommon. Nonetheless, a LRA has been completed in accordance with the requirements of the AGS (2007) to assess the risk to life for the properties P1 to P3.

The level of "Tolerable Risk" should be defined by the Regulator (in this case, MPS) (Section 8.2 of AGS (2007c). "Tolerable Risk" as defined in Table 1 of Section 8.2 of AGS (2007c) is presented in Table 2.

[1] Fell,R. MacGregor, P.Stapledon, D. Bell, G. 2005. Geotechnical Engineering of Dams. CRC Press.

Table 2 – Tolerable Risk as per Section 8.2 of AGS (2007c)

Risk Type for Low Rise Residential Development	Tolerable Risk Level
Risk to Life for existing slopes and development (Quantitative Assessment)	1×10^{-4}
Risk to Life for new slopes and development (Quantitative Assessment)	1×10^{-5}

4.2 Hazards and modes of failure

Table 3 provides a summary of the modes of failure and hazards. The hazards are presented on Inset 11. The November 2022 landslide had the following characteristics:

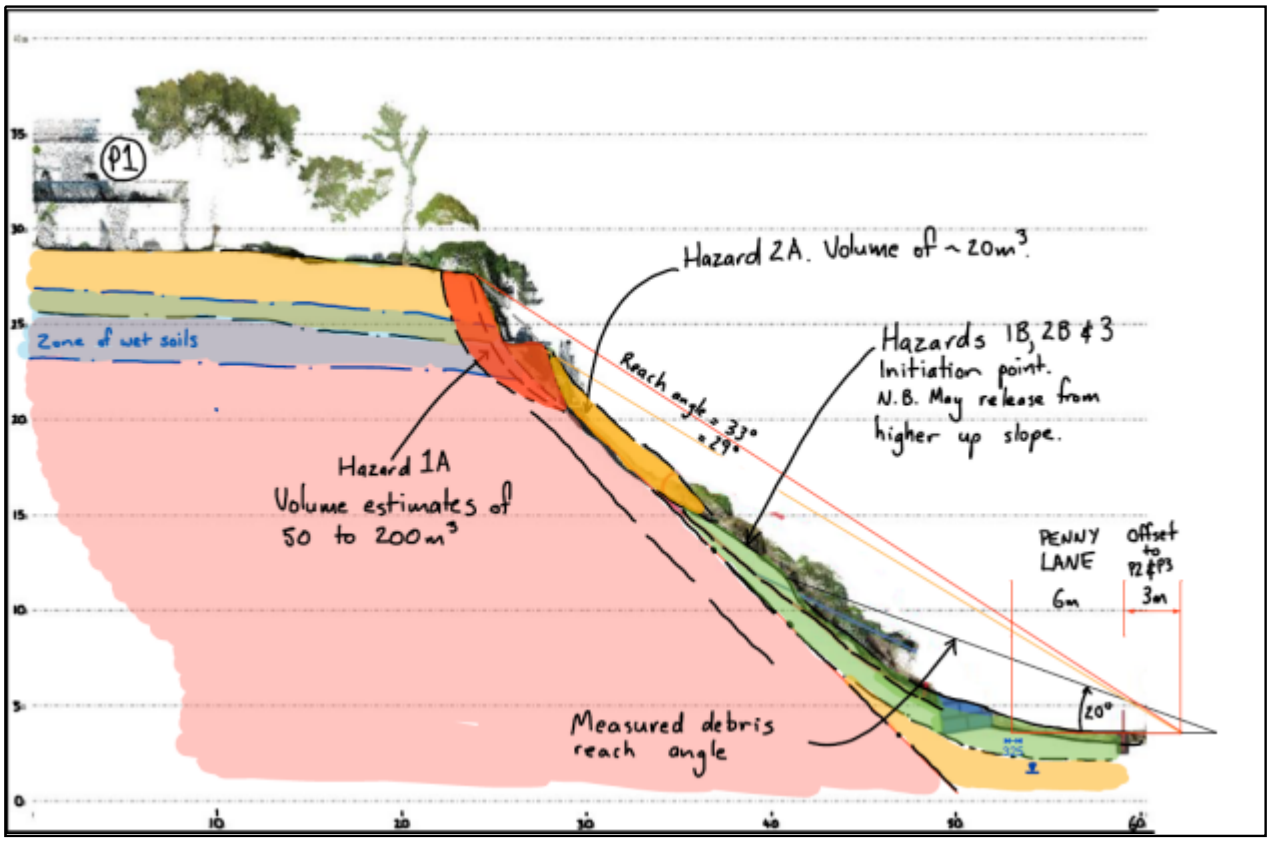
- Approximate dimensions of reported translational slide of 8 m wide x 5 m long x 0.5 m deep (parallel to slope).
- Approximate mobile translational slide volume of 20 m^3.
- Approximate dimensions of reported debris flow of 4 m wide x 12 m long x less than 0.5 m deep (parallel to slope). Volume less than 24m^3. Note that volume of water accumulated prior to failure is unknown and ignored.
- The reach angle of the debris flow was in the order of 20° from the source point of the debris flow, Figure A6 of Appendix A. This angle is similar to those published by Finlay et al (1999)(2) and Mostyn and Sullivan (2002)[3] for washout and liquefaction failures in fills, Inset 12.

PSM notes that tree removal is a significant conditional event that has occurred at the Site and suction will change in the escarpment slopes over a period of 12 months to 5 years from tree removal (Richards, 1983)[4]. Trees have been removed in 2021 and further vegetation has been removed by the landslide. In PSM's experience it is common in Victoria for surficial soil landslides to follow tree/vegetation removal (either by fire, storm or physical removal).

(2) Finlay, P.J. Mostyn, G.R. Fell, R. 1999. Landslides: Prediction of travel distance and guidelines for vulnerability of persons. Australian Geomechanics June 1999. Pp.45-54.

[3] Mostyn.G. Sullivan. T.2002.Quantitative Risk Assessment of the Thredbo Landslide. Australian Geomechanics May 2002. Pp 169-181.

[4] Richards, B.G., Peter, P., Emerson, W.W. 1983. The effects of vegetation on the swelling and shrinkage of soils in Australia. Geotechnique, 33(2), 127-139.



Inset 11: Landslide hazards

Table 3 – Summary of hazards

Hazard ID	Mode of Failure	Discussion	Estimated $P_{(H)}$
1A	Translational slide – regression of escarpment	Volume estimate = 50 m^3 (favourable) to 200 m^3 (unfavourable). Adopt 100m^3 Failure may impact zone 2 m (typical) to 5 m (adverse) behind the escarpment 1% AEP event may trigger the failure. Recent failure has removed some passive support and stabilising vegetation from the slope. Table 7 of RMS (2014): • *Potential mechanism is apparent.* • *Evidence of earlier failures (over period > 30 years).* AGS (2007c): • *The event will probably occur under adverse conditions over the design life.*	$1x10^{-2}$
1B	Debris flow following 1A	Half of 1A. Volume estimate = 25 to 100m^3 Adopt 50m^3. Triggers as per 1A. Assumed to initiate from similar slope location (with reach angle of ~24° to dwellings P2 and P3). N.B. could initiate from higher and have greater energy.	$1x10^{-2}$
2A	Translational slide of flanks of landslide scarp	Volume estimate = 20 m^3 Table 7 of RMS (2014): • *Detachment mechanism is active* AGS (2007c): • *The event is expected to occur over the design life.*	$5x10^{-1}$
2B	Debris flow following 2A	Volume estimate = 20 m^3 Similar rainfall event to November 2022 event and occurring between 8 to 24 hours considered a likely trigger. Initiates as per 1B	$5x10^{-2}$ to $1x10^{-2}$
3	Debris flow of existing debris	Volume estimate less than 20 m^3 Similar rainfall event to November 2022 event in a day considered a likely trigger. Initiates as per 1B	$5x10^{-2}$

4.3 Risk to life

The risk of loss of life ($R_{(LoL)}$) can be estimated using the AGS quantitative risk assessment, expressed with the following equation:

$$R_{(LoL)} = P_{(H)} \times P_{(S:H)} \times P_{(T:S)} \times V_{(D:T)}$$

4.3.1 Annual Probability of Occurrence, $P_{(H)}$:

Values for the annual probability of occurrence are calculated where information is available, or they are taken directly from:

- Appendix C of AGS (2007c) which recommends values for the probability of occurrence and the qualitative descriptor equivalent.
- Table 7 of the RMS (2014)[5].

Supporting evidence and discussion for $P_{(H)}$ is provided in Section 4.2 and Table 3.

4.3.2 Probability of Spatial impact, $P_{(S:H)}$:

Spatial impacts have been estimated as a probability of the given failure mode physically imposing on the:

- Dwelling in which occupants may be situated.
- Slopes on which pedestrians may be situated.

PSM has assumed that:

- Penny Lane is 6 m wide.
- Properties P2 and P3 have 3 m offsets to the southeastern boundary.

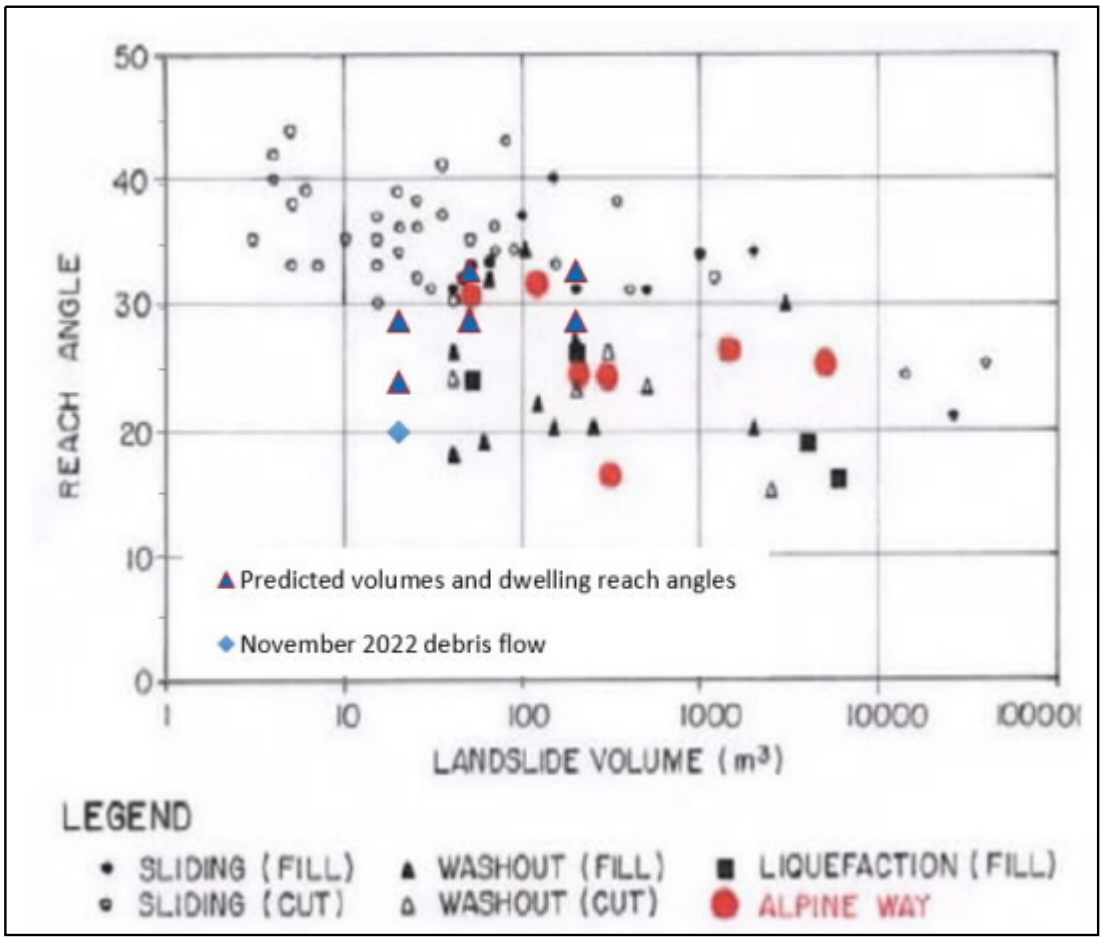
For property P1:

- Spatial risks are high (1) when on or below the landslide hazards.
- It is anticipated that regression of the escarpment may impact a zone 2 to 5 m behind the escarpment, Inset 11.

For properties P2 and P3:

- The November 2022 translational slide did not reach P2 and P3. However, the debris slide reached P2 and P3 and created a preferential flow path with significantly less obstructions for future landslides and increased the slope angle at the toe of the slope.
- Measured reach angles of the November 2022 landslide and those of the downslope dwellings to the respective hazards upslope are presented in Inset 11 and Inset 12.
- The measured reach angle between the hazards and the dwellings generally are between one and two standards deviations of the mean of the published Mostyn and Sullivan (2002) data set, Inset 12 (excluding the debris flow data point).
- Based on the comparison to published data sets and the measured debris flow the adopted $P_{(S:H)}$ varies from 0.1 to 1.0.
- The debris flow run out angle was measured as 20° which exceeds the adopted hazard reach angle of 24° of the proposed debris flow hazards. The $P_{(S:H)}$ for these scenarios is 1.

[5] RMS. 2014. RMS Guide to Slope Risk Analysis Version 4.



Inset 12: Predicted volumes and measured reach angles to P2 and P3, plotted on Mostyn and Sullivan (2002) landslide data

4.3.3 Temporal Spatial Probability $P_{(T:S)}$:

Temporal spatial probability describes the likelihood of a person being at the Site (or in the house) at the time of occurrence.

PSM have assumed the following:

- Pedestrians on lower slopes (maintenance) and within 5 m of escarpment - 0.5 hours per day (1/48)
- The P2 and P3 homes are occupied 80% of the time:
  - If the homes are destroyed in an event $P_{(T:S)} = 0.8$
  - If the homes are damaged in an event, $P_{(T:S)} = 0.5 \times 0.8 = 0.4$ (representing use of the rear of the dwellings for half of the day).

4.3.4 Vulnerability, $V_{(D:T)}$

Example vulnerability values are provided in Appendix F of AGS 2007c. The basic approach adopted by PSM is presented in Finlay, Mostyn & Fell (1999) and discussed as follows:

- CivilTest borehole log records indicate the debris flow is between 0.7 to 1.2 m thick on Penny Lane. It is assumed that this volume of material would bury a pedestrian. Pedestrians and occupants of dwellings have a high vulnerability where buried by large slides (1.0), but reduced vulnerability where they are not buried (0.1 to 0.2).
- For the Site, rapid failure has occurred and therefore significant damage to properties P2 and P3 and burial of pedestrians and occupants is possible.

- Pedestrians on top of a slide and within the zone of potential hazards, Inset 11, have a low vulnerability (0.1) as they may fall rather than be struck by debris.

4.4 Results of assessment

The results of the assessment are provided in Appendix A and indicate:

1. For pedestrians and occupants below the escarpment and within run out distances of the hazards, the risk to life varies from 2.1 $x10^{-4}$ to 6.27 $x10^{-2}$. In accordance with Table 1 of Section 8.2 of AGS (2007c), this is an unacceptable risk to life.
2. For pedestrians on the escarpment the risk to life is 2.1 $x10^{-5}$. Although this is tolerable to AGS (2007c), it is not recommended for pedestrians to occupy this area of the Site due to fall from heights hazards in a post landslide environment.
3. For sensitivity purposes, for Hazard 1A where it is assumed that:
   a. The biggest landslide volume is 50m^3,
   b. The return period of the translational slide is 1:200 years (which is not well supported by actual rainfall data),
   c. The pedestrians on the slope and occupants of dwellings P2 and P3 are not buried (considered to be an aggressive assumption),

   the risk to life is 2.4$x10^{-4}$ for the occupants of dwellings P2 and P3 and is considered unacceptable.

5. Conclusion

In accordance with Table 1 of Section 8.2 of AGS (2007c), the results of the risk assessment indicate an unacceptable risk to life for occupants of dwellings P2 and P3 and pedestrians on and below the escarpment slopes at the Site on properties P1 to P3.

The scope of this risk assessment excludes the assessment of all other neighbouring downslope properties.

Yours Sincerely

Personal Information

DANE POPE
PRINCIPAL

ATTACHMENTS

APPENDIX A – FIGURES
APPENDIX B – RISK ASSESMENT

Appendix A
Figures

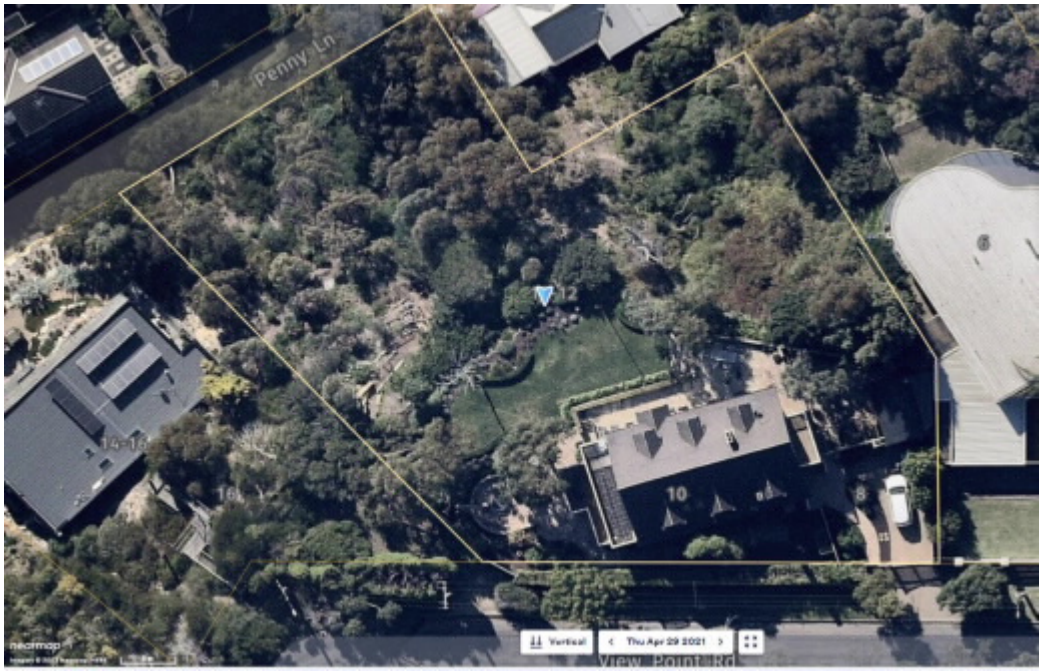


Figure A1: Nearmap 29/04/2021

Figure A2: Nearmap16/09/2021

Harwood Andrews
Risk Assessment
10-12 View Point Road, McRae

Tree removal

PSM5226-002L	Appendix A

Figure A3: Google Street View February 2018

Figure A4: Google Street View October 2022

Figure A5: Nearmap 3/12/2022 approximate head scarp dimensions

Figure A6: Nearmap 3/12/2022 approximate run out distances

Harwood Andrews Risk Assessment 10-12 View Point Road, McRae Landslide characterisation	
PSM5226-002L	Appendix A

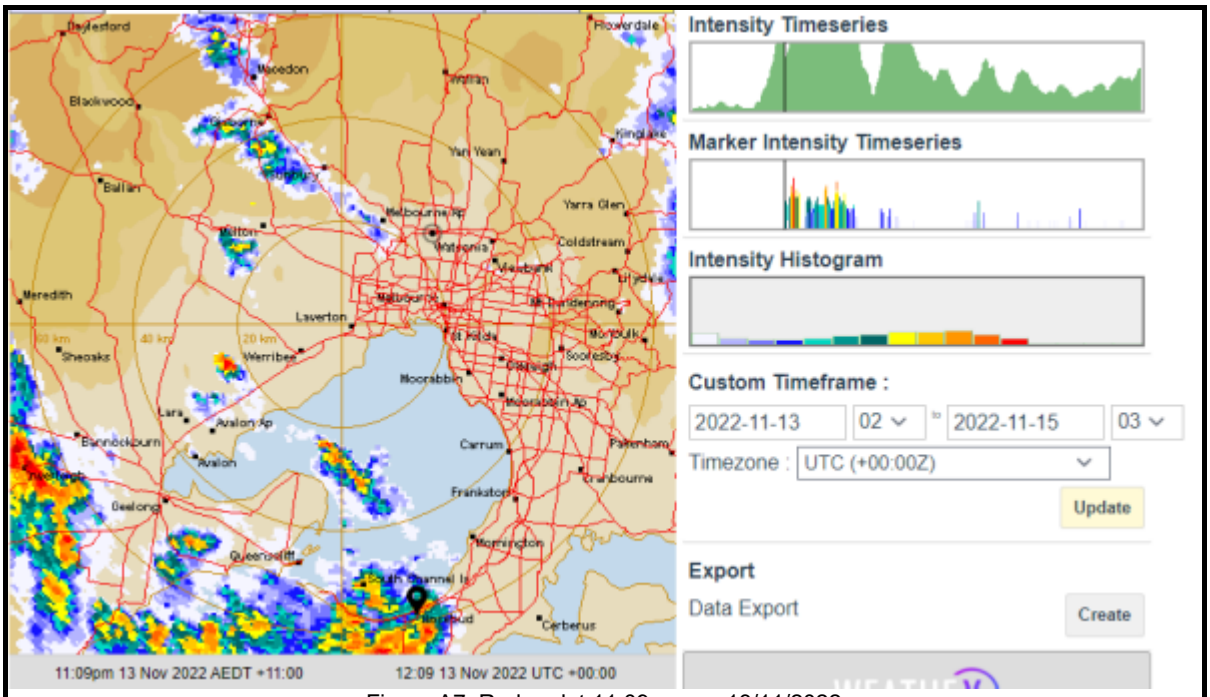


Figure A7: Radar plot 11:09 pm on 13/11/2022

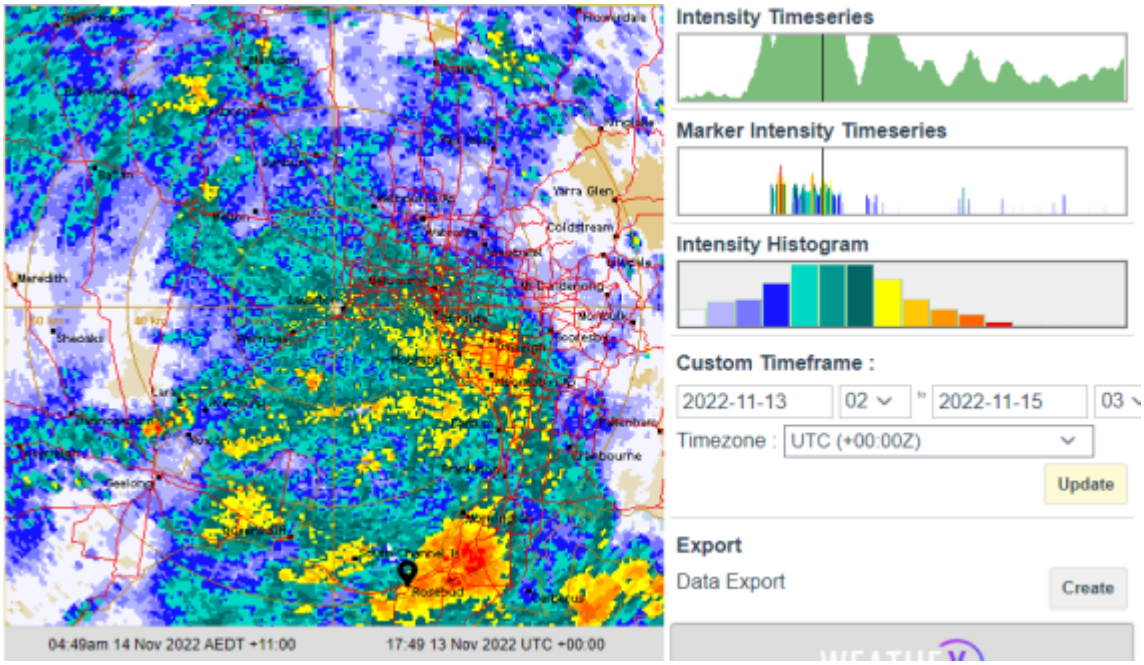


Figure A8: Radar plot 04:49 am on 14/11/2022

Harwood Andrews Risk Assessment 10-12 View Point Road, McRae Archived radar imagery	
PSM5226-002L	Appendix A

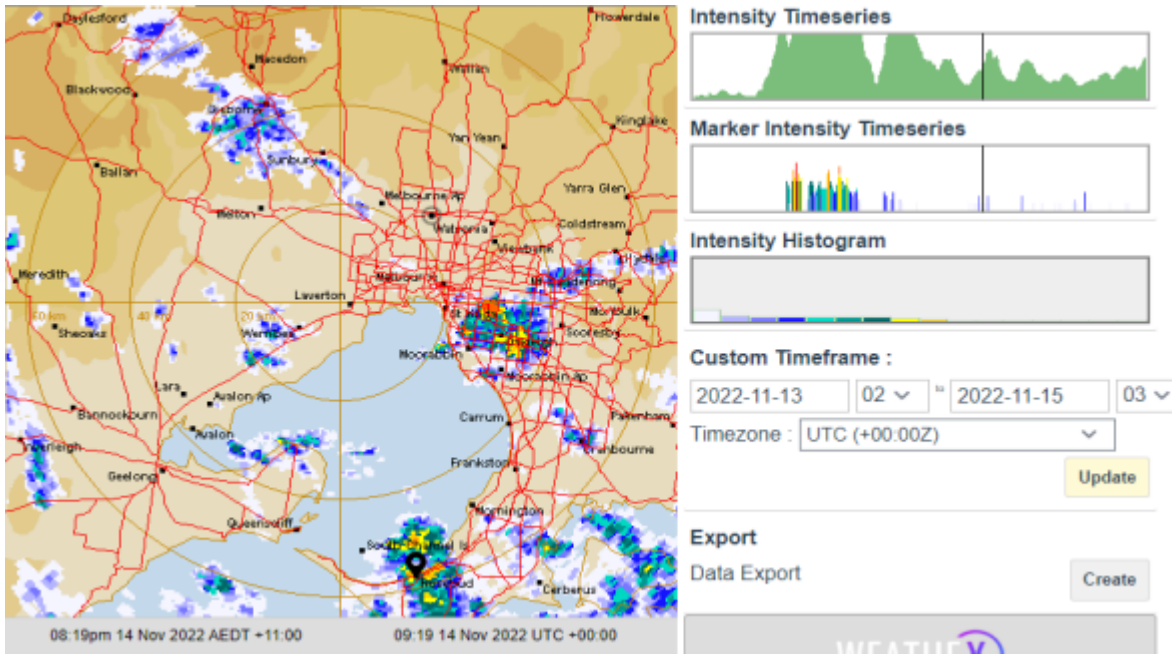


Figure A9: Radar plot 8:19 pm on 14/11/2022

Harwood Andrews Risk Assessment 10-12 View Point Road, McRae Archived radar imagery	
PSM5226-002L	Appendix A

Appendix B
Risk Assessment

QUANTITATIVE RISK ASSESSMENT - LIFE

Job Number: PSM5226
Site Address: 10-12 View Point Road

Hazard ID	DESCRIPTION	SLOPE TYPE	VOLUME ESTIMATE (m^3)	REACH ANGLE (^{0})	Element at Risk	CURRENT RISK TO LIFE						ADDITIONAL CONTROL MEASURES	RESIDUAL RISK TO LIFE					
						$P_{(H)}$	$P_{(SH)}$	$P_{(TS)}$	$V_{(DT)}$	$R_{(LoL)}$	TOLERABLE RISK		$P_{(H)}$	$P_{(SH)}$	$P_{(Ts)}$	$V_{(DT)}$	$P_{(DI)}$	TOLERABLE RISK
1A	Translational slide – regression of escarpment	Existing	100	33	Occupant in damaged house below	1E-02	0.7	0.40	1	2.7E-03	NO							
				On slope below failure	Pedestrian on property	1E-02	1.0	0.02	1	2.1E-04	NO							
				On escarpment	Pedestrian on property	1E-02	1.0	0.02	0.1	2.1E-05	YES							
1B	Debris flow following 1A	Existing	50	24	Occupant in damaged house below	1E-02	0.2	0.40	1	9.6E-04	NO							
				On slope below failure	Pedestrian on property	1E-02	1.0	0.02	1	2.1E-04	NO							
2A	Translational slide of flanks of landslide scarp	Existing	20	29	Occupant in damaged house below	5E-01	0.3	0.40	1	6.2E-02	NO							
				On slope below failure	Pedestrian on property	5E-01	1.0	0.02	1	1.0E-02	NO							
2B	Debris flow following 2A	Existing	20	24	Occupant in damaged house	1E-02	1.0	0.40	1	4.0E-03	NO							
				On slope below failure	Pedestrian on property	1E-02	1.0	0.02	1	2.1E-04	NO							
3	Debris flow of existing debris	Existing	20	24	Occupant in damaged house	5E-02	0.1	0.40	1	2.2E-03	NO							
				On slope below failure	Pedestrian on property	5E-02	1.0	0.02	1	1.0E-03	NO							

LEGEND

$P_{(H)}$ Annual probability of the landslide
$P_{(SH)}$ Spatial impact by hazard
$P_{(Ts)}$ Temporal Probability
$V_{(DT)}$ Vulnerability
$R_{(LoL)}$ Risk (annual probability of loss of life (death) of an individual)