Landslide Planning Map Update Consultation Paper

Mineral Resources Tasmania[1]
Department of Premier and Cabinet[2]

July 2023

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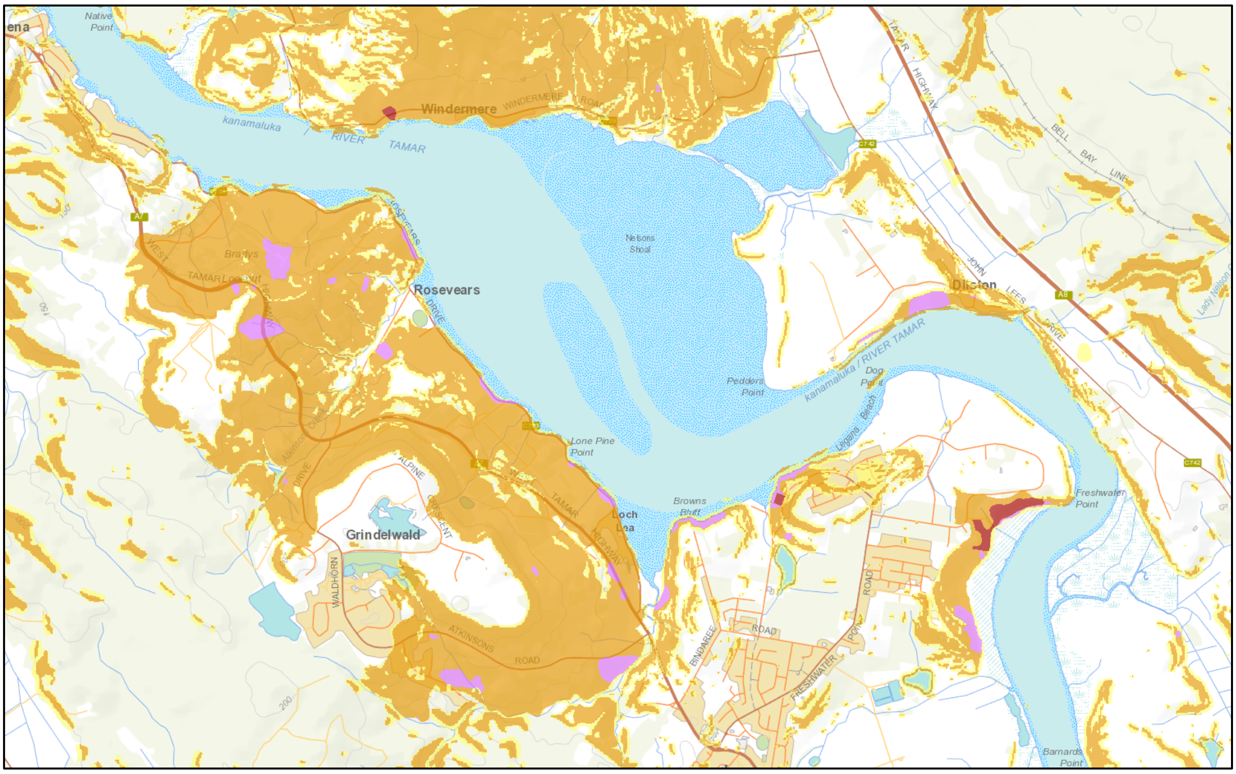

Landslide Planning Map Hazard Bands in the Tamar Valley. From ListMap 2022.

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Glossary

This glossary contains the definitions for terms used in the text, as defined by international standards and the Australian Geomechanics Society (where source is listed).

Term	Definition	Source
Hazard*	Source of potential harm Note 1: Hazard can be a risk source	ISO 73:2009
	A condition with the potential for causing an undesirable consequence. The description of landslide hazard should include the location, volume (or area), classification and velocity of the potential landslides and any resultant detached material and the probability of their occurrence within a given period of time.	AGS 2007a
Inventory [Landslide]	A record of the location, classification, volume, activity and date of occurrence of individual landslides in an area.	AGS 2007a
Landslide	The movement of a mass of rock, debris, or earth (soil) down a slope.	AGS 2007a
Landslide Planning Map Components	The scientific datasets that underpin the landslide planning map hazard bands. These datasets include landslide inventory mapping, susceptibility modelling and slope angle mapping. See Section 7.1 for a full list of components.	
Landslide Planning Map Hazard Bands	Five bands (acceptable, low, medium, medium – active, and high) that guide the management of landslide in Tasmania through the land use planning and building regulatory systems.	
Risk	Effect of uncertainty on objectives Note 1 to entry: An effect is a deviation from the expected — positive and/or negative. Note 2 to entry: Objectives can have different aspects (such as financial, health and safety, and environmental goals) and can apply at different levels (such as strategic, organization-wide, project, product and process). Note 3 to entry: Risk is often characterized by reference to potential events (3.5.1.3) and consequences (3.6.1.3), or a combination of these. Note 4 to entry: Risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated likelihood (3.6.1.1) of occurrence. Note 5 to entry: Uncertainty is the state, even partial, of deficiency of information related to, understanding or knowledge of, an event, its consequence, or likelihood.	ISO 73:2009
	A measure of the probability and severity of an adverse effect to health, property or the environment. Risk is often estimated by the product of probability and consequences. However, a more general interpretation of risk involves a comparison of the probability and	AGS 2007a

	consequences in a non-product form. For these guidelines risk is further defined as: (a) *For life loss,* the annual probability that the person most at risk will lose his or her life taking account of the landslide hazard and the temporal spatial probability and vulnerability of the person. (b) *For property loss*, the annual probability of the consequence or the annualised loss taking account of the elements at risk, their temporal spatial probability and vulnerability.	
Susceptibility [Landslide]	A quantitative or qualitative assessment of the classification, volume (or area) and spatial distribution of landslides which exist or potentially may occur in an area. Susceptibility may also include a description of the velocity and intensity of the existing or potential landsliding.	AGS 2007a

**Note that the term 'hazard' is commonly used in two different ways. It can be used to denote a hazardous process or to indicate the magnitude-frequency relationship of that process.*

Executive Summary

Landslide risk in Tasmania is managed through the land use planning and building systems. The current system was established in 2013 and comprises the Landslide Planning Report, the Landslide Planning Map Hazard Bands, and the statutory overlay. These products are due for review.

This report outlines the proposed updates to the mapping components of the Landslide Planning Map, and opens the discussion for changes to the policy map.

The existing mapping has five Landslide Planning Map Hazard Bands, based on

- mapped landslides
- susceptibility modelling, and
- slope angle calculations.

We believe the 2013 banding is based on good scientific principles; however, it has reached the end of its design life and we believe improvements can be made in the next iteration. Proposed changes include updating input datasets to use the best available data, expanding the susceptibility modelling in key areas, and replacing the current susceptibility slope angle approach with a generalised susceptibility model.

1. Introduction

The Tasmanian Government is responsible for the direct management of public risk, and the provision of information and planning tools that support individuals and business in understanding and managing private risk[1]. The aim is to protect life and property from known risks, and permit development in the appropriate band where it is safe to do so. It is important to note that the methods of mapping may vary for different hazards. The remainder of this consultation paper is specific to landslides.

The Landslide Planning Map is made up of two statewide overlays: the Components, which represent the scientific landslide datasets, and the Hazard Bands, which translate the science into a policy map. These products were scheduled for review in 2018, while this update is now overdue, it had been delayed so as to incorporate the capture of LiDAR that was scheduled for completion in late 2020.

The Tasmanian Government endorsed the *Landslide Planning Report* (DPAC, 2013c) and Landslide Planning Map – Hazard Bands as the basis for a statutory code and overlay in 2014. This report and mapping set out the planned for arrangements to manage landslide risk in Tasmania through the land use planning and building regulatory systems, the balance of the proposed settings evolved as the planning and building controls systems moved through the Interim Planning System to the Tasmanian Planning Scheme, and the redevelopment of the Building Act in 2016. Landslide hazard is regulated via the *Land Use Planning and Approvals Act 1993*, the *Building Act 2016*, a number of area-specific Acts pertaining to Proclaimed Landslip Areas *(under the Mineral Resources Development Act 1995)*. The hazard bands are incorporated into the Landslip Hazard Code of the Tasmanian Planning Scheme (TPS), which applies to all Local Government Areas (LGAs) as their Local Provisions Schedules are completed. However, the approach has already been operational for several years in the Interim Planning Schemes for the southern and north-western LGAs.

This report outlines the proposed changes to the mapping and invites discussion on other ways to improve the accuracy and usability of the Landslide Planning Map components and hazard bands.

[1] *Principles for the consideration of Natural Hazards in the Planning System* and companion Guidelines document (DPAC 2013 a, b). Land use planning relies on the use of strategic 'hazard banding' for most types of hazards.

2. Landslide exposure in Tasmania

Definition and driving factors

A landslide is the downslope movement of a mass of rock, debris, or earth, and includes falls, topples, slides, flows and spreads (AGS 2007b). For planning purposes, ground subsidence and shallow soil creep have been excluded.

Landslides occur due to gravity, but certain combinations of land characteristics can make a slope more prone to failure. These factors may include:

- slope angle,
- geology, soil,
- geomorphology, and
- vegetation cover.

Factors that trigger landslides in susceptible areas include intense rainfall, changes to groundwater levels, human modification of slopes, and earthquakes.

History

Since the 1950s, over 170 buildings are known to have been damaged or destroyed by landslides. The most significant events in Northern Tasmania include the Lawrence Vale landslide, which destroyed 43 houses in the 1950s, and the Beauty Point landslide, which destroyed 15 houses and significantly damaged another 13 in the 1970s.

More recently, landslides in Deviot and Legana led to the removal of or damage to several houses. In Southern Tasmania, the Taroona landslide affected 10 houses and a high school, and the Rosetta Landslide caused damage and/or demolition of 23 houses since 1992. Mineral Resources Tasmania maintains an inventory of landslide locations and damaged infrastructure.

3. The Landslide Planning Map and Hazard Bands

The existing Landslide Planning Map divides the landscape into five hazard bands, detailed in DPAC (2013c) and summarised in Table 1. These bands were determined based on known evidence for landslide processes and susceptibility, with the translation from scientific datasets to hazard bands undertaken in consultation with regulatory bodies and industry users. Figure 1 summarises the landslide planning mapping process, and an example of landslide component mapping and resulting hazard bands is shown in Figure 2 and Figure 3, respectively.

Input datasets include peer-reviewed landslide inventory mapping and landslide susceptibility modelling performed by MRT. In areas without detailed landslide mapping, landslide susceptibility is assumed from slope angle. Because susceptibility differs by type of landslide, the zones are derived by combining components (individual map layers) that separately consider shallow slides and flows, deep-seated landslides, rockfalls/topples, and debris flows (see Table 2 for the full description and spatial coverage of each component).

The methodology for the hazard banding was developed by DPAC and MRT, and the boundaries between the hazard bands were defined based on a component ranking process and consultation with regulators and industry bodies. The thresholds are a judgment that is consistent with landslide hazard tolerance in the most affected local government areas and considers the fact that the most severely impacted areas in Hobart, the Tamar Valley and the North West Coast have undergone more detailed mapping.

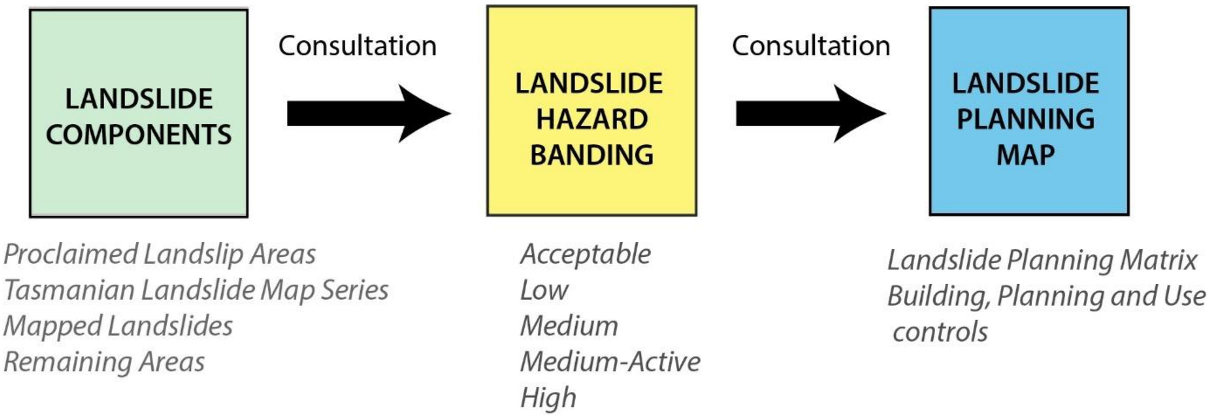

Figure 1. Landslide planning mapping process

Table 1. Summary of existing landslide hazard bands and the required controls around land use planning and development. From DPAC (2013c).

Level	Description
Acceptable	A landslide is a rare event in this area based on current understanding of the hazard, but it may occur in some exceptional circumstances. Development and use are not subject to landslide controls.
Low	This area has no known landslides, however it has been identified as being susceptible to landslide by Mineral Resources Tasmania (MRT). While non-construction requirements are not necessary for most use and development, controls may be necessary to reduce the risks associated with vulnerable and hazardous uses or post-disaster and catastrophic risk-based use to ensure that risks are tolerable (as recommended by AGS 2007a) The low band covers 19% of the land area of Tasmania.
Medium	The area has known landslide features, or is within a landslide susceptibility zone, or has legislated controls to limit disturbance of adjacent unstable areas. Planning controls are necessary for all use and development to ensure that risks are tolerable (as recommended by AGS 2007a). Any vulnerable or hazardous use will only be allowed in exceptional circumstances. The medium band covers 15% of the land area of Tasmania.
Medium-Active	The area has known recently active landslide features. Planning controls are necessary for all use and development to ensure that risks are tolerable (ABCB 2006 Landslide Hazards – Handbook for good hillside construction).

	Any vulnerable and hazardous uses or post-disaster and catastrophic risk-based uses are prohibited. The medium-active band covers less than 0.1% of the land area, vacant parcels and residential buildings.
High	The site is within a declared Landslip A area. All use and development requires significant investigation and engineered solutions to mitigate the natural hazard and enable the development to achieve and maintain a tolerable level of risk, however, the mitigation measures may never achieve comprehensive levels of security and safety. The high band covers less than 0.1% of the land area, vacant parcels and residential buildings.

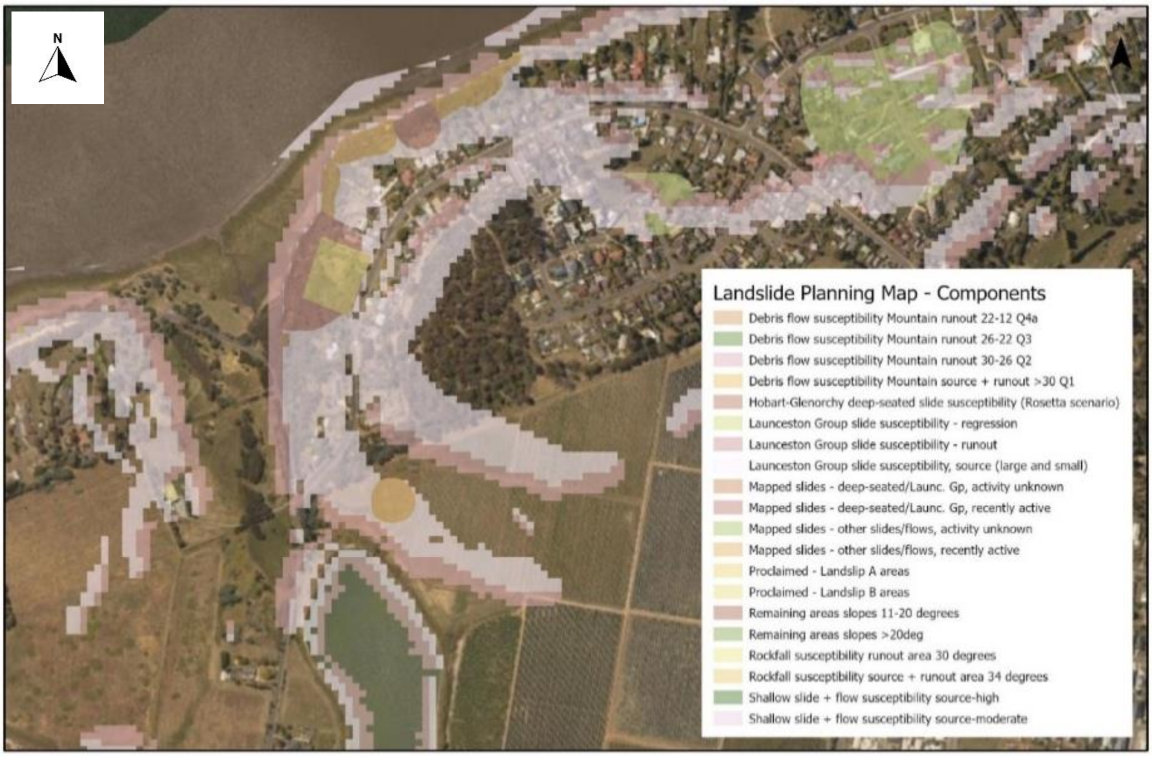

Figure 2. An example of landslide component mapping for an area in Legana, north of Launceston. Components are derived from MRT mapping and modelling, proclaimed landslip zones, and slope thresholds, as described in Mazengarb and Stevenson (2010). Note that components in the legend comprise the entire set considered for Tasmania and not all are present at Legana.

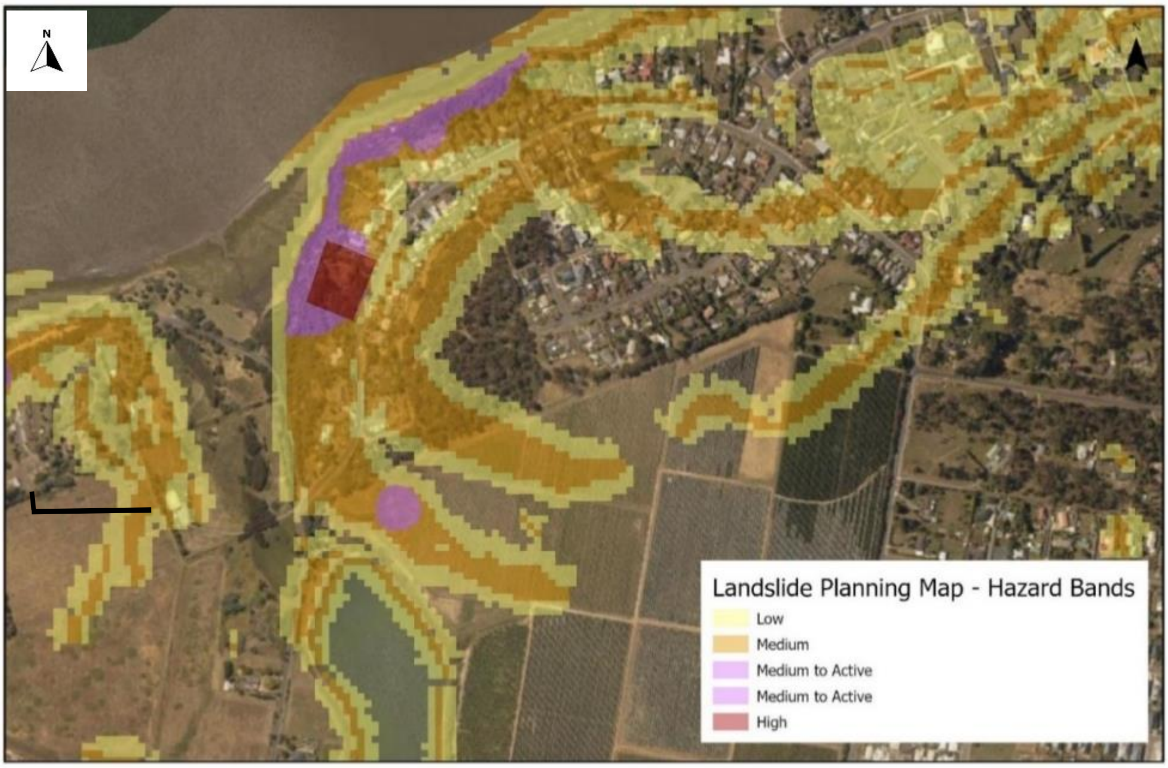

Figure 3. Landslide hazard band map for the Legana area, north of Launceston. The bands are assigned from the landslide components shown in Figure 1, based on the methodology described in the Landslide Planning Report (DPAC, 2013c)

Table 2. the landslide components that underpin the current landslide hazard bands. The spatial coverage of each component is also summarised.

Mapping type	**Components**	**Statewide Mapping**	**MRT Susceptibility Mapping Area**				
			Glenorchy	**Hobart**	**Launceston**	**Tamar Valley**	**North West**
Proclaimed Landslip Areas	Landslip A areas		X	X	X	X	X
	Landslip B areas		X	X	X	X	X
Remaining areas susceptibility	Slope <11 degrees	X					
	Slope 11-20 degrees	X					
	Slope >20 degrees	X					
Tasmanian Landslide Map Series	Rockfall susceptibility source and runout area 34 degrees		X	X	X	X	X
	Rockfall susceptibility source and runout area 30 degrees		X	X	X	X	X
	Shallow slide + flow susceptibility source high						X
	Shallow slide + flow susceptibility source moderate						X
	Shallow slide + flow susceptibility source low						X
	Debris flow susceptibility Mountain source + runout > 30 Q1		X	X		X	

	Debris flow susceptibility Mountain source + runout 30-26 Q2		X	X			
	Debris flow susceptibility Mountain source + runout 26-22 Q3		X	X			
	Debris flow susceptibility Mountain source + runout 22-12 Q4		X	X			
	Launceston Group slide susceptibility (large and small)				X		
	Hobart-Glenorchy deep-seated susceptibility (Rosetta scenario)		X	X			
	Deep-seated slide susceptibility					X	X
	Very low to no susceptibility		X	X	X		X
Known landslides - actual	Mapped slides – deep-seated Launceston Group, recently active	X (limited)	X	X	X	X	X
	Mapped slides – deep-seated Launceston Group, activity unknown	X (limited)	X	X	X	X	X
	Mapped slides – other slides/flows, recently active	X (limited)	X	X	X	X	X
	Mapped slides – other slides/flows, activity unknown	X (limited)	X	X	X	X	X

4. Proposed updates to the Landslide Planning Map - Components

This section explores upcoming changes to the datasets that underpin the Landslide Planning Map - Hazard Bands. In most cases, changes involve updates to input data or expansion of mapping and modelling. However, we also invite feedback on the methodological approach and thresholds.

Table three sets is a summary of the proposed changes to the components, each component that is proposed to change is discussed in remainder or section 4.

Table 3. Summary of updates to the landslide component datasets that underpin the hazard banding

Mapping type	2013 Landslide Planning Map Component	Update recommendation	2022 Proposed Landslide Planning Map Component
Proclaimed Landslip Areas	Landslip A areas	No change*	Landslip A areas
	Landslip B areas	No change*	Landslip B areas
Tasmanian Landslide Map Series	Rockfall susceptibility source + runout area 34 degrees	Expand to statewide	Rockfall susceptibility source + runout area 34 degrees
	Rockfall susceptibility runout area 30 degrees	Expand to statewide	Rockfall susceptibility runout area 30 degrees
	NA	New component	Regression areas adjacent to cliffs > 42 degrees
	Shallow slide + flow susceptibility source high	No change	Shallow slide + flow susceptibility source high
	Shallow slide + flow susceptibility source moderate	No change	Shallow slide + flow susceptibility source moderate

	Shallow slide + flow susceptibility source low	No change	Shallow slide + flow susceptibility source low
	NA	New component	Shallow slide + flow susceptibility runout
	Debris flow susceptibility Mountain source + runout > 30 degrees Q1	No change	Debris flow susceptibility Mountain source + runout > 30 degrees Q1
	Debris flow susceptibility Mountain source + runout 30-26 degrees Q1	No change	Debris flow susceptibility Mountain source + runout 30-26 degrees Q1
	Debris flow susceptibility Mountain source + runout 26-22 degrees Q1	No change	Debris flow susceptibility Mountain source + runout 26-22 degrees Q1
	Debris flow susceptibility Mountain source + runout 22-12 degrees Q4	No change	Debris flow susceptibility Mountain source + runout 22-12 degrees Q4
	Debris flow susceptibility Mountain runout – dam-burst	Remove component	NA
	Launceston Group slide susceptibility (large and small)	Expand – Evandale Remove Launceston Group specification Restructure as source/regression/ runout	Undifferentiated slide susceptibility - Source
			Undifferentiated slide susceptibility - Regression
			Undifferentiated slide susceptibility - Runout
	Hobart-Glenorchy deep-seated slide susceptibility (Rosetta scenario)	Merge with Deep-seated slide susceptibility	Deep-seated slide susceptibility - Source
	Deep-seated slide susceptibility		
	NA	Merge region-based components across state	Deep-seated slide susceptibility - Regression
	NA	Merge region-based components across state	Deep-seated slide susceptibility - Runout
	Very low to no susceptibility	Expand – Evandale and Penna	Very low to no susceptibility
Known landslides - actual	Mapped slides – deep-seated/Launceston Group, recently active	Merge components and expand to new map areas across the state	Mapped slides – Recently active
	Mapped slides – other slides/flows, recently active		
	Mapped slides – deep-seated/Launceston Group, activity unknown	Merge components and expand to new map areas across state	Mapped slides – Activity unknown
	Mapped slides – other slides/flows, activity unknown		
	NA	New component	Mapped slides – Extremely unlikely to

			reactivate/susceptible mass removed
	NA	New component	Mapped slides – point features
Remaining areas susceptibility	Slope < 11 degrees	Update DEM and review thresholds AND/OR replace with general susceptibility modelling	Generalised slide susceptibility – Runout
	Slope 11-20 degrees	Update DEM and review thresholds AND/OR replace with general susceptibility modelling	Generalised slide susceptibility – Source
	Slope > 20 degrees	Update DEM and review thresholds AND/OR replace with general susceptibility modelling	Generalised slide susceptibility - Regression

4.1. Proclaimed Landslip A and B Areas

These areas cover recent or historically active landslides that are covered by specific legislation pertaining to their use and development. No new Proclaimed Landslip A or B Areas have been declared since the 2013 mapping. However, some of the existing Proclaimed Landslip Areas are legally tied to cadastral boundaries, and these will be checked, and possible minor adjustments may be required.

Activities in Landslip A and B Areas are controlled by separate legislation and are fundamentally different to other components in the Landslide Planning Map. We would like to consider separating these from the other components and mapping them as a separate group (discussed further in Section 5.1).

Summary: No data updates are planned for Landslip A and B Areas.

4.2. Tasmanian Landslide Map Series – Susceptibility Zones

The Tasmanian Landslide Map Series includes rockfall susceptibility and runout modelling, debris flow susceptibility and runout modelling, and both deep-seated and shallow landslide/flow susceptibility. In areas underlain by Launceston Group (or similarly weak sedimentary units), shallow and deep-seated susceptibility processes have not been differentiated.

The Launceston Group slide susceptibility components include source areas, regression areas, and runout areas. This mapping style will be extended to two new areas: Evandale (near Launceston) and Penna (near Hobart). These regions were prioritised due to observed active landslide processes coinciding with interest in development. The new susceptibility modelling has been performed at 10 m resolution and is consistent with the existing Launceston Group modelling methodology performed in 2013. We also intend to remove the name “Launceston Group” from the component names and replace it with “Undifferentiated slide susceptibility – Source/Regression/Runout.” This change will create a consistent naming convention that can be used across the entire state and will correct areas in the existing datasets that have been incorrectly categorised. The merging of these components does not result in any loss of information, because the underlying geology is considered in the slope thresholds applied to the susceptibility modelling. In addition, the geological information can be queried using a separate publicly available layer. The coverage of MRT’s detailed slide susceptibility mapping programme is shown in Figure 4.

A comparative example of the 2013 and 2022 mapping components for Evandale is given in Figure 5 and 6. The changes are significant, because the recent mapping has picked up new landslides and the susceptibility modelling has highlighted susceptible areas that were not previously captured by the simple slope categorisation algorithm.

The shallow slide and flow susceptibility components apply to a limited area in northern Tasmania, and have been separated into low, medium and high susceptibility. This mapping methodology has not been extended to any other areas of the state since 2013. However, we propose to modify the way in which the existing data is incorporated into the planning map components, to provide more consistency in the treatment of susceptibility components across the state (see Figure 7 and Figure 8 for a comparison). In addition to the “Shallow slide low/medium/high – Source” susceptibility areas, we propose to include runout areas as well. Note that shallow slides do not regress like deeper failures and so no “Shallow slide + flow susceptibility – Regression” component is proposed.

Deep-seated slide susceptibility has been modelled in northern Tasmania and the Greater Hobart region. This modelling also includes source, regression and runout areas, and we have not expanded this methodology to any new areas since 2013. However, we propose to combine the existing region-specific deep-seated components into a single set of layers, titled “Deep-seated slide susceptibility – Source/Regression/Runout”. This change will simplify the component list and provide a consistent naming convention across the state.

We propose an extension of the rockfall susceptibility components from the current limited coverage (around kunanyi/Mt Wellington and along the central north coast) to a statewide layer. The existing components consider rockfall source and runout areas, with thresholds of 34 degrees and 30 degrees. These thresholds will be reviewed for the new statewide dataset to ensure they remain appropriate. In addition, the new dataset will include a rockfall regression component, which will indicate a susceptible set-back area behind steep slopes and cliffs (> 42 degrees). This modelling has been undertaken on a 10 m statewide DEM, of which approximately 70% is built from LiDAR data. An example of the rockfall source and runout mapping is shown in Figure 9

No changes are proposed for the primary debris flow susceptibility and runout components. These components were modelled on a 10 m LiDAR-based DEM and remain fit for purpose in the current mapping. However, we propose that the debris flow – dam burst component be removed. This component was originally named to represent a scenario-specific model of the 1872 Glenorchy debris flow. This model has now been superseded by more recent data, and current scientific thinking does not support a dam burst mechanism in this event.

Summary: Updates are proposed to take advantage of new mapping and simplify the component names. The debris flow – dam-burst component will be removed.

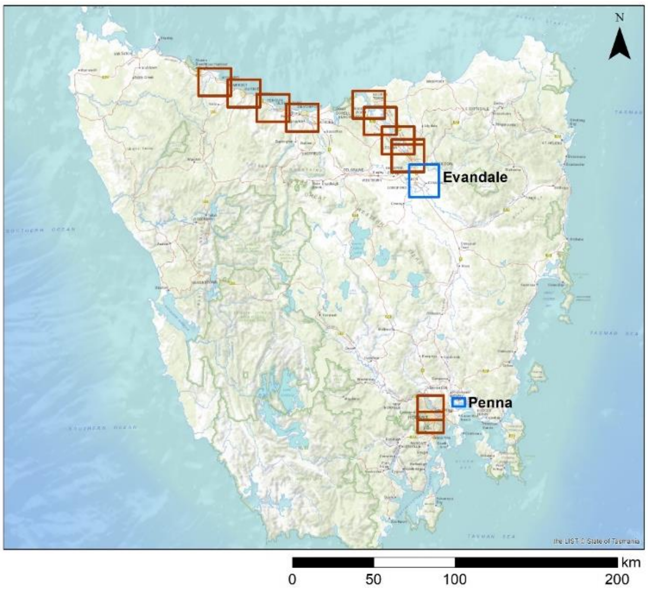

Figure 4. Spatial coverage of the Tasmanian Landslide Map Series. Red boxes indicate mapping that was performed prior to 2013, and blue boxes indicate newly mapped areas.

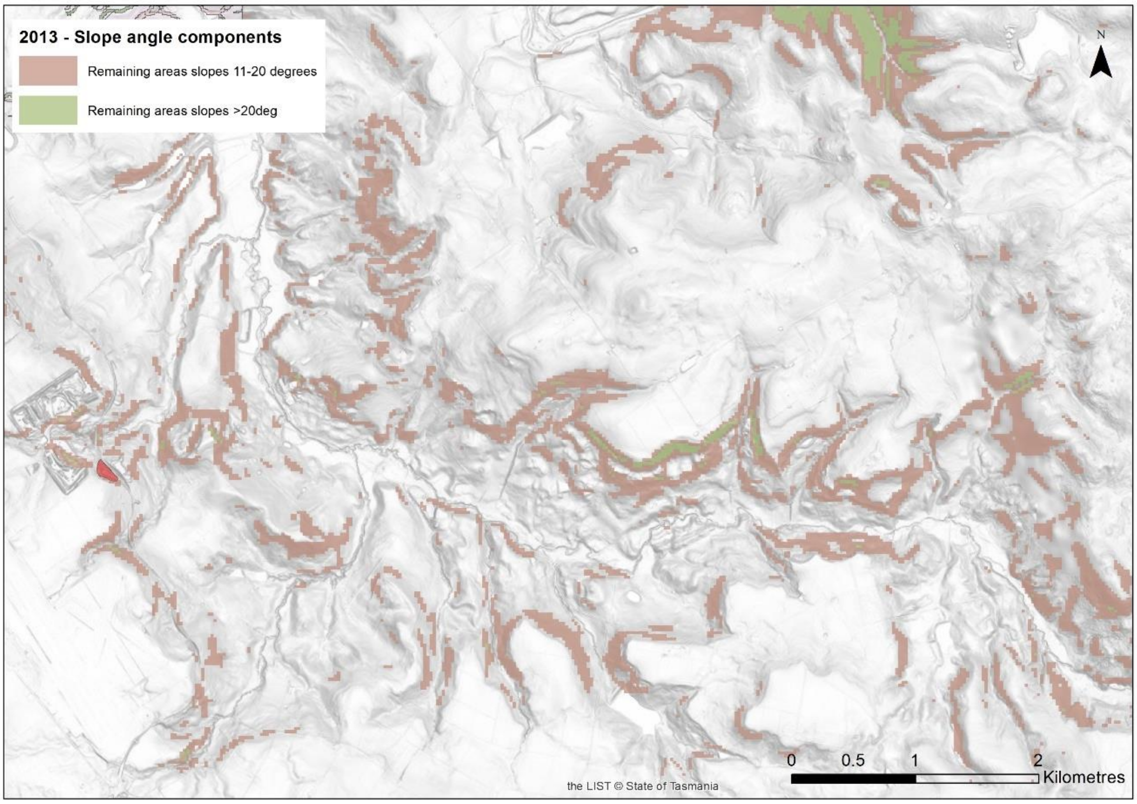

Figure 5. Landslide Planning Map components in the 2013 (current) mapping

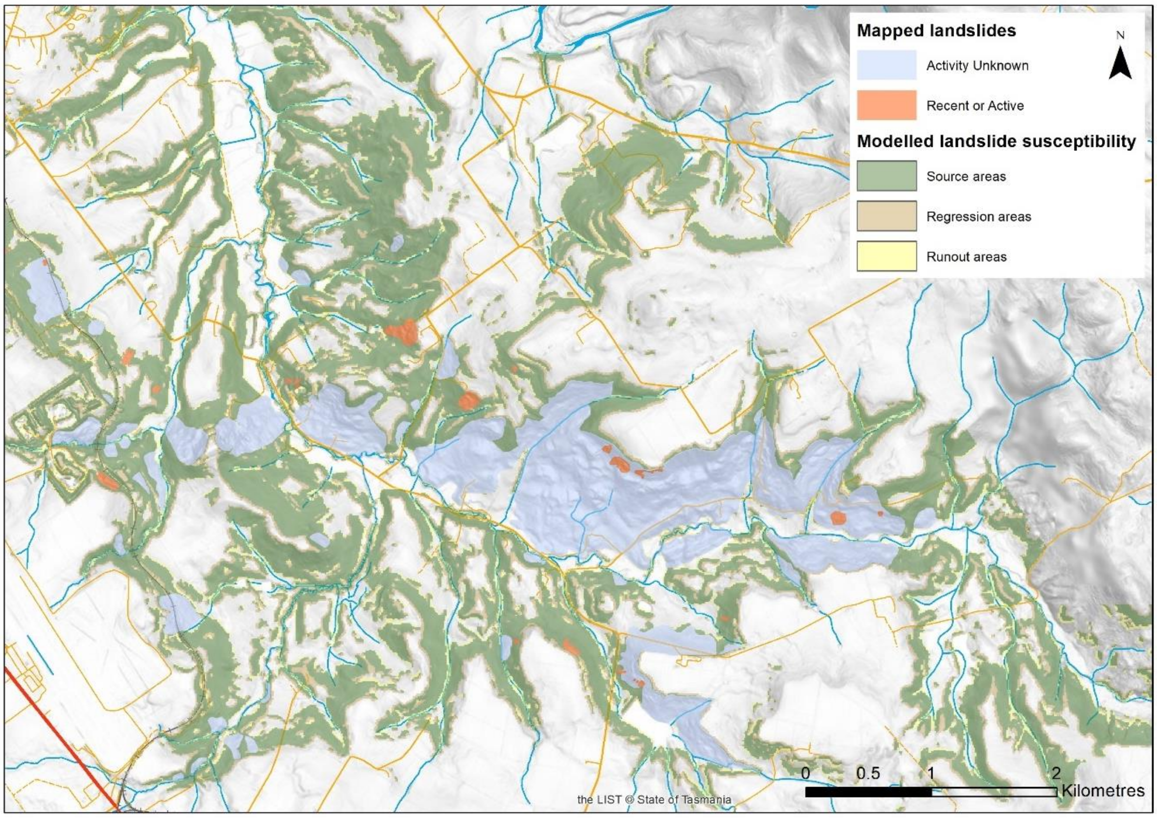

Figure 6. Landslide Planning Map components derived from the new Evandale mapping, completed in 2022.

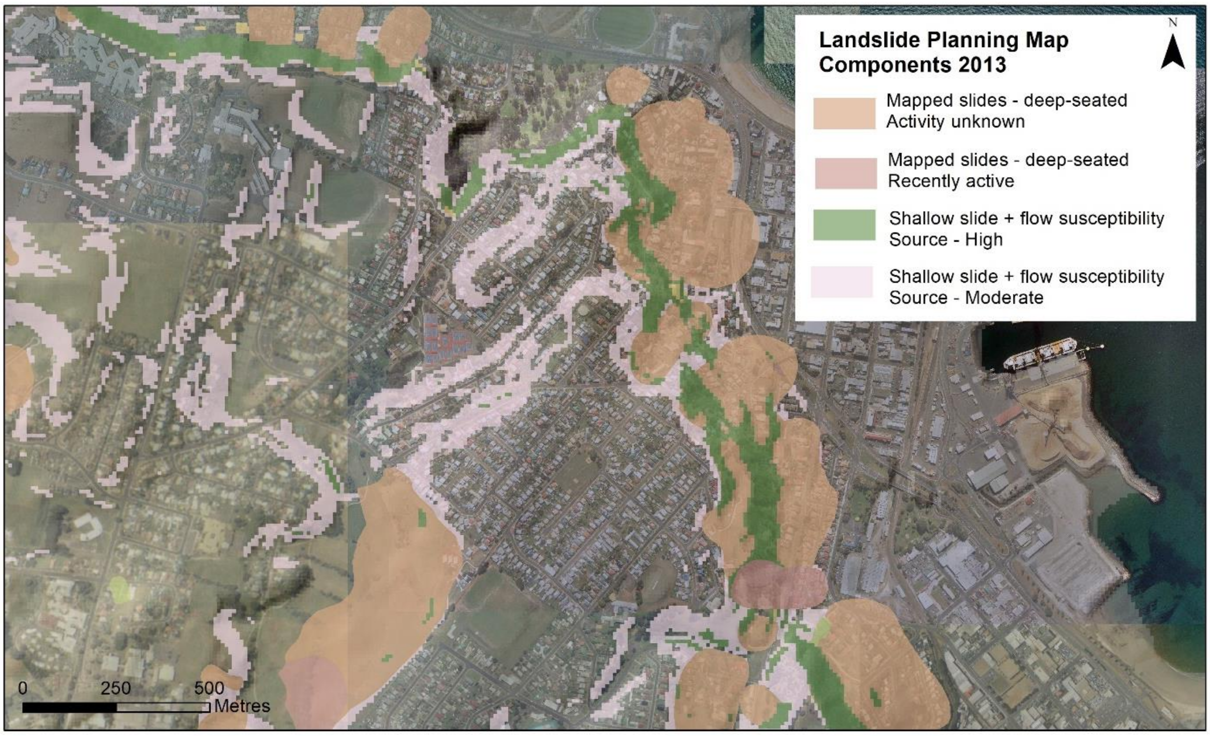

Figure 7. 2013 Landslide Planning Map Components around the Burnie area

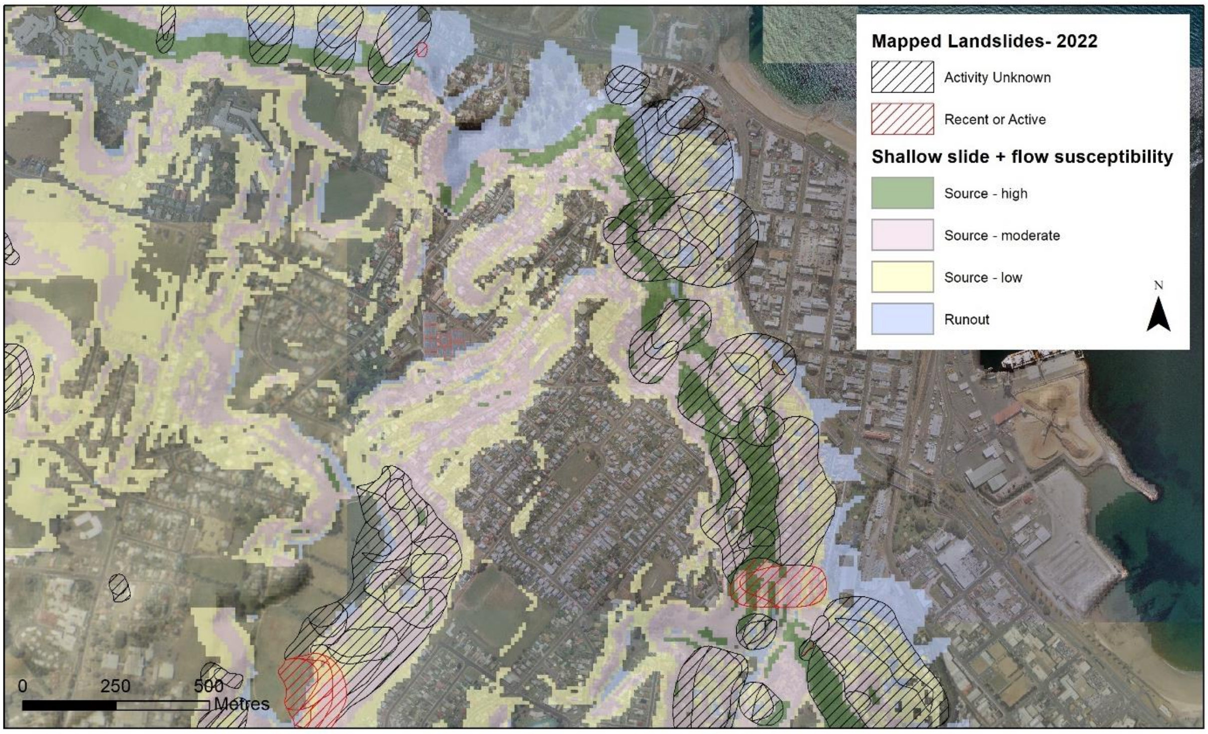

Figure 8. Shallow slide and flow susceptibility mapping around Burnie, showing the addition of runout and source-low components.

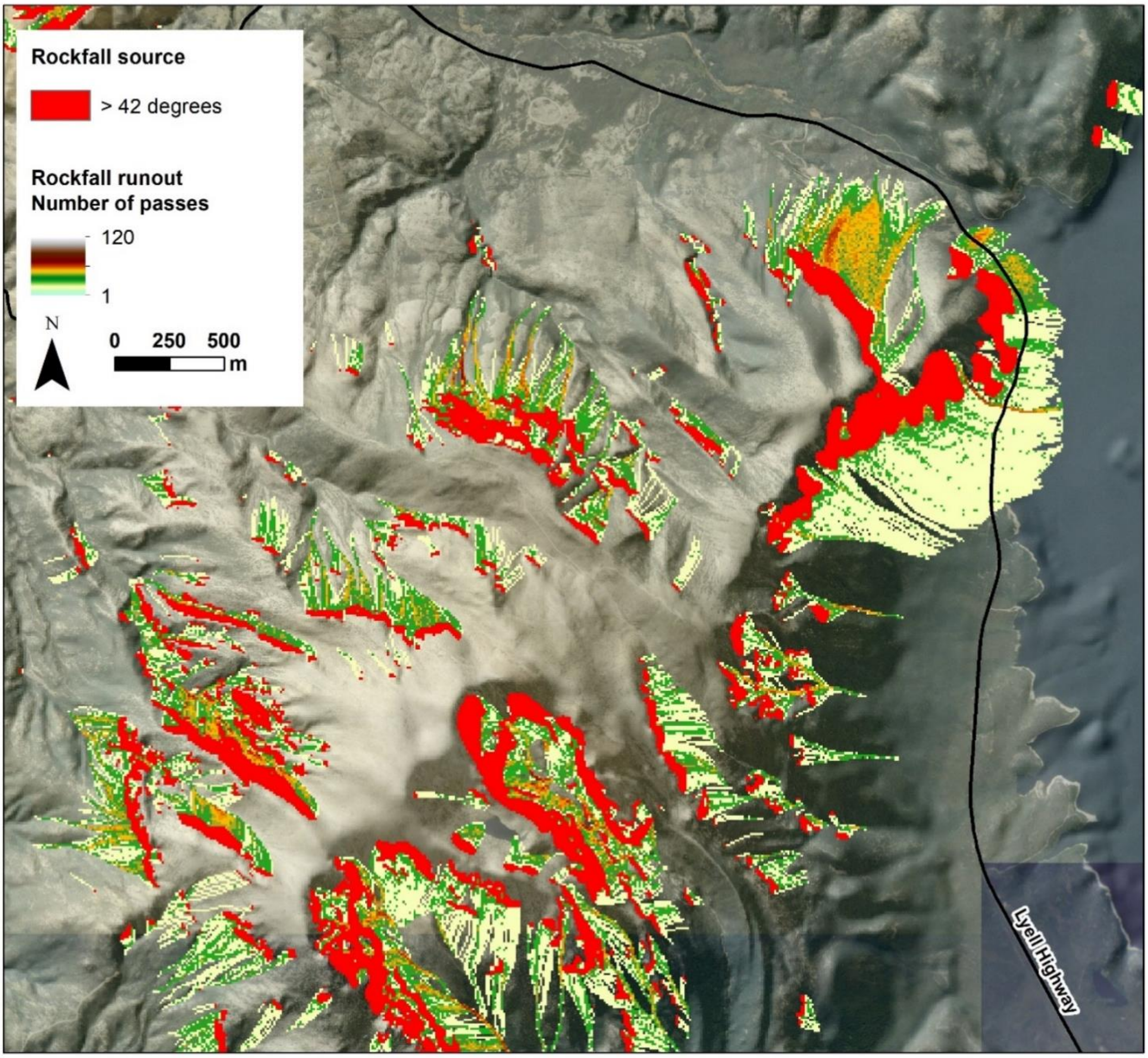

Figure 9. Example of the statewide Rockfall source and runout layers. The runout output shows the number of times a cell is 'passed over' by a rockfall runout angle calculation, but this is not a measure of probability.

4.3. Mapped Landslides

Landslides that are mapped in the hazard bands are derived from Mineral Resources Tasmania's Landslide Database, which is a dynamic inventory that is continually updated with newly mapped landslide features. In addition to active features that have been mapped since 2013, MRT has recently completed a programme of detailed landslide mapping across priority urban and peri-urban areas. These areas include Tasman Peninsula and Greater Hobart, Central Coast, main highways, and parts of the Western Tiers. This mapping includes dormant or relict landslide features that have not been active since European settlement, but which could reactivate in the future. An example of the updated feature mapping in the Launceston-Evandale area is shown in Figure 10 (2013) and Figure 11 (2022).

Mapped landslides are identified as either 'recently active' or 'activity unknown' in MRT's landslide database. The landslide planning map components further divide these into Launceston Group deep-seated slides and other slides/flows, making a total of four components. However, some of the slides are incorrectly mapped as Launceston Group and are located in areas with different underlying geology. We propose that these four components be simplified to two: “Mapped slides – Recently active” and “Mapped slides – Activity unknown”. No information is lost in this merging process, as the underlying geology can be queried in a separate publicly available layer.

MRT also maintains a database of point features, which represent landslides that have not been mapped in detail (e.g. Figure 11). These point landslides were not included in the 2013 iteration of the Landslide Planning Map, and we would like to consider adding these features in the current update. For example, a buffer of 10 m (or some other agreed threshold) could be applied around each point to create an approximate landslide polygon.

In the current hazard bands, ‘recently active’ slides fall into the medium-active hazard band and ‘activity unknown’ slides fall into the medium hazard band. We would like to explore the possibility of introducing a new category in MRT’s database, to capture features that have been thoroughly investigated for landslide risk and found to be incapable of further movement (e.g. relict periglacial features).

Summary: Updates are proposed to take advantage of new mapping and simplify component names. Two new components are proposed: 1) to signal areas where previously mapped landslides have either been removed entirely or investigated and found to be incapable of further movement, and 2) To include landslide features mapped as points in MRT’s database.

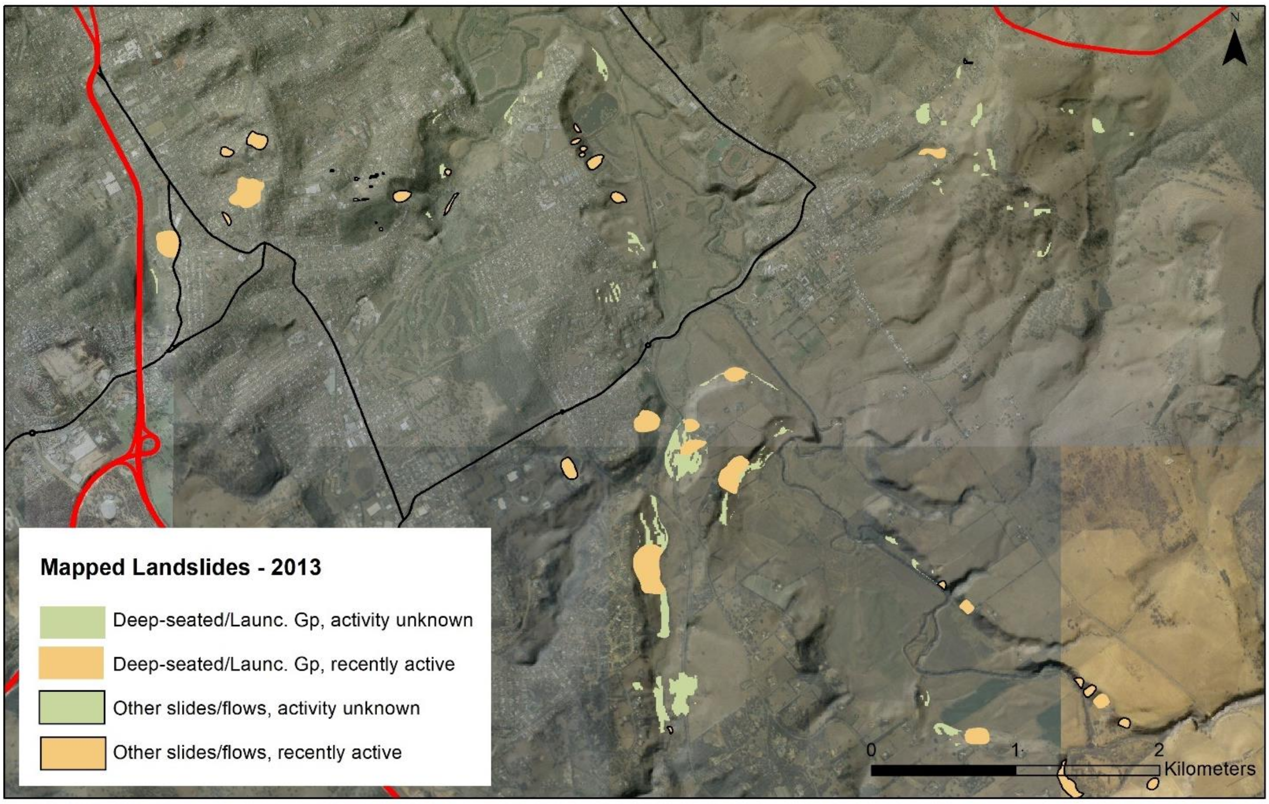

Figure 10. Landslide features as mapped in 2013. Note that the 2013 components use four categories, separating Launceston Group slides from other slides and flows.

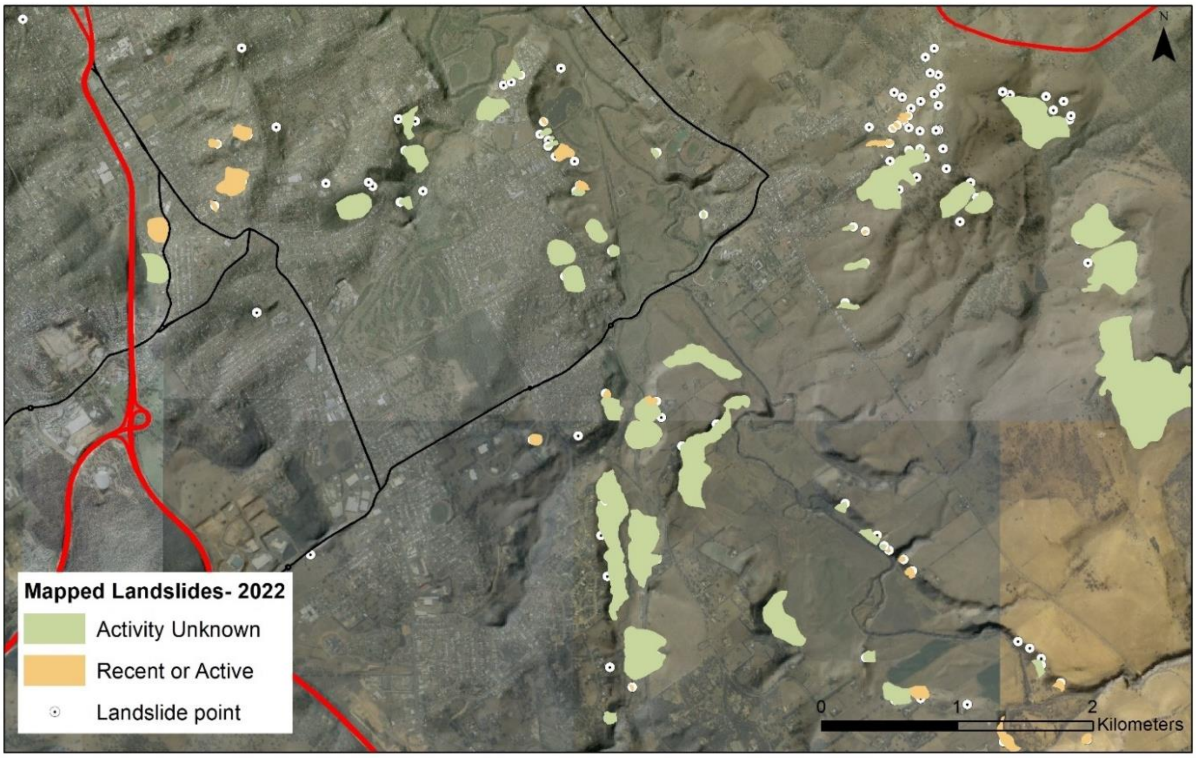

Figure 11. Landslide features as mapped at August 2022 (including point features, not included in 2013). Component names have been simplified into two categories.

4.4. Remaining Areas – Susceptibility

Slope angle is currently used as a proxy for landslide susceptibility in areas that are not covered by the feature mapping or source-regression-runout susceptibility modelling. Since 2013, a substantial amount of new LiDAR data has been captured and an updated DEM has been created for the state. The slope angle mapping has been refreshed using the latest DEM, which is a significant improvement from the previous 25 m DEM that underlies the 2013 slope angle calculations. An example of the improvement in resolution is shown in Figure 12 (2013, 25 m DEM) and Figure 13 (2022, 10 m DEM).The current approach divides the landscape into three slope categories with thresholds of <11 degrees, 11-20 degrees, and >20 degrees, and we invite feedback on the suitability of these values.

We are also exploring a simplified landslide susceptibility model at a statewide level, which could replace the slope angle categorisation described above. This modelling uses the same basic methodology as the detailed susceptibility modelling, but source and runout angle thresholds have been set to a conservative value of 11 degrees, rather than varying across the landscape according to underlying geology. The output datasets include "Generalised slide susceptibility – Source/Regression/Runout" components, but lack the detailed field validation and geomorphic mapping that underpins the detailed susceptibility modelling in other areas.

The generalised susceptibility layers will be compared to the 2013 slope category outputs, and we invite feedback on the relative suitability of these approaches (either alone or a combination) and the thresholds applied in the susceptibility modelling. An example of these component datasets is provided in Figure 14

Summary: Updates are proposed based on the most recent DEM for Tasmania. This change improves the slope mapping resolution from 25 m to 10 m. We also invite feedback on a generalised landslide susceptibility modelling approach for remaining areas, which could replace the slope category classification method.

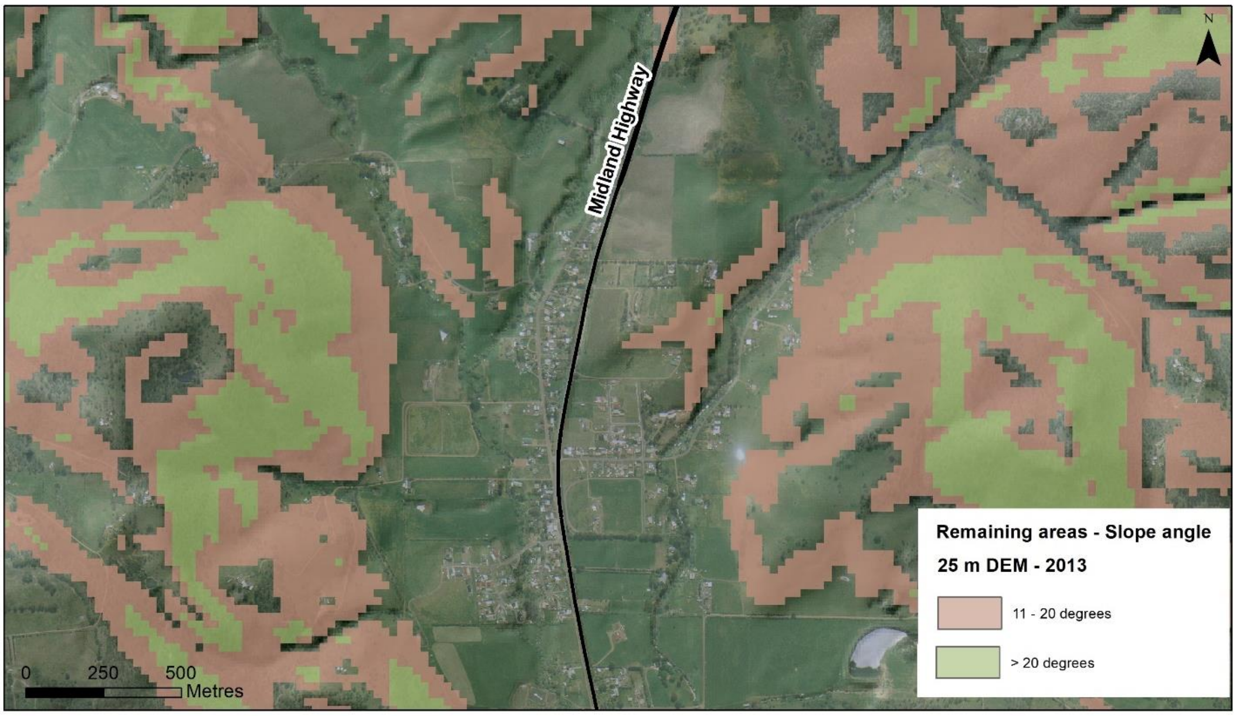

Figure 12. Remaining areas, slope angle components as mapped in 2013 using a 25 m DEM.

Figure 13. Slope angle categories (2013 methodology) mapped on the updated 10 m DEM.

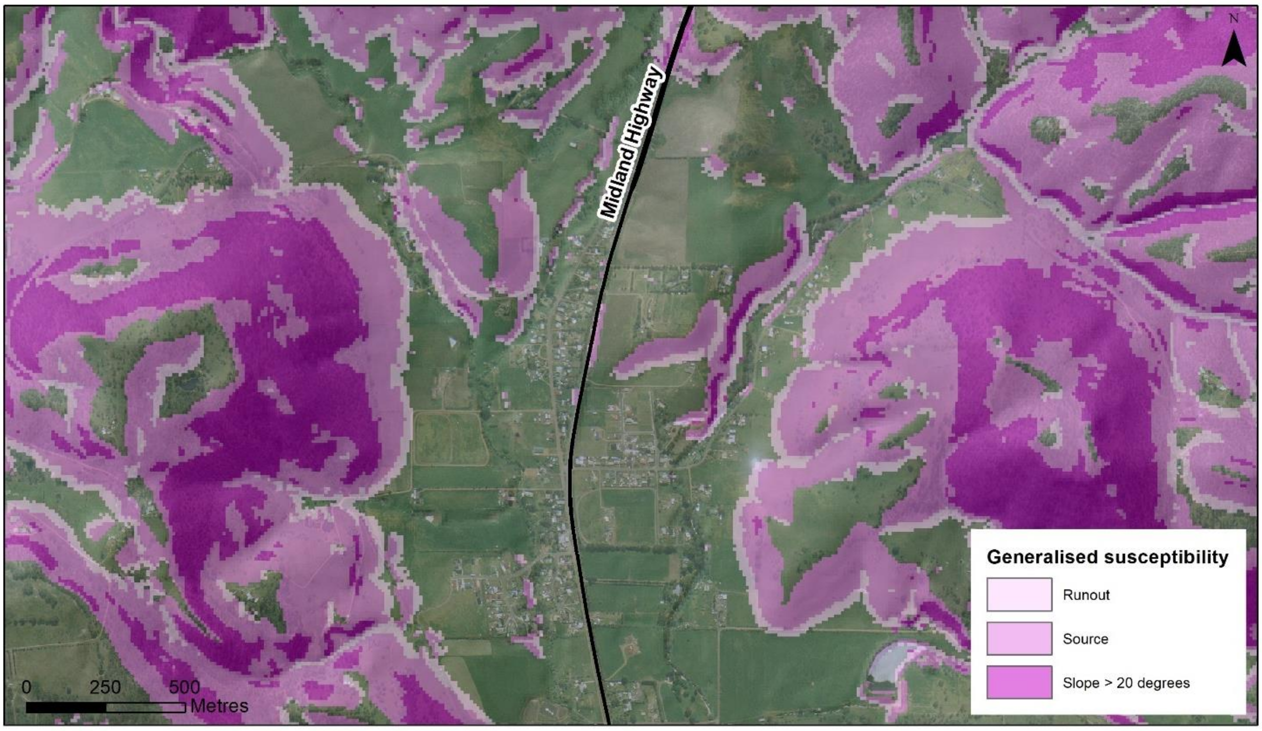

Figure 14. Proposed generalised susceptibility components. These components are a potential alternative to using a slope classification in areas without detailed landslide susceptibility mapping.

5. Changes to the Landslide Hazard Bands policy map

Updates to the component mapping are largely limited to improvements in input data. However, these updates will result in some changes to the boundaries of the zones in the hazard bands. This part of the work will be coordinated with the review of the State Planning Provisions (SPPs), to ensure that all changes are complementary.

5.1. Translation of the Components to Hazard Bands

The 2013 landslide planning map used a pairwise assessment to rank the components. The pairwise assessment used the *Potentially All Pairwise Rankings of all possible Alternatives* (PAPRKiA) method. This method gives a qualitative overall rank to each feature based on the decisions makers preference. With their two types of pairs – dominated (implicitly ranked) and un-dominated pairs. When the pair is not implicitly ranked then, the following criteria is used:

- Is one more likely to occur than the other?
- Which has a greater area subject to an event?
- How broad is the category, and does it encompass more than one landslide hazard type?
- Which presents the greater hazard to areas of existing or likely future development?
- Are land use controls required by legislation?

The resultant pairwise ranking is a decision support tool that gives an indication on the relative importance for intervention. The final ranking of the component was subject to sensitivity testing through the design of the intervention to manage the manage the landslide risk in the planning and building system.

In the 2023 remapping of the landslide planning map components a sensitivity analysis will be undertaken to assess the component positions and ranking methodology, which will include:

- Undertaking the pairwise assessment of components,
- A heat or density map of landslide components to identify areas with multiple overlapping components and process,
- Reassessment of how Landslip A and B are treated within the hazard bands – including the possibility that they are assessed under their own hazard band, external to the ordinal system of Acceptable, low, medium, medium-active and high.

6. References

Australian Geomechanics Society (AGS) 2007a. Guideline for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning. *Journal and News of the Australian Geomechanics Society* 42(1). https://landsliderisk.org/wp-content/uploads/2017/04/ags_2007a1.pdf

Australian Geomechanics Society (AGS) 2007c. Practice Note Guideline for Landslide Risk Management. *Journal and News of the Australian Geomechanics Society* 42(1). https://landsliderisk.org/wp-content/uploads/2017/04/ags_2007c2.pdf

Building Act 2016: https://www.legislation.tas.gov.au/view/html/inforce/current/act-2016-025 [Accessed 15 July 2022]

Building in Landslip Hazard Areas Determination: https://www.cbos.tas.gov.au/topics/technical-regulation/building-standards/building-practitioners/landslip-hazard-areas [Accessed 15 July 2022]

Clague, J.J., Roberts, N.J. 2012. Landslide hazard and risk. In *Landslides: Types, Mechanisms and Modeling*, (Clague, J.J., Stead, D. [eds.]), Cambridge University Press. P. 1-9.

Corominas, J., van Westen, C., Frattini, P., Cascini, L., Malet, J.-P., Fotopoulou, S., Catani, F., van den Eeckhaut, M., Mavrouli, O., Agliardi, F., Pitilaskis, K., Winter, M.G., Pastor, M., Ferlisi, S., Tobani, V., Hervas, J., Smith J.T., 2014. Recommendation for the quantitative analysis of landslide risk. *Bulletin of Engineering Geology and the Environment* 73, 209-263.

Department of Premier and Cabinet (DPAC), Tasmanian Government, 2013a: *Principles for the consideration of natural hazards in the planning system*. Report 12/11635. 16 pp.

Department of Premier and Cabinet (DPAC), Tasmanian Government, 2013b: *Guide to considering natural hazard risks in land use planning and building control*. Report 12/11634. 43 pp.

Department of Premier and Cabinet (DPAC), Tasmanian Government, 2013c: *Landslide Planning Report.* Report 12/11943. 84 pp.

International Organisation for Standardization (ISO) 2018: *ISO 31000:2018 – Risk Management.* https://www.iso.org/obp/ui/#iso:std:iso:31000:ed-2:v1:en [Accessed 15 July 2022]

International Organisation for Standardization (ISO) 2009: *ISO 73:2009 – Risk Management - Vocabulary.* https://www.iso.org/obp/ui/#iso:std:iso:guide:73:ed-1:v1:en [Accessed 15 July 2022]

Land Use Planning and Approvals Act 1993 (LUPAA): https://www.legislation.tas.gov.au/view/html/inforce/current/act-1993-070 [Accessed 15 July 2022]

Landslip Hazard Code (Section C15.0 of Tasmanian Planning Scheme State Planning Provisions): https://planningreform.tas.gov.au/__data/assets/pdf_file/0004/559759/Tasmanian-Planning-Scheme-State-Planning-Provisions-effective-20-July-2022.pdf. [Accessed 29 July 2022]

Mazengarb, C. and Stevenson, M., 2010: Tasmanian Landslide Map Series: User Guide and Technical Methodology. *Tasmanian Geological Survey Record* 2010/01.

Mineral Resources Tasmania: *Landslide Database – TIGER.* https://www.mrt.tas.gov.au/geoscience/engineering_geology/accordion/landslide_database [Accessed 29 July 2022]

Tasmanian Planning Scheme: https://planningreform.tas.gov.au/planning/scheme [Accessed 15 July 2022]

van Westen C.J., van Asch, T.W.J., Soeters, R., 2006. Landslide hazard and risk zonation – why is it still so difficult? *Bulletin of Engineering Geology and the Environment* 65, 167-184.