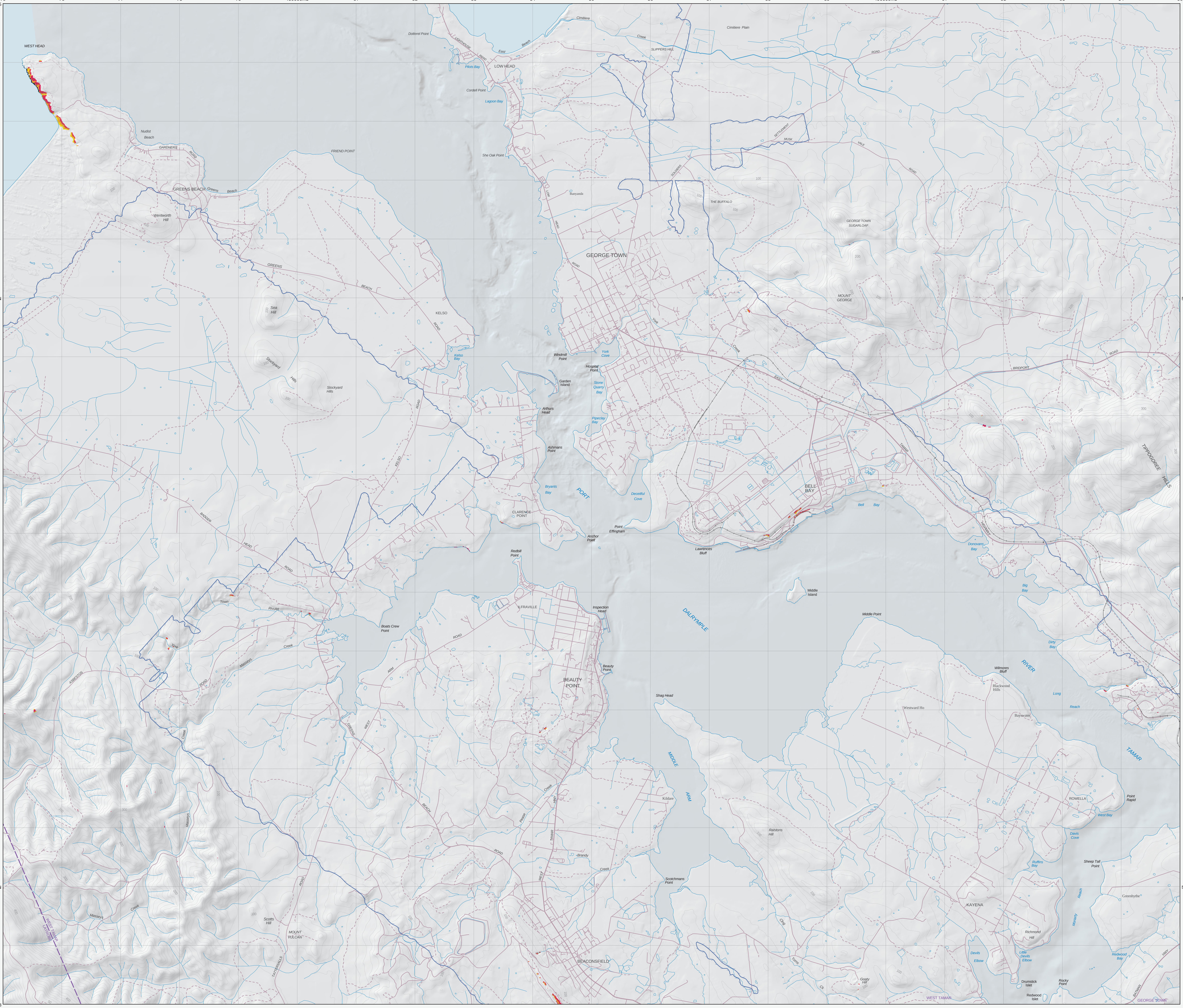
Department of Infrastructure Energy and Resources
MINERAL RESOURCES TASMANIA

TASMANIAN LANDSLIDE MAP SERIES

BELL BAY - ROCKFALL SUSCEPTIBILITY

MAP 4



Landslide Hazard Series

Background, Aim and Purpose

This map is one of a set of thematic maps addressing regional landslide susceptibility and hazard for urban areas and surrounds in Tasmania. The project is undertaken by Mineral Resources Tasmania, in partnership with Local Government and sponsored by the Natural Disaster Mitigation Programme (involving Federal and State contributions).

Large tracts of land throughout Tasmania are subject to slope instability and over 75 houses have been destroyed by landslides since the 1950s with many more significantly damaged. While only minimal loss of life has occurred such events are highly traumatic to those directly affected and the financial cost to individuals, organisations and the State runs into many millions of dollars. Recent disasters such as the Thredbo Landslide in New South Wales, serve to remind society of the potential for loss of life even from relatively small landslides. Fortunately, landslide damage can be avoided when ground conditions are properly understood before construction proceeds and, in already developed areas, this understanding can be used to mitigate the hazard through various measures.

Method

A methodology has been specially developed for this map series and is used for other areas of Tasmania. Refer to the document "Tasmanian Landslide Map Series: User Guide and Technical Methodology" (see Further Information). The methodology has evolved since the earlier maps were published, in part due to the Australian Geomechanics Society publishing guidelines for landslide zoning (AGS 2007a,b) - changes have been made to conform to these as much as possible.

The methodology used is based on:

- Recording observations of land instability in- and surrounding- the study area (the landslide inventory).
- Analysis of the processes that control each landslide type.
- Computer assisted modelling that simulates each of the landslide processes to predict areas that could be affected by future landslides.

Caveats for Use

The information provided is in the public domain and anyone is free to use it provided they read and understand the purpose and limitations.

The following caveats shall apply to the maps.

- The hazards identified are based on imperfect knowledge of ground conditions and models to represent our current understanding of the landslide process. As this knowledge improves our perception of the hazard and the depiction on the map may also change.
- These maps can be used as a guide (or flag) to the need for specific assessment in potential hazard areas.
- Planning decisions should not be made solely on the basis of the zones delineated on the map.
- The scale limitations of the data should be considered at all times as exceeding this limit could lead to inaccurate decisions about the hazard.
- Site specific assessment of landslide hazard and risk should be undertaken by suitably qualified and experienced practitioners in the fields of engineering geology and geotechnical engineering.
- Practitioners undertaking site specific assessments should read the map text and associated documents to obtain a thorough understanding of the methodology and limitations of the maps.
- Areas where no susceptibility or hazard is shown can still have issues with slope instability.
- Anthropogenic influence on slopes cannot be predicted and the occurrence of slope instability resulting from the influence of human actions is specifically excluded from these maps.
- The identification and performance of cut and filled slopes have not been specifically considered in map production and their scale is such that they often cannot be resolved on the maps. The presence of such slopes should always be considered in site specific assessments.

Rockfall Hazards

The rockfall susceptibility zones shown on this map apply to two types of landslide process, rockfall (sensu stricti) and topples. A rockfall is defined as the independent movement of rock or soil fragments through freefall, bouncing, rolling and sliding. They are usually sourced from cliffs or steep slopes and are a fast moving type of landslide. A topple as the name implies involves a forward rotation of material, usually on an escarpment, that may develop into a rockfall if the landscape and properties of the displaced mass allow. For the purposes of the map they are modelled together and for convenience generally referred to as rockfall. It is possible that a third process may be involved in some cases - rock or debris avalanches that describe the movement of a large number of boulders in a single event but this has not been witnessed in the region and is difficult to prove from available geological evidence.

The process of rockfall modelling consists of predicting source areas and runout paths. The methodology is explained more fully in Mazengarb (2005) and Mazengarb and Stevenson (2010, 2011) but is has been necessary to modify some aspects to suit local conditions and to satisfy the AGS (2007a,b) guidelines for Landslide Risk Management. Source areas were determined by selecting slopes greater than or equal to 42 degrees. The choice of angle is based on the angle of repose for dolerite talus defined in published literature (e.g. Caine 1983) and from unpublished field observations in Tasmania. It is recognised that isolated rockfalls can occur on slopes lower than this value, but this is considered to be generally of lower probability. A 10m pixel digital elevation model (DEM) was constructed from which the source areas were derived. It is important to realise that the reliability of the source prediction is variable because the digital elevation model from which the source is derived is based on a combination of disparate datasets of varying resolution and quality. In areas covered by superior LiDAR data, source areas were extracted from a 5m DEM which was subsequently resampled to 10m pixels. In the remaining areas, a 10m DEM was used which experience shows, tends to underpredict rock fall source areas.

Runout paths were modelled from each source cell, travelling in the direction of maximum downhill slope as defined by an aspect digital terrain model derived from the 10m DEM. This is a simplistic technique that represents the most likely path of boulder(s) travelling downhill. In reality the actual path of material may deviate from this to some degree. The modelling does not take into account obstacles and small scale topography that are beyond the resolution of the input layers; such as trees, structures and protective fences. The extent of each runout has been defined using the travel angle method with two values, 34 and 30 degrees, representing decreasing probability respectively (see conceptual diagram). These values are based on field studies of dolerite talus fan slope angles in Tasmania. For rockfalls occurring in weaker rock units, the travel angle values chosen may, in many instances, be too low and thus overestimate the runout distance.

Relative or quantitative susceptibility descriptors of Very Low, Low, Moderate and High as defined in the AGS (2007a) guidelines were not adopted because of insufficient field evidence in the study area. Instead the guidelines allow an alternative approach, although not entirely satisfactory, of susceptible or not- susceptible. The three zones on the map (source area and the two runout zones) can be considered as susceptible to rockfall. Areas outside these zones are considered not susceptible with the proviso that because the modelling is not perfect there may be special cases where rockfall could occur.

This map identifies a number of locations (less than 0.03% of the study area) that could be affected by rockfall events. The main areas are associated with topple and rockfall of basalt and dolerite along coastal and estuarine cliffs, basalt escarpments such as Bradys Lookout and incised valley walls in dolerite such as Supply Creek. Rockfalls will also occur on artificial slopes such as quarry and mine faces and road- cuttings that are spread throughout the study area. There are few records of rockfall in the landslide database, which is partly a reflection of the limited areas in which the process can occur but also because these features are more poorly preserved in the landscape, not generally visible on aerial photographs and often not reported.

The velocity and size of boulders involved in rockfall is expected to vary from place to place and should be considered in site specific investigations. The potential risks from rockfall are highly variable ranging from minor to serious injury or death to unprotected persons. Structures could also receive significant damage from typical sized boulders of basalt or dolerite.

The frequency of rockfall events in the study area is difficult to quantify and needs further work for site specific instances.

Rainstorms, ocean waves, frost heaving, colluvial wedging, root jacking and human activities are all potential triggers for rockfall events. Seismic shaking (earthquakes) is another potential trigger, but the seismicity of the study area is low and the probability of strong ground shaking is considered to be minimal (Burbidge 2012).

Conclusions

The rockfall susceptibility map identifies small areas of land within the modelled boundaries that may experience this potentially dangerous process. Most of these areas are in remote and sparsely populated regions where exposure of structures and persons is minimal. While a few recent (European era) rockfall records are known, there is insufficient information to calculate likelihoods.

Despite the low spatial incidence of the rockfall hazard, caution is required in the susceptible zones identified. We recommend that new developments within these areas should require geotechnical investigation - the methodology outlined in the Practice Note Guidelines for Landslide Risk Management (AGS 2007c,d). The risks should also be assessed in established developments and public areas such as walking tracks and lookouts. The risk of destruction of property, injury or loss of life should be estimated on a site by site basis. Rockfall may also occur in areas modelled as not susceptible given the limitation of the methodology used and consideration should be given to the hazard for developments on or adjacent to steep slopes.

References

AGS 2007a: Guideline for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning. Australian Geomechanics, 42(1), 13- 36.

AGS 2007b: Commentary on Guideline for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning. Australian Geomechanics, 42(1), 37- 58.

AGS 2007c: Practice note guidelines for landslide risk management, Australian Geomechanics, 42(1), 63- 114.

AGS 2007d: Commentary on practice note guidelines for landslide risk management, Australian Geomechanics, 42(1), 115- 158.

Burbidge, D.R. (ed.), 2012. The 2012 Australian Earthquake Hazard Map. Record 2012/71. Geoscience Australia: Canberra.

Caine, N., 1983: The mountains of northern Tasmania. A.A. Balkema, Rotterdam. 200pp.

Mazengarb, C. 2005: The Tasmanian landslide hazard map series: Methodology. Tasmanian Geological Survey Record 2005/04, Mineral Resources Tasmania, Hobart. 43pp.

Mazengarb, C.; Stevenson, M.D. 2010. Tasmanian Landslide Map Series: user guide and technical methodology. Tasmanian Geological Survey Record 2010/01. Mineral Resources Tasmania. 44pp. [available online: www.mrt.tas.gov.au].

Mazengarb, C.; Stevenson, M.D. 2011. Evaluation of the Tasmanian North- west Coast landslide map series against the AGS 2007 landslide zoning guideline. Australian Geomechanics 46(2): 219- 233.

Further Information

IMPORTANT: This map should be used in conjunction with an understanding of the information contained within the document "Tasmanian Landslide Map Series: User Guide and Technical Methodology" (Mazengarb, C. and Stevenson, M.D. 2010. Tasmanian Geological Survey Record 2010/01).

This document, and other information on this map series or Tasmanian landslides in general can be obtained from the MRT web site at www.mrt.tas.gov.au or by contacting the agency directly. Copies of the map images (PDF format) are freely available from the MRT website. GIS layers developed by MRT and shown on the map are supplied to each Council in the area and are available for purchase at a minimal cost of supply.

Summary information from the MRT landslide databse and map images from the Tasmanian Landslide Map Series can be viewed with the MRT online web map viewer (choose Map: Landslides).

Susceptibility Zones

Source areas.

Runout area - travel angle 34 degrees (more susceptible).

Runout area - travel angle 30 degrees (less susceptible).

Source area: An area of hillside with the potential to form a slope failure, identified largely on the basis of slope angle.

Runout area: An area down- slope of a source area where the moving earth, debris or rock can potentially travel.

Rockfall Features

Rockfall deposit.

1590 Rockfall, recent or active.

1591 Rockfall, activity unknown.

Note: Most of the rockfall locations in the landslide database are points without matching polygons. The number shown against the symbol is the landslide ID from the MRT database.

Data Sources

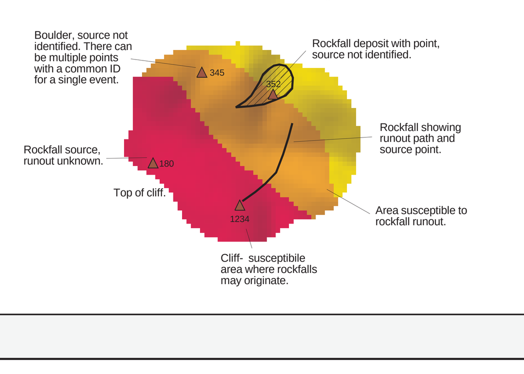
The sources for the digital elevation model (DEM) used in the susceptibility modelling are shown as follows:

Boundary between Airborne Laser Scanning (survey centred on the Tamar Valley) and 1:5 000 / 1:25 000 topographic contours - for DEM derivatives.

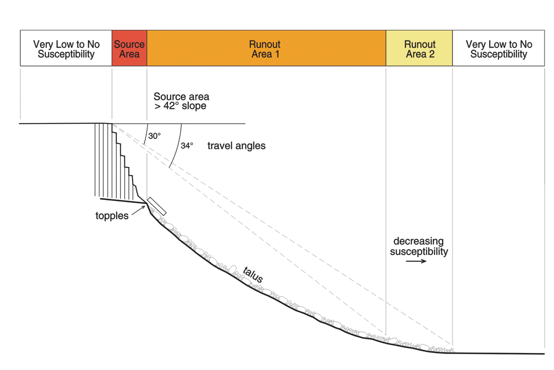
Miscellaneous

Municipality boundary.

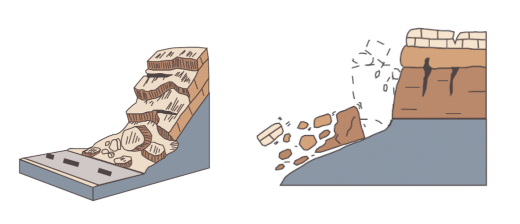
Conceptual Relationships for the Depiction of Rockfalls and Susceptibility in Plan View



Conceptual Diagram Illustrating Rockfall Modelling Technique



Examples of Slope Failure Depicted on Map



Rockfall

Topple

(Source: United States Geological Survey fact sheet 2004- 3072)

Scale: 1:25 000

0 500 1000 1500 2000 2500m

GDA94 - MGA Zone 55. Contour Interval 20 metres.

Citation:

Mazengarb, C. 2013. Bell Bay, map 4 - Rockfall Susceptibility. Tasmanian Landslide Map Series. Mineral Resources Tasmania, Department of Infrastructure Energy and Resources, Hobart.

Acknowledgements:

Contributions to the map from M. Stevenson, R. Blake, J. Bowerman and A. Mayne.

Base data from the Land Information System of Tasmania (LIST), Copyright State of Tasmania.

Sources for digital terrain model: airborne laser data derived from Climate Futures for Tasmania LiDAR dataset (2008), available from the LIST. Bathymetry derived from data supplied by SeaMap Tasmania (Institute of Marine and Antarctic Studies, 2009), and TasPorts Corporation, including the Tamar River Hydrographic Survey (2009).

Map produced by the Geoscience Information Branch of Mineral Resources Tasmania using GIS software.

Disclaimer:

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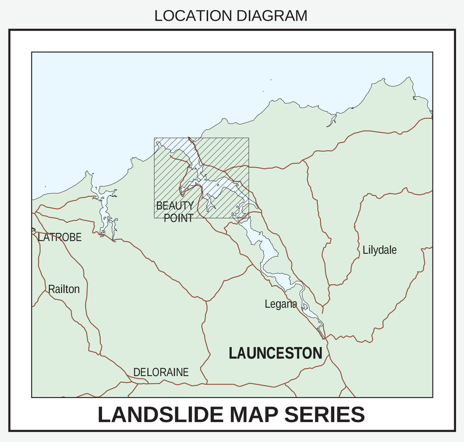
LOCATION DIAGRAM



LANDSLIDE MAP SERIES

Data correct & plotfile generated: 07-MAR-2014

WARNING:INKS ARE LIGHT SENSITIVE