

**Landslide evidence and
pairwise assessment
agenda item 3**

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A landslide hazard is a source of potential harm resulting from the *downslope **movement** of a mass of rock, debris or earth* that may have a negative consequence on vulnerable infrastructure or communities.

Landslides are caused by a combination of conditioning and triggering factors:

	Types
Conditioning factors	Slope, geology, soil
Trigger events	Rainfall, rising groundwater, earthquake, and human intervention

Mapping

See the GIS

Landslide features

- Landslip A areas
- Landslip B areas
- Slope 25m and LiDAR 0-9
- slope 25m and LiDAR 9-14
- slope 25m and LiDAR 14-42
- slope 25m and LiDAR > 42
- Rockfall susceptibility source + runout area 1
- Rockfall susceptibility runout area 2
- Shallow slide and flow susceptibility source high
- Shallow slide and flow susceptibility source moderate
- Shallow slide and flow susceptibility source low
- Debris flow susceptibility Mountain source + runout >30 Q1
- Debris flow susceptibility Mountain runout 30-26 Q2
- Debris flow susceptibility Mountain runout 26-22 Q3
- Debris flow susceptibility Mountain runout 22 - 12 Q4a
- Debris flow susceptibility Mountain runout 12 - 5 Q4b
- Deep seated susceptibility
- Landslides Activity known- multiple deep seated slides
- Landslides Activity known
- Landslides Activity unknown

Understanding the mapping - features



Pairwise comparison method

- Potentially All Pairwise Rankings of all possible Alternatives (PAPRKiA)
- Qualitative assessment - based on the decision makers preference
- Gives an overall rank to each feature
- Two types of pairs – dominated (implicitly ranked) and un-dominated pairs
- Criteria:
 - Is one more likely to occur than the other?
 - Which has a greater area subject to an event?
 - How broad is the category, 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?

What does it tell us?

- The relative importance for intervention from land use planning
- It is a decision support tool – it does not make the decisions

	Landslip A areas	Landslip B areas	Slope 25m and LiDAR 0-9	slope 25m and LiDAR 9-14	slope 25m and LiDAR 14-42	slope 25m and LiDAR > 42	Rockfall susceptibility source + runout area 1	Rockfall susceptibility runout area 2	Slide + flow susceptibility source high	Slide + flow susceptibility source moderate	Slide + flow susceptibility source low	Debris flow susceptibility	Mountain source + runout	Debris flow susceptibility	Mountain runout 30-26 Q2	Debris flow susceptibility	Mountain runout 26-22 Q3	Debris flow susceptibility	Mountain runout 22 - 12 Q4a	Debris flow susceptibility	Mountain runout 12 - 5 Q4b	Deep seated slide susceptibility	Landslides Activity known multiple	Landslides Activity known	Landslides Activity unknown
Landslip A areas	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Landslip B areas	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	=	=	N
Slope 25m and LiDAR 0-9	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
slope 25m and LiDAR 9-14	Y	Y	N	Y	Y	Y	=	Y	=	N	Y	Y	Y	=	N	=	Y	Y	Y	=	Y	Y	Y	Y	Y
slope 25m and LiDAR 14-42	Y	Y	N	N	Y	=	Y	N	Y	=	N	Y	Y	Y	=	N	=	Y	Y	=	Y	Y	Y	Y	=
slope 25m and LiDAR > 42	Y	Y	N	N	=	Y	=	N	=	N	N	=	=	=	N	N	=	Y	Y	=	Y	Y	Y	Y	=
Rockfall susceptibility source + runout area 1	Y	Y	N	N	N	=	Y	N	Y	=	N	Y	Y	=	N	N	=	Y	Y	=	Y	Y	Y	Y	=
Rockfall susceptibility runout area 2	Y	Y	N	=	Y	Y	Y	Y	Y	=	N	Y	Y	Y	=	N	N	Y	Y	=	Y	Y	Y	Y	=
Shallow slide + flow susceptibility source high	Y	Y	N	N	N	=	N	N	Y	N	N	=	N	N	N	N	N	N	N	N	N	Y	Y	Y	=
Shallow slide + flow susceptibility source moderate	Y	Y	N	=	=	Y	=	=	Y	Y	Y	Y	=	=	N	=	Y	Y	Y	=	Y	Y	Y	Y	=
Shallow slide + flow susceptibility source low	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	=	Y	Y	Y	Y	Y
Debris flow susceptibility Mountain source + runout >30 Q1	Y	Y	N	N	N	=	N	N	=	N	N	Y	Y	N	N	N	N	N	N	N	N	Y	Y	Y	=
Debris flow susceptibility Mountain runout 30-26 Q2	Y	Y	N	N	N	=	N	N	Y	=	N	Y	Y	N	N	N	N	N	N	N	N	=	Y	Y	=
Debris flow susceptibility Mountain runout 26-22 Q3	Y	Y	N	N	N	=	=	N	Y	=	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	=	Y	Y	=
Debris flow susceptibility Mountain runout 22 - 12 Q4a	Y	Y	N	=	=	Y	=	=	Y	=	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	=	Y	Y	=
Debris flow susceptibility Mountain runout 12 - 5 Q4b	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	=	Y	Y	N	N	N	N	N	N	N	N	Y	Y	Y	Y
Deep seated slide susceptibility	Y	Y	N	=	=	=	=	N	Y	=	N	Y	=	=	=	=	N	Y	Y	Y	Y	Y	Y	Y	=
Landslides Activity known- multiple deep seated slides	Y	=	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	N
Landslides Activity known	Y	=	N	N	N	N	=	N	=	N	N	=	=	N	N	N	N	N	N	N	N	Y	Y	Y	N
Landslides Activity unknown	Y	Y	N	N	=	=	=	=	=	=	N	=	=	=	=	=	N	=	Y	Y	Y	Y	Y	Y	Y

Pairwise assessment – what is the relative importance?

N = not as important (1)

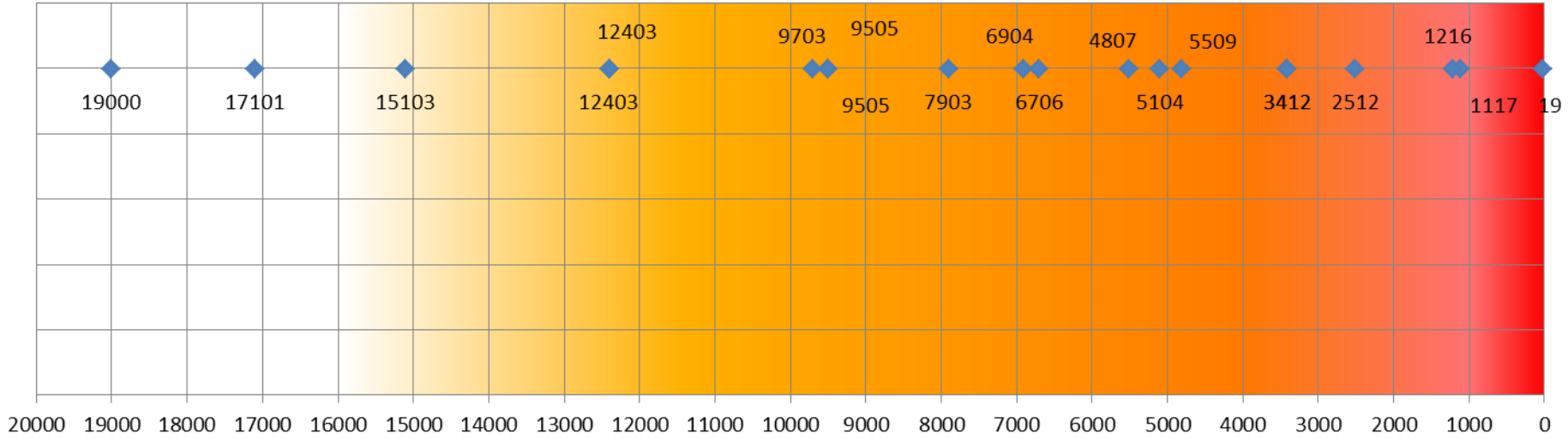
Y= more important (1000)

"=" = as important (100)

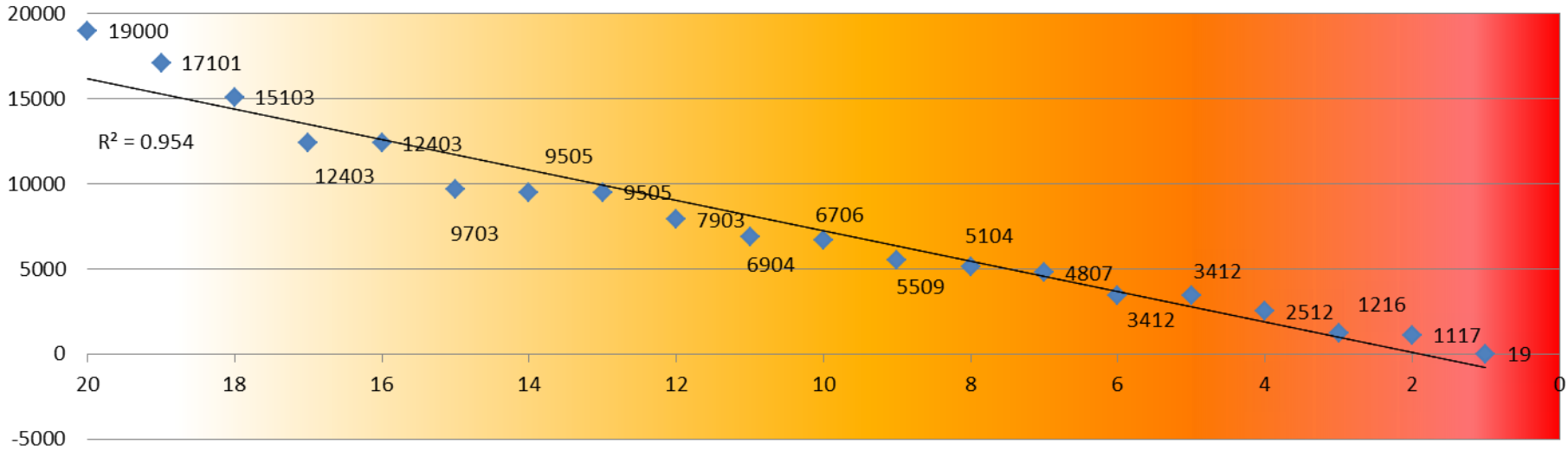
	Landslip A areas	Landslip B areas	Slope 25m and LiDAR 0-9	slope 25m and LiDAR 9-14	slope 25m and LiDAR 14-42	slope 25m and LiDAR > 42	Rockfall susceptibility	Rockfall susceptibility	Shallow slide + flow	Shallow slide + flow	Shallow slide + flow	Debris flow susceptibility	Debris flow susceptibility	Debris flow susceptibility	Debris flow susceptibility	Debris flow susceptibility	Deep seated slide susceptibility	Landslides Activity known	Landslides Activity known	Landslides Activity known	Landslides Activity unknown	Total columns
Landslip A areas		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	19
Landslip B areas	1000		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100	100	1	1	1216
Slope 25m and LiDAR 0-9	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	19000
slope 25m and LiDAR 9-14	1000	1000	1	1000	1000	1000	100	1000	100	1000	100	1	1000	1000	100	1	100	1000	1000	1000	1000	12403
slope 25m and LiDAR 14-42	1000	1000	1	1	1000	100	1000	1	1000	100	1	1000	1000	1000	100	1	100	1000	1000	100	100	9505
slope 25m and LiDAR > 42	1000	1000	1	1	100	1000	100	1	100	1	1	100	100	100	1	1	100	1000	1000	100	100	4807
Rockfall susceptibility source + runout area 1	1000	1000	1	1	1	100	1000	1	1000	100	1	1000	1000	100	100	1	100	1000	100	100	100	6706
Rockfall susceptibility runout area 2	1000	1000	1	100	1000	1000	1000	100	1000	100	1	1000	1000	1000	100	1	1000	1000	1000	100	100	12403
Shallow slide + flow susceptibility source high	1000	1000	1	1	1	100	1	1	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Shallow slide + flow susceptibility source moderate	1000	1000	1	100	100	1000	100	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Shallow slide + flow susceptibility source low	1000	1000	1	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Debris flow susceptibility Mountain source + runout >30 Q1	1000	1000	1	1	1	100	1	1	100	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Debris flow susceptibility Mountain runout 30-26 Q2	1000	1000	1	1	1	100	1	1	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Debris flow susceptibility Mountain runout 26-22 Q3	1000	1000	1	1	1	100	100	1	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Debris flow susceptibility Mountain runout 22 - 12 Q4a	1000	1000	1	100	100	1000	100	100	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Debris flow susceptibility Mountain runout 12 - 5 Q4b	1000	1000	1	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Deep seated slide susceptibility	1000	1000	1	100	100	100	100	1	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Landslides Activity known- multiple deep seated slides	1000	100	1	1	1	1	1	1	1	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Landslides Activity known	1000	100	1	1	1	1	100	1	100	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Landslides Activity unknown	1000	1000	1	1	100	100	100	100	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Total rows	19000	16201	19	3412	5509	7804	6706	3412	12403	3412	17101	15103	1117	19	19000	1216	17101	15103	1117	19	19000	1216

Understanding the mapping – feature ranking

Spread of Importance Values



Importance value



Classifying the features

Feature	Relative importance	Area (ha) 6952964 ha	public / private land (proportion of all land)	Number of residential buildings (185580)	Hazard Band ?
Landslip A areas	19	143 ha	41.9 (<0.01%) / 101.1 (<0.01%)	165 (0.08%)	
Landslides Activity known- multiple deep seated slides	1117	not part of model			
Landslip B areas	1216	152 ha	20 (< 0.01%) / 132 (< 0.01%)	212 (0.1%)	
Landslides Activity known	2512	588 ha	318 (< 0.01%) / 270 (< 0.01%)	532 (0.28%)	
Shallow slide + flow susceptibility source high	3412	626 ha	121 (< 0.01%) / 505 (0.01%)	16 (0.008%)	
Debris flow susceptibility Mountain source + runout >30 Q1	3412	2093 ha	1586 (0.02 %) / 507 (0.01 %)	28 (0.01%)	
slope 25m and LiDAR > 42	4807			NA	
Landslides Activity unknown	5104	11833 ha	824 (0.01 %) / 11009 (0.16 %)	1939 (1 %)	
Debris flow susceptibility Mountain runout 30-26 Q2	5509	280 ha	189 (<0.01 %) / 91 (<0.01%)	20 (0.01%)	
Rockfall susceptibility source + runout area 1	6706	148 ha	107 (<0.01%) / 41 (<0.01%)	4 (0.002%)	
Deep seated slide susceptibility	6904	13268 ha	3832 (0.06%) / 9436 (0.14 %)	11479 (6.18%)	
Shallow slide + flow susceptibility source moderate	7903	3243 ha	243 (<0.01%) / 3000 (0.04%)	650 (0.35%)	
slope 25m and LiDAR 14-42 / 20 -42	9505			1444 (0.7%) / 153 (0.08%)	
Debris flow susceptibility Mountain runout 26-22 Q3	9505	294 ha	173 (<0.01%) / 121 (<0.01%)	20 (0.01%)	
Debris flow susceptibility Mountain runout 22 -12 Q4a	9703	Part of Debris flow susceptibility Mountain runout 12 - 5 Q4b			
slope 25m and LiDAR 9-14 / 12 -20	12403			6917 (3.7%)/ 2877 (1.5%)	
Rockfall susceptibility runout area 2	12403	21.7 ha	14 (<0.01%) / 7.7 (<0.01%)	NA	
Debris flow susceptibility Mountain runout 12 -5 Q4b	15103	1760 ha	883 (0.01%) / 877 (0.01%)	788 (0.4%)	
Shallow slide + flow susceptibility source low	17101	9402 ha	933 (0.01%) / 8469 (0.12%)	2985 (1.6%)	
Slope 25m and LiDAR 0-9 / 0 - 12	19000			68962 (37%) / 74293 (40%)	
Not susceptible	19000 (Inferred)	187 290 ha	49661 (0.71%) / 137629 (1.98%)	89434 (48%)	



Remaining tasks on the mapping:

1. Should we use Percentage Slope or Degrees?
2. Which thresholds for the slope should be used? Why?
3. Calculate the basic susceptibility using LiDAR where available.
4. Revisit rockfall mapping over Hobart to include LiDAR.
5. Once the landslide hazard matrix is complete - the mapping will need to be revisited.

Slope

- Basic susceptibility options for mapping

Basic susceptibility	<9 (<12)	9-14 (12-20)	14-42 (20-42)	>42
Total area by tenure	Public land 4284413 (61%) / Private land 2437397 (35.06%)			
Area				
Number of residential buildings	68962 (74293)	6917 (2877)	1444 (153)	1 (not residential)