a.s.miner
Geotechnical
Consulting Engineers
50 Calder Street, Manifold Heights, VICTORIA 3218
Tel : 03.52294568 Mobile : 0438.294568
ABN 72 856 478 451
Email: aminer@pipeline.com.au

Corangamite Catchment Management Authority

Landslide and Erosion Susceptibility Mapping in the CCMA region.

APPENDICES

Report No: 306/01/06

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Prepared for Peter Dahlhaus
Geology Department
University of Ballarat
PO Box 283
Colac
VIC 3250

Appendices

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Appendix A

Assembled Data Sets

As supplied by the CCMA and Peter Dahlhaus

DEG I.D.	***Data Category***	***Data layer***	***Time/date/series/comment***	***Type***	***Source***
9	Climate	Rainfall	ANUCLIM Average monthly and annual	300m grid	DEG
10	Climate	Raindays	ANUCLIM Average monthly and annual	300m grid	DEG
11	Climate	Evaporation	ANUCLIM Average monthly and annual	300m grid	DEG
12	Climate	Solar Radiation	ANUCLIM Average monthly and annual	300m grid	DEG
13	Climate	Solar Radiation Corrected for Cloud	ANUCLIM Average monthly and annual	300m grid	DEG
14	Climate	Max daily Temp	ANUCLIM Average monthly and annual	300m grid	DEG
15	Climate	Min daily temp	ANUCLIM Average monthly and annual	300m grid	DEG
16	Climate	Dry bulb temp at 9am	ANUCLIM Average monthly and annual	300m grid	DEG
17	Climate	Dry bulb temp at 3pm	ANUCLIM Average monthly and annual	300m grid	DEG
18	Climate	Wet bulb at 9 am	ANUCLIM Average monthly and annual	300m grid	DEG
19	Climate	Wet bulb at 3 pm	ANUCLIM Average monthly and annual	300m grid	DEG
20	Climate	Dew Point at 9am	ANUCLIM Average monthly and annual	300m grid	DEG
21	Climate	Dew point at 3 pm	ANUCLIM Average monthly and annual	300m grid	DEG
22	Climate	Wind speed at 9 am	ANUCLIM Average monthly and annual	300m grid	DEG
23	Climate	Wind Speed at 3 pm	ANUCLIM Average monthly and annual	300m grid	DEG
24	Climate	Wind Run	ANUCLIM Average monthly and annual	300m grid	DEG
25	Climate	Evapotranspiration (actual aerial)	BoM Average monthly and annual	10km grid	BoM
26	Climate	Evapotranspiration (potential aerial)	BoM Average monthly and annual	10km grid	BoM
27	Climate	Evapotranspiration (point potential)	BoM Average monthly and annual	10km grid	BoM
28	Physiography	Digital elevation Model (20m resolution	VicMap 1:25,000 contours, hydrological enforcement	20m grid	DEG
29	Physiography	Slope (0-90 degs and percent)	Derived from DEM	20m grid	DEG
30	Physiography	Slope aspect (0-360 degrees)	Derived from DEM	20m grid	DEG

DEG I.D.	***Data Category***	***Data layer***	***Time/date/series/comment***	***Type***	***Source***
31	Physiography	LIDAR (1m resolution)	LiDAR VVP project	1m grid	CCMA
32	Geomorphology	Land systems	SCA land systems and land capability	Polygon	PIRVic
33	Geology	Geology units	GSV mapping	Polygon	DPI(GSV)
34	Geology	Structures	GSV mapping	Lines	
35	Geology	Pre-Permian basement	GSV mapping	Polygon	DPI(GSV)
36	Geology	Pre-Permian basement structures	GSV mapping	Lines	
37	Geology	Recorded seismicity	SRC to 2000	Points	DEG(SRC)
38	Geomorphology	1st tier Geomorphic units	Corangamite LRA study	Polygons	DPI(CLPR)
39	Geomorphology	2nd tier Geomorphic units	Corangamite LRA study	Polygons	
40	Geomorphology	3rd tier Geomorphic units	Corangamite LRA study	Polygons	
41	Soil	Soil-landform units	Corangamite LRA study	Polygons	
42	Soil	Existing soil surveys (Soil series)	Various SCA studies, Maher & Martin, etc.	Polygons	DPI(CLPR)
43	Soil	Existing soil surveys (Land Capability)	Various SCA studies, Pitt, Costello, etc.	Polygons	
44	Geology	Exploration Licenses	DPI / GSV historical	Polygons	DPI(GSV)
45	Geology	Mining/ quarrying licenses	DPI / GSV historical	Polygons	DPI(GSV)
46	Geochemical	Geochemical surveys	DPI / GSV historical	Polygons	DPI(GSV)
47	Geochemical	Geochemical data	DPI / GSV historical	Points	
48	Hydrology	Groundwater flow systems	Corangamite GFS project	Polygons & lines	DEG (CCMA)
49	Hydrology	Groundwater Management Areas	DSE cover (out of date)	Polygons	DEG/DSE
50	Hydrology	Mapped salinity polygons	Various salinity mapping 1976 - 2005	Polygons	DPI(CLPR)
51	Hydrology	Mapped salinity lines	Various salinity mapping 1976 - 2006	Lines	
52	Hydrology	GW boreholes	Corangamite Bore Database project	Points	CCMA
53	Hydrology	Rainfall stations	BoM list	Points	BoM
54	Hydrology	Hydrographic gauging stations	VWQN list	Points	VWQN
55	Hydrology	Wetlands and classifications	Corrick classes 1770 & 1994; CEM (2005)	Polygons	DSE
56	Hydrology	Depth to watertable	SKM study 2005	100m grid	SKM / DSE
57	Hydrology	Watertable trends	SKM study 2006	100m grid	SKM / DSE
58	Hydrology	Predicted depth to watertable 2020	SKM study 2007	100m grid	SKM / DSE
59	Hydrology	Predicted depth to watertable 2050	SKM study 2008	100m grid	SKM / DSE
60	Hydrology	Proclaimed rivers	DSE study	lines	CCMA
61	Hydrology	Priority streams	CCMA river health strategy	lines	CCMA

DEG I.D.	***Data Category***	***Data layer***	***Time/date/series/comment***	***Type***	***Source***
62	Hydrology	Index of stream condition	CCMA river health strategy	lines	CCMA
63	Hydrology	River basins and drainage divisions	AusLIG drainage divisions	polygons	DEG
64	Hydrology	Gauging stations details and time series	River health and salinity projects	data	DEG/CCMA
65	Geophysics	Bouger gravity	GSV Corangamite special 2000	Image (GIS registered)	DPI(GSV)
66	Geophysics	Total magnetic intensity	GSV Corangamite special 2000	Image (GIS registered)	DPI(GSV)
67	Geophysics	First vertical derivative of magnetics	GSV Corangamite special 2000	Image (GIS registered)	DPI(GSV)
68	Geophysics	Radiometric potassium	GSV Corangamite special 2000	Image (GIS registered)	DPI(GSV)
69	Geophysics	Radiometric thorium	GSV Corangamite special 2000	Image (GIS registered)	DPI(GSV)
70	Geophysics	Radiometric uranium	GSV Corangamite special 2000	Image (GIS registered)	DPI(GSV)
71	Geophysics	Radiometric total count	GSV Corangamite special 2000	Image (GIS registered)	DPI(GSV)
72	Geophysics	Radiometric ternary ratio	GSV Corangamite special 2000	Image (GIS registered)	DPI(GSV)
73	Geophysics	Bouger gravity	GSV SW (Colac) run 1999	Grid	DPI(GSV)
74	Geophysics	Total magnetic intensity	GSV SW (Colac) run 1999	Grid	DPI(GSV)
75	Geophysics	First vertical derivative of magnetics	GSV SW (Colac) run 1999	Grid	DPI(GSV)
76	Geophysics	Radiometric potassium	GSV SW (Colac) run 1999	Grid	DPI(GSV)
77	Geophysics	Radiometric thorium	GSV SW (Colac) run 1999	Grid	DPI(GSV)
78	Geophysics	Radiometric uranium	GSV SW (Colac) run 1999	Grid	DPI(GSV)
79	Geophysics	Radiometric total count	GSV SW (Colac) run 1999	Grid	DPI(GSV)
80	Geophysics	Radiometric ternary ratio	GSV SW (Colac) run 1999	Grid	DPI(GSV)
81	Vegetation	Ecological vegetation classes	DSE Statewide mapping 2003	Polygon	DSE(CCMA)
82	Vegetation	Bioregions	DSE Statewide mapping 2003	Polygon	DSE(CCMA)
83	Land use	Land Use	DSE Statewide mapping 2004	Polygon	CCMA
84	Orthophotos	Aerial photography	All shires in CCMA	Image (GIS registered)	CCMA

DEG I.D.	***Data Category***	***Data layer***	***Time/date/series/comment***	***Type***	***Source***
85	Susceptibility	Mass wasting susceptibility	Corangamite LRA study	Polygon	CLPR
86	Susceptibility	Sheet and Rill Susceptibility	Corangamite LRA study	Polygon	CLPR
87	Susceptibility	Gully and Tunnel susceptibility	Corangamite LRA study	Polygon	CLPR
88	Susceptibility	Wind Erosion Susceptibility	Corangamite LRA study	Polygon	CLPR
89	Susceptibility	Soil Structure Decline	Corangamite LRA study	Polygon	CLPR
90	Susceptibility	Waterlogging	Corangamite LRA study	Polygon	CLPR
91	Geochemical	Acid Sulphate Occurrence	CSIRO CoGG	Polygon	CCMA(CSIRO)
92	Geochemical	Potential acid sulphate Soils	PIRVic coastal study	Polygon	Rampart
93	Susceptibility	Landslide Susceptibility	GHD CoGG study	Polygon	GHD
94	Susceptibility	Gully and Tunnel susceptibility	GHD CoGG study	Polygon	GHD
95	Susceptibility	Sheet and Rill susceptibility	GHD CoGG study	Polygon	GHD
96	Susceptibility	Wind Erosion	GHD CoGG study	Polygon	GHD
97	Geomorphology	Third tier Geomorphic Units	DEG CoGG study	Polygon	DEG
98	Susceptibility	Landslide susceptibility	DEG CoGG study	Grid	DEG
99	Susceptibility	Sheet and rill susceptibility	DEG CoGG study	Grid	DEG
100	Susceptibility	Gully and Tunnel susceptibility	DEG CoGG study	Grid	DEG
101	Occurrences	Mapped Landslides and Erosion	Warren's mapping 2005	Polygon, line, point	UoB
102	Basemap	Contours, Roads, Drainage, Cultural, etc.	VicMap 1:25,000 digital map coverage	Polygon, line, point	UoB/DSE/CCMA/DEG
103	Basemap	Parish boundaries	DSE standard cover	Polygon	DSE/DEG
104	Basemap	Shire boundaries	DSE standard cover	Polygon	DSE/DEG
105	Basemap	CMA boundaries	DSE standard cover	Polygon	DSE/DEG
106	Basemap	Public land by Act	GSV cover	Polygon	GSV
107	Basemap	Landscape Zones	CCMA landscape zones	Polygon	CCMA/DEG
108					
109					
110					
111					
112					

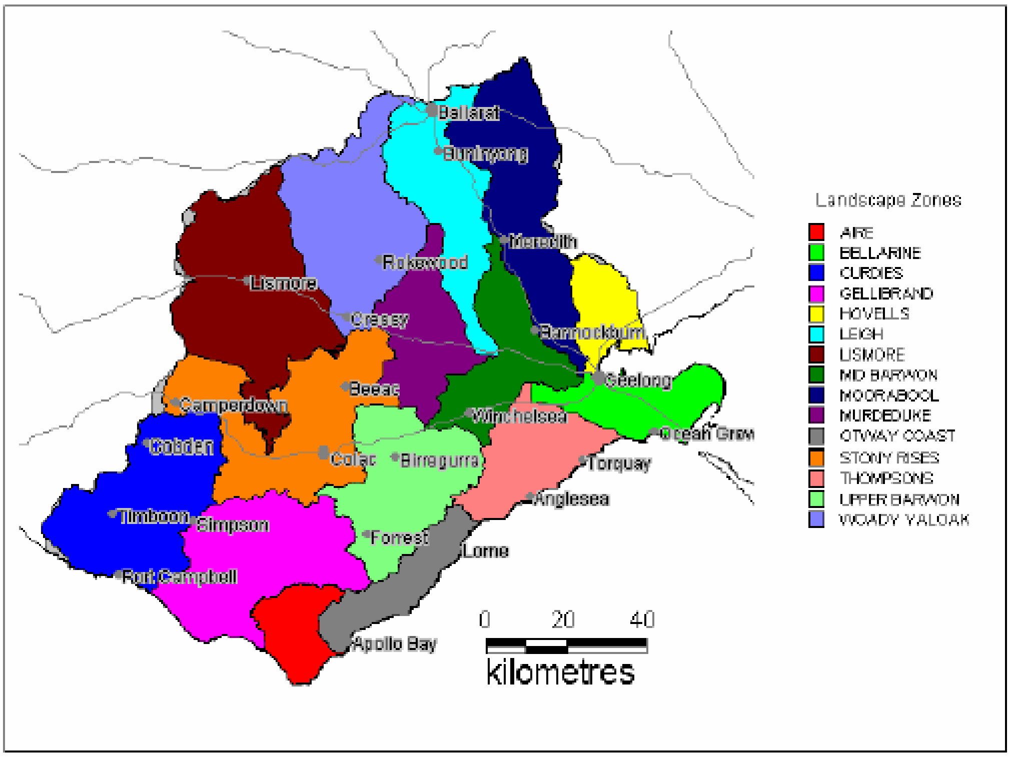
DEG I.D.	***Data Category***	***Other Possible Data layer***	***Time/date/series/comment***	***Type***	***Source***
113	Geology	Geological units			GSV
114	Geology	Geological units			GSV
115	Geomorphology	Terrain classification (PUCE)			K Grant
116	Susceptibility	Special Area A landslip hazard			COS
117	Susceptibility	Special Area B Soil Erosion			COS
118	Susceptibility	Enclosure 3 (Wild Dog creek)			Cooney and Wood (1982)
119	Susceptibility	Enclosure 4 (Parts of Kaangalang, Krambruk and Wongarra)			Cooney 1982
120	Susceptibility	Geological hazards			Rural mapping Project
121	Susceptibility	Erosion Hazard (as part of Land capability)			Rural Mapping project
122	Susceptibility	Erosion Hazard			Rural Mapping project
123	Climate	Rainfall erosivity			SCA
124	Climate	24hr rainfall 1 year recurrence interval			SCA
125	Climate	24hr rainfall 2 year recurrence interval			SCA
126	Climate	24hr rainfall 5 year recurrence interval			SCA
127	Climate	24hr rainfall 10 year recurrence interval			SCA
128	Climate	24hr rainfall 20 year recurrence interval			SCA
129	Climate	24hr rainfall 50 year recurrence interval			SCA
130	Climate	Rainfall erosivity contours			Sheridan and Rosewell
131	Physiography	Slope length			Possibly GIS generated
132	Physiography	Soil erodibility			Availability Unknown
133	Land Use	Landscape Zones			
134	Physiography	1963 5 ft contours			
135	Susceptibility	Previous Assessment and Adopted Classifications			COS C8
136					
137					
138					

DEG I.D.	Data Category	New Data layers from this study	Time/date/series/comment	Type	Source
200	Hydrology	20 m buffer around streams and waterways	Current study	Polygon	UoB
201	Geology	20 m buffer around geological boundaries	Current study	Polygon	UoB
202	Geology	200 m buffer around geological structures	Current Study	Polygon	UoB
203	Hydrology	Coastal Buffer	Current Study	Polygon	UoB
204	Physiography	Curvature (combined Plan and Profile)	2nd derivative layers in Arc Format from CSIRO	Grid	GIS generated
205	Physiography	Plan Curvature;	2nd derivative layers in Arc Format from CSIRO	Grid	GIS generated
206	Physiography	Profile Curvature	2nd derivative layers in Arc Format from CSIRO	Grid	GIS generated
207	Physiography	Flow accumulation	2nd derivative layers in Arc Format from CSIRO	Grid	GIS generated
208	Physiography	Topographic Wetness Index	2nd derivative layers in Arc Format from CSIRO	Grid	GIS generated

Appendix B

GIS Based Statistics

Corangamite Landscape Zones

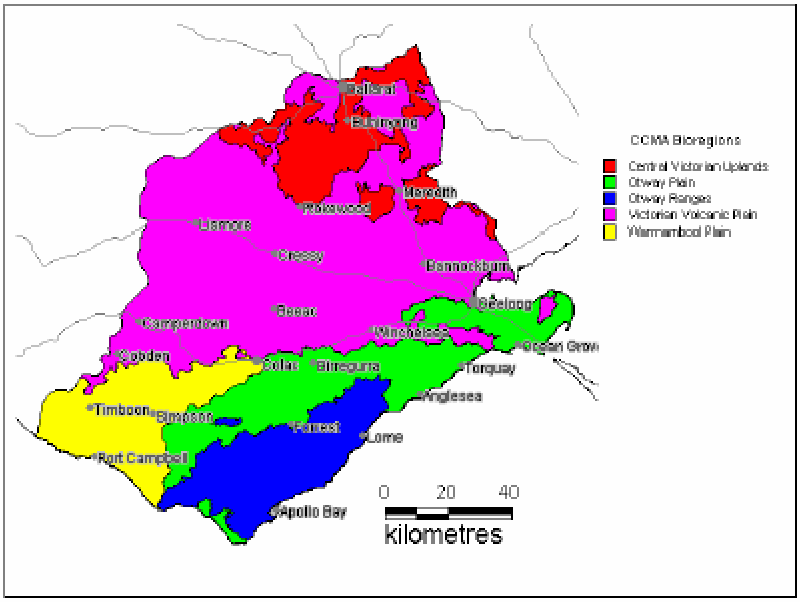


Distribution of soil degradation by Landscape Zones

Landscape Zone	Gully Erosion	Sheet Erosion	Mass Wasting	Stream Erosion
Aire	0	21	125	0
Bellarine	29	14	23	13
Curdies	13	1	462	1
Gellibrand	5	57	561	1
Hovells	18	73	3	18
Leigh	184	141	2	46
Lismore	5	6	0	17
Mid Barwon	13	59	14	11
Moorabool	144	222	24	27
Murdeduke	0	17	0	2
Otway Coast	0	21	399	0
Stony Rises	3	4	6	3
Thompsons	8	49	49	13
Upper Barwon	28	52	205	19
Woady Yaloak	263	163	0	88

Extract of details from Feltham (2005a). (Hazard feature by count)

Corangamite Bioregions

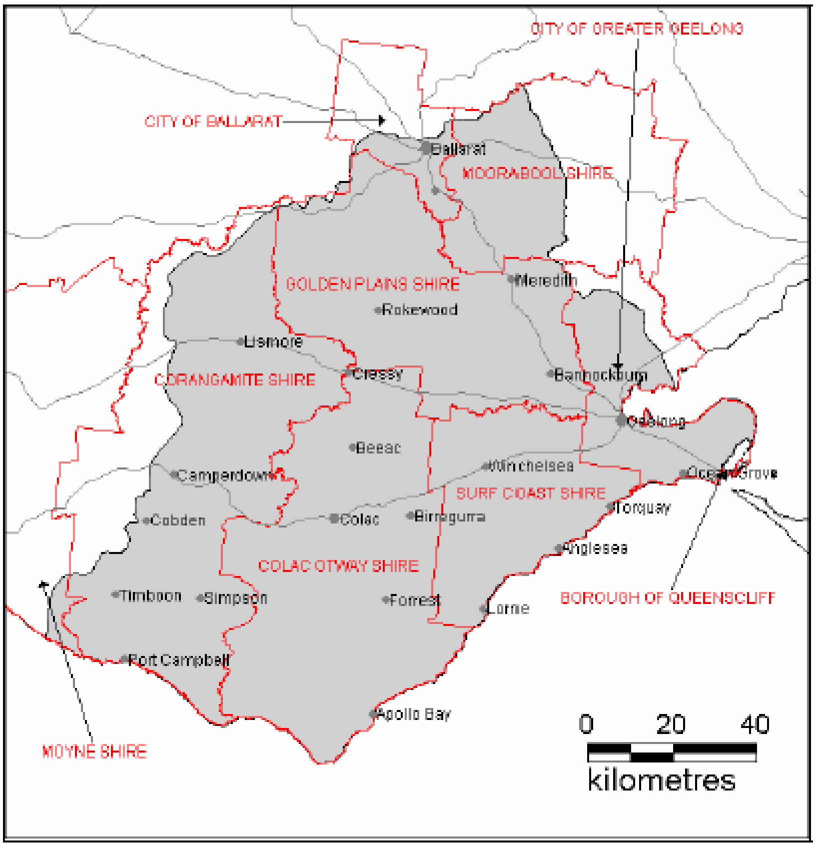


Distribution of soil degradation by Bioregions

Bioregion name	Gully Erosion	Sheet Erosion	Mass Wasting	Stream Erosion
Central Victorian Uplands	474	454	4	137
Otway Plain	61	146	304	39
Otway Ranges	4	75	979	2
Victorian Volcanic Plain	236	394	84	132
Warrnambool Plain	16	6	618	4

Extract of details from Feltham (2005a). (Hazard feature by count)

Local Government Areas (Municipalities)



Distribution of soil degradation by Municipality

Municipality	Gully Erosion	Sheet Erosion	Mass Wasting	Stream Erosion	Other Soil Degradation
Borough of Queenscliff	0	0	0	0	1
City of Ballarat	7	15	2	6	24
City of Greater Geelong	60	239	42	48	91
Colac-Otway Shire	14	120	1014	6	66
Corangamite Shire	23	23	658	19	47
Golden Plains Shire	450	384	14	129	112
Moorabool Shire	148	132	10	29	27
Moyne Shire	1	0	24	0	2
Surfcoast Shire	30	109	152	35	67

Extract of details from Feltham (2005a). (Hazard feature by count)

Geological Units (Surface Geology)

Distribution of Landslides by Geology

map_symbol	unitname	count (no.)	area (hectares)	total unit area (ha)	% unit area affected
-Pnd	Demons Bluff Formation	57	248.2	12471.01	2.0%
-Po	Older Volcanic Group	2	0.3	5042.89	0.0%
-Pon	Narrawaturk Marl, Jan Juc Formation	17	115.9	6780.98	1.7%
-Pwd	Dilwyn Formation	57	528.7	28311.54	1.9%
-Pwe	Eastern View Formation	13	31.0	19759.99	0.2%
-Pwp	Pebble Point Formation	12	0.0	19517.24	0.0%
Dgl	Undifferentiated Late Devonian granitic rocks	2	0.1	13471.78	0.0%
Ko	Otway Group	998	781.9	160676.7	0.5%
	Otway subclass				
Ko01	Bellarine	0	0.0	382.75	0.0%
Ko02	Barrabool Hills	1	11.0	7766.78	0.1%
Ko03	Barongarook	20	7.0	7584.02	0.1%
Ko04	Northern Ranges	312	173.3	46623.51	0.4%
Ko05	Central Ranges	45	97.5	51179.16	0.2%
Ko06	South East Coast	401	359.5	21994.34	1.6%
Ko07	Cape Otway			5750.53	
Ko08	Johanna	219	159.2	19396.28	0.8%
Na	Unnamed incised alluvium	19	109.6	16211.66	0.7%
Nbh	Hanson Plain Sand	56	403.1	178277.1	0.2%
Nh	Heytesbury Group	446	6347.1	78862.03	8.0%
	Heytesbury subclass				
Nh01	Geelong/Bellarine	11	39.584	4958.6	0.8%
Nh02	Kawarren	44	446.598	24822.5	1.8%
Nh03	Heytesbury	384	5852.47	48134.1	12.2%
Nh04	Cape Otway	6	8.43447	946.8	0.9%
Nhp	Port Campbell Limestone	126	455.3	22551.93	2.0%
Oc	Castlemaine Group	2	12.2	19272.92	0.1%
Ocl	Castlemaine Group - Lancefieldian	3	2.9	71812.05	0.0%
Qa	Unnamed alluvium	111	457.1	115306.97	0.4%
Qdl	Unnamed coastal dune deposits	5	10.5	30308.28	0.0%
Qn	Newer Volcanic Group	22	15.1	455195.62	0.0%
Qns	Unnamed scoria deposits	12	13.6	16199.24	0.1%

Distribution of Sheet Erosion by Geology

map_symbol	unitname	count (no.)	area (hectares)	total unit area (ha)	% unit area affected
-Ca	St Arnaud Group	21	22.7	8473.09	0.3
-Cxv	Unnamed Cambrian 'greenstone'	1	0.8	168.287	0.5
-Pa	Unnamed alluvium	7	1.5	1058.1	0.1
-Pnd	Demons Bluff Formation	16	91.2	12471.01	0.7
-Po	Older Volcanic Group	8	2.8	12471.01	0.0
-Pon	Narrawaturk Marl, Jan Juc Formation	4	6.5	6780.98	0.1
-Pwd	Dilwyn Formation	8	9.6	28311.54	0.0
-Pwe	Eastern View Formation	5	51.3	19759.99	0.3
-Pwp	Pebble Point Formation	5	4.6	19517.24	0.0
Dgl	Undifferentiated Late Devonian granitic rocks	37	64.8	13471.78	0.5
Ko	Otway Group	81	86.6	160676.7	0.1
Na	Unnamed incised alluvium	22	65.9	16211.66	0.4
Nbh	Hanson Plain Sand	168	342.7	178277.1	0.2
Nh	Heytesbury Group	39	75.2	78862.03	0.1
Nhp	Port Campbell Limestone	1	2.4	22551.93	0.0
Oc	Castlemaine Group	35	58.3	19272.92	0.3
Ocd	Castlemaine Group - Darriwillian	53	82.1	6568.65	1.2
Ocl	Castlemaine Group - Lancefieldian	233	454.7	71812.05	0.6
Qa	Unnamed alluvium	122	179.9	115306.97	0.2
Qdl	Unnamed coastal dune deposits	3	9.3	30308.28	0.0
Qn	Newer Volcanic Group	158	182.3	455195.62	0.0
Qns	Unnamed scoria deposits	1	2.3	16199.24	0.0

Distribution of Gully Erosion by Geology

map_symbol	Unit name	count (no.)	area (hectares)	total unit area (ha)	% unit area affected
-Ca	St Arnaud Group	52	116.7	8473.1	1.38
-Pnd	Demons Bluff Formation	5	12.6	12471.0	0.10
-Po	Older Volcanic Group	6	5.0	5042.9	0.10
-Pwd	Dilwyn Formation	5	3.4	28311.5	0.01
-Pwe	Eastern View Formation	7	64.6	19760.0	0.33
Dgl	Undifferentiated Late Devonian granitic rocks	17	36.3	13471.8	0.27
Ko	Otway Group	19	63.4	160676.7	0.04
Na	Unnamed incised alluvium	9	32.4	16211.7	0.20
Nbh	Hanson Plain Sand	116	208.6	178277.1	0.12
Nh	Heytesbury Group	15	33.5	78862.0	0.04
Nhp	Port Campbell Limestone	2	2.4	22551.9	0.01
Oc	Castlemaine Group	37	31.1	19272.9	0.16
Ocd	Castlemaine Group - Darriwillian	45	61.8	6568.7	0.94
Ocl	Castlemaine Group - Lancefieldian	293	483.7	71812.1	0.67
Qa	Unnamed alluvium	45	109.9	115307.0	0.10
Qdl	Unnamed coastal dune deposits	1	6.9	30308.3	0.02
Qn	Newer Volcanic Group	75	86.5	455195.6	0.02

Slope Angle (by Geology)

Distribution of Landslides by Slope Angle (as per Geology)

			% of total no. of landslide cells in each slope division							
Groups	**Geology**	**Total unit area (cells)**	**Count landslides (cells)**	**0 to 2º**	**2 to 5º**	**5 to 10º**	**10 to 15**	**15 to 20**	**20 to 25**	**25 to 30**
Na,	Quaternary Non Marine Sedimentary Rocks	3291448	13552	23%	23%	31%	16%	6%	2%	0%
Qa	Quaternary Non Marine Sedimentary Rocks									
Qdl	Quaternary Beach Deposits	757893	372							
Qn, Qns	Quaternary Newer Volcanics	11799334	657							
Nbh	Neogene Fluvial sedimentary Rocks	4462806	10008	22%	23%	41%	12%	1%	0%	0%
Nh	Neogene Gellibrand Marl	1973560	131972	6%	26%	61%	7%	1%	0%	0%
Nhp	Neogene Port Campbell Limestone	563412	10504	9%	20%	33%	21%	13%	4%	0%
Pon	Palaeogene Marine Sedimentary Rocks	169720	2174	12%	30%	47%	10%	1%	0%	0%
Pnd	Palaeogene Marine Sedimentary Rocks	312066	5039	4%	8%	40%	21%	12%	8%	5%
Pwd	Palaeogene Marine Sedimentary Rocks	708503	11963	8%	13%	30%	24%	14%	6%	4%
Pwp	Palaeogene Marine Sedimentary Rocks	488459								
Pa, Pwe, Pxh	Palaeogene Non Marine Sedimentary Rocks	535446								
Po	Palaeogene Older Volcanics	126351								
Ko	Cretaceous Otway Group	4021908	16837	2%	4%	14%	25%	21%	17%	10%
Dge, Dgl	Devonian Granitic Rocks	339509								
Oc, Ocd, Ocl	Ordovician Sedimentary Rocks	2444590	372							
Ca	Cambrian Sedimentary Rocks	212017								
Cxv	Cambrian Volcanics	4223								
	Total No of Cells	32211245	203450							

Distribution of Landslides by Slope Angle (as per Geology) (Continued)

Groups	Geology	Total unit area (cells)	Count landslides (cells)	% of total no. of landslide cells in each slope division			
				30 to 35	35 to 40	40 to 50	50 to 70
Na,	Quaternary Non Marine Sedimentary Rocks	3291448	13552	0%	0%	0%	0%
Qa	Quaternary Non Marine Sedimentary Rocks						
Qdl	Quaternary Beach Deposits	757893	372				
Qn, Qns	Quaternary Newer Volcanics	11799334	657				
Nbh	Neogene Fluvial sedimentary Rocks	4462806	10008	0%	0%	0%	0%
Nh	Neogene Gellibrand Marl	1973560	131972	0%	0%	0%	0%
Nhp	Neogene Port Campbell Limestone	563412	10504	0%	0%	0%	0%
Pon	Palaeogene Marine Sedimentary Rocks	169720	2174	0%	0%	0%	0%
Pnd	Palaeogene Marine Sedimentary Rocks	312066	5039	1%	0%	0%	0%
Pwd	Palaeogene Marine Sedimentary Rocks	708503	11963	2%	0%	0%	0%
Pwp	Palaeogene Marine Sedimentary Rocks	488459					
Pa, Pwe, Pxh	Palaeogene Non Marine Sedimentary Rocks	535446					
Po	Palaeogene Older Volcanics	126351					
Ko	Cretaceous Otway Group	4021908	16837	5%	1%	0%	0%
Dge, Dgl	Devonian Granitic Rocks	339509					
Oc, Ocd, Ocl	Ordovician Sedimentary Rocks	2444590	372				
Ca	Cambrian Sedimentary Rocks	212017					
Cxv	Cambrian Volcanics	4223					
	Total No of Cells	32211245	203450				

Distribution of Sheet Erosion by Slope Angle (as per geology)

			% of total no. of sheet cells in each slope division									
		total unit area (cells)	**count sheet (cells)**	**0 to 2**	**2 to 5**	**5 to 10**	**10 to 15**	**15 to 20**	**20 to 25**	**25 to 30**	**30 to 35**	**35 to 40**
Ocl, Ocd, Oc	Ordovician Marine sedimentary	2444590	13924	9%	15%	39%	27%	8%	1%	0%	0%	
Nbh	Neogene fluvial	4462806	7035	32%	46%	16%	5%	1%				
Qn Qns	Quaternary Newer Volcanics	11799334	4444	56%	15%	19%	8%	2%	1%			
Qa Na	Quaternary Non Marine	3291448	5755	52%	12%	15%	16%	4%	1%			
Ko	Cretaceous Otway Group	4021908	2155	8%	16%	28%	22%	11%	7%	4%	3%	1%
Nh	Neogene Gellibrand Marl	1973560	1879	10%	16%	27%	24%	16%	6%	1%		
Dgl Dge	Devonian Granitic Rocks	339509	1602	20%	56%	19%	5%	0%				
Pnd, Pwd,Pon,Pwp	Palaeogene Marine	1678748	2754	6%	11%	21%	17%	18%	19%	6%	2%	
Ca	Cambrian	212017	556	15%	12%	23%	29%	18%	3%			
Pwe Pa Pxh	Paelaoegene Non Marine	535446	1320	24%	34%	36%	6%					
Po	Palaeogene Older Volcanics	126351	72	0%	13%	39%	29%	15%	4%			
Qdl	Quaternary Beach Deposits	757893	233	9%	18%	19%	9%	18%	21%	6%		
Nhp	Neogene Port Campbell Limestone	563412	0									
Cxv	Cambrian Volcanics	4223	0									
	totals	32211245	41729									

Distribution of Gully Erosion by Slope Angle (as per Geology)

		total unit area (cells)	count gully (cells)	% of the total no of Gully cells in each slope division							
				0 to 2	2 to 5	5 to 10	10 to 15	15 to 20	20 to 25	25 to 30	30 to 35
Oc, Ocd, Oci	Ordovician Marine sediments	2444590	13297	12%	24%	35%	22%	6%	1%	0%	0%
Nbh	Neogene Fluvial sediments	4462806	4875	33%	41%	21%	5%	1%	0%	0%	0%
Qn, Qns	Quaternary newer Volcanics	11799334	2167	33%	34%	25%	8%	0%	0%	0%	0%
Na, Qa	Quaternary Non marine Sediments	3291448	3222	40%	27%	20%	10%	3%	0%	0%	0%
Ca	Cambrian sedimentary	212017	2899	7%	25%	42%	21%	4%	0%	0%	0%
Dgl	Devonian Granitic Rocks	339509	908	21%	63%	13%	4%				
Nh	Neogene Gellibrand Marl	1973560	841	27%	31%	29%	8%	4%	1%		
Ko	Cretaceous	4021908	772	22%	33%	22%	12%	9%	2%		
Pwe	Palaeogene Non Marine	535446	384	24%	41%	31%	4%				
Po	Palaeogene Older Volcanics	126351	128	2%	44%	42%	1%	9%	2%		
Nhp	Neogene Port Campbell	563412	62	68%	8%	15%	3%	6%			
Qdl	Quaternary Beach deposits	757893	176	0%	14%	15%	12%	23%	28%	8%	
Pnd Pon Pwd Pwp	Palaeogene marine Sedimentary Rocks	1678748	0								
Cxv	Cambrian Volcanics	4223	0								
	totals	32211245	29731								

Proximity to Geological Boundaries

Distribution of land degradation by Proximity to Geological Boundaries

degradation type	no. features	no. in 20m buffer	%age of total	no. features where > 50% of feature within buffer
gully erosion	609	151	24%	16
sheet erosion	1012	184	18%	16
landslides	850	332	39%	28

Proximity to Geologic Structure

No statistics were undertaken.

Proximity to Waterways

Distribution of landslides by Proximity to Waterways

buffer	area affected landslides (ha)	% of total affected area	count landslides	% of total landslides
20 metre buffer	7260	76.3	826	42.40
40 metre buffer	7975	83.8	990	50.82
60 metre buffer	8565	90.0	1156	59.34
total	9520		1948	

Distribution of Sheet Erosion by Proximity to Waterways

buffer	area affected sheet (ha)	% of total affected	count sheet	% of total sheet
20 metre buffer	998	55.1	377	37%
40 metre buffer	1091	60.3	452	44%
60 metre buffer	1163	64.3	516	50%
total	1810		1027	

Distribution of Gully Erosion by Proximity to Waterways

buffer	area affected gully (ha)	% of total affected	count gully	% of total gully
20 metre buffer	864	66%	383	52%
40 metre buffer	909	70%	443	61%
60 metre buffer	975	75%	503	69%
total	1305		730	

3rd Tier Geomorphic Units (gmu3)

gmu3 symbol	unit description	count gully erosion	count sheet erosion	count landslides	count stream erosion
2.1.1	Dissected Western Uplands associated with Palaeozoic sedimentary and metamorphic rocks	458	314	4	120
2.1.2	Dissected Western Uplands associated with granitic rocks and aureoles	22	7	0	12
2.1.3	Dissected Western Uplands associated with Cainozoic gravel and sediments	140	101	0	35
2.1.4	Dissected Western Uplands associated with volcanic landforms	47	28	3	21
2.1.5	Alluvial terraces, floodplains and swamps of the Western Uplands	31	25	7	3
3.1.1	Deeply dissected upland plateaux of the Southern Uplands	0	14	83	0
3.1.2	Deeply dissected upland ranges of the Southern Uplands	3	51	880	2
3.2.2	Dissected upland ranges of the Southern Uplands	12	35	130	9
3.3.1	Dissected low hills plateaux of the Southern Uplands	24	13	43	5
3.3.2	Dissected rolling low hills of the Southern Uplands	13	33	202	0
3.3.3	Alluvial terraces and floodplains associated with Dissected low hills of the Southern Uplands	9	35	132	7
6.1.1	Eruption points of the Volcanic Western Plains	0	1	13	0
6.1.3	Volcanic Western Plains with poorly developed drainage	7	89	15	23
6.1.4	Volcanic Western Plains with well developed drainage	13	34	5	19
6.1.5	Alluvium, terraces, floodplains, lakes, swamps and lunettes of the Volcanic Western Plains	18	64	12	21
6.2.2	Dissected plains, rises and low hills of the Sedimentary Western Plains	11	6	681	1
6.2.3	Karst plains, rises and low hills with depressions of the Sedimentary Western Plains	1	0	18	0
6.2.4	Plains, rises and low hills of the Sedimentary Western Plains	31	108	16	38
6.2.5	Alluvium, alluvial terraces, floodplains and coastal plains of the Sedimentary Western Plains	31	66	46	15
6.3.1	Granitic hill inliers of the Western Plains	17	39	1	12

Soil Landform Units

Distribution of Landslides by Soil Landform Units

landform unit	total unit area	count landslides	area affected (hectares)	% unit area affected
1	2680.8	1	12.0	0.45
2	47128.7	1	0.9	0.00
4	9370.6	2	0.6	0.01
32	1466.5	1	0.0	0.00
50	38761.5	1	0.2	0.00
57	26264.3	19	40.3	0.15
59	9404.8	12	0.0	0.00
60	14337.2	54	2.0	0.01
61	76671.6	457	439.9	0.57
62	4861.0	16	201.5	4.15
63	14235.7	55	20.9	0.15
64	20842.2	289	151.3	0.73
65	3229.4	12	0.5	0.02
66	5663.7	33	9.1	0.16
67	3282.7	11	1.7	0.05
68	5853.5	14	55.9	0.96
70	9137.7	4	41.1	0.45
72	4023.9	15	0.7	0.02
73	10969.9	45	30.5	0.28
75	2634.6	8	8.3	0.31
76	6558.5	17	73.3	1.12
77	12945.2	6	6.8	0.05
78	18433.0	14	27.7	0.15
79	8546.1	9	0.0	0.00
80	2667.1	1	4.7	0.18
81	17550.6	146	2493.0	14.20
84	707.4	3	1.1	0.15
85	1491.1	10	19.5	1.31
86	6845.2	7	80.7	1.18
87	10417.6	49	772.1	7.41
88	5378.2	2	2.7	0.05
89	8355.9	22	82.0	0.98
90	5116.3	30	294.6	5.76
91	1755.2	19	166.4	9.48
92	10355.4	9	4.8	0.05
93	7735.6	18	129.1	1.67
94	2466.8	3	0.4	0.02
95	8424.6	47	169.7	2.01
96	4488.1	24	165.0	3.68
98	855.6	1	1.6	0.19
107	597.6	8	4.2	0.71
110	4512.8	3	7.8	0.17
117	61888.0	2	0.7	0.00
121	16608.3	3	10.7	0.06
122	5046.5	2	11.2	0.22

Distribution of Landslides by Soil Landform Units (Continued)				
landform unit	**total unit area**	**count landslides**	**area affected (hectares)**	**% unit area affected**
138	1132.1	3	3.4	0.30
155	7309.4	8	8.5	0.12
157	1191.1	2	0.0	0.00
160	7286.3	54	575.9	7.90
161	11099.0	52	440.4	3.97
162	13441.3	3	13.5	0.10
163	1095.1	2	0.0	0.00
164	7905.3	112	1476.0	18.67
165	11645.1	60	879.9	7.56
166	14823.7	81	334.1	2.25
167	1481.6	17	13.2	0.89
169	386.1	2	2.0	0.51
170	5431.1	2	0.5	0.01
171	14716.6	1	7.0	0.05
181	16703.4	11	108.5	0.65
186	748.7	1	0.1	0.02
189	3044.4	2	0.0	0.00
190	7550.4	1	0.7	0.01
193	134.2	1	2.3	1.68
198	1198.3	17	73.5	6.13
199	1223.3	7	14.1	1.15
203	730.9	1	0.0	0.00
205	16098.9	5	2.3	0.01

Distribution of Sheet and Rill Erosion by Soil Landform Unit

landform unit	total unit area	count sheet erosion	area affected (hectares)	% unit area affected
2	47128.7	134	340.8	0.72
4	9370.6	11	3.4	0.04
5	3540.7	5	18.2	0.52
6	6015.3	30	37.3	0.62
7	1284.7	1	1.4	0.11
8	3027.0	56	95.4	3.15
9	11433.2	43	28.9	0.25
11	3549.6	13	30.8	0.87
12	1310.8	2	1.7	0.13
14	1975.3	2	10.1	0.51
15	1517.3	2	14.7	0.97
16	246.5	2	0.4	0.15
17	3980.1	1	0.3	0.01
20	7844.0	2	0.1	0.00
21	3704.8	3	5.1	0.14
22	1311.9	2	1.6	0.12
23	25803.1	34	65.8	0.25
26	609.5	16	9.3	1.53
27	3204.2	5	1.8	0.06
28	1632.2	5	7.0	0.43
32	1466.5	1	2.2	0.15
43	1386.0	1	2.3	0.16
47	3022.3	3	3.7	0.12
50	38761.5	5	3.3	0.01
53	15767.3	11	45.3	0.29
57	26264.3	77	159.5	0.61
60	14337.2	12	17.3	0.12
61	76671.6	25	29.6	0.04
62	4861.0	7	11.6	0.24
63	14235.7	5	7.8	0.05
64	20842.2	17	8.1	0.04
65	3229.4	1	0.2	0.01
68	5853.5	1	0.2	0.00
70	9137.7	11	11.1	0.12
72	4023.9	1	0.7	0.02
73	10969.9	6	45.5	0.41
74	10582.2	1	0.6	0.01
75	2634.6	5	3.8	0.15
76	6558.5	4	3.2	0.05
77	12945.2	2	6.7	0.05
78	18433.0	4	2.0	0.01
79	8546.1	2	10.9	0.13
81	17550.6	5	7.9	0.04
85	1491.1	5	17.7	1.19
86	6845.2	1	1.6	0.02
87	10417.6	1	0.2	0.00
88	5378.2	2	0.2	0.00
89	8355.9	9	31.6	0.38

Distribution of Sheet and Rill Erosion by Soil Landform Unit (continued)				
landform unit	**total unit area**	**count sheet erosion**	**area affected (hectares)**	**% unit area affected**
90	5116.3	1	2.4	0.05
91	1755.2	6	11.3	0.64
93	7735.6	6	16.5	0.21
94	2466.8	5	4.7	0.19
95	8424.6	9	51.0	0.60
96	4488.1	9	20.3	0.45
117	61888.0	7	15.4	0.02
118	43636.1	12	4.1	0.01
119	32064.6	2	0.9	0.00
121	16608.3	37	13.5	0.08
125	5697.0	4	13.6	0.24
128	1026.0	12	22.5	2.19
133	15246.8	11	3.2	0.02
136	58381.3	1	1.3	0.00
140	15797.9	1	1.0	0.01
143	4525.6	5	6.2	0.14
153	16767.8	1	3.2	0.02
155	7309.4	44	49.2	0.67
161	11099.0	1	2.4	0.02
169	386.1	1	1.4	0.36
170	5431.1	2	0.1	0.00
171	14716.6	33	28.6	0.19
172	9928.0	6	6.7	0.07
173	1099.1	2	5.8	0.53
174	3772.9	4	3.6	0.10
178	770.2	6	2.1	0.27
179	602.8	21	22.2	3.69
180	8171.6	5	1.4	0.02
185	4574.0	2	0.9	0.02
186	748.7	4	1.2	0.17
190	7550.4	5	2.5	0.03
198	1198.3	1	1.3	0.11
199	1223.3	7	18.2	1.49
203	730.9	15	43.9	6.01
204	3444.2	19	51.9	1.51
205	16098.9	2	0.5	0.00

Distribution of Gully Erosion by Soil Landform Units

landform unit	unit area	gully count	gully area hectares	% affected	Within 20 m buffer		Outside 20 m buffer	
					gully count	gully area (ha)	gully count	gully area (ha)
1	2680.8	4	2.5	0.09	3	2.5	1	0.0
2	47128.7	237	401.5	0.85	215	391.4	22	10.0
4	9370.6	4	1.8	0.02	3	1.7	1	0.1
5	3540.7	1	0.4	0.01	1	0.4	0	0.0
6	6015.3	5	19.0	0.32	5	19.0	0	0.0
8	3027.0	61	128.0	4.23	39	86.4	22	41.7
9	11433.2	89	49.9	0.44	79	48.0	10	1.8
11	3549.6	12	28.5	0.80	10	27.7	2	0.8
12	1310.8	2	3.4	0.26	2	3.4	0	0.0
14	1975.3	12	13.1	0.66	11	13.0	1	0.1
15	1517.3	5	14.7	0.97	4	0.9	1	13.7
16	246.5	1	0.0	0.00	1	0.0	0	0.0
17	3980.1	1	0.3	0.01	0	0.0	1	0.3
18	1113.1	1	0.0	0.00	1	0.0	0	0.0
19	4014.6	7	0.0	0.00	7	0.0	0	0.0
21	3704.8	7	4.7	0.13	6	4.5	1	0.2
22	1311.9	8	2.6	0.20	8	2.6	0	0.0
23	25803.1	44	54.4	0.21	42	54.0	2	0.4
26	609.5	4	12.2	2.00	4	12.2	0	0.0
27	3204.2	9	5.2	0.16	6	2.6	3	2.6
47	3022.3	4	2.0	0.07	4	2.0	0	0.0
50	38761.5	15	13.3	0.03	11	11.6	4	1.8
53	15767.3	6	0.2	0.00	6	0.2	0	0.0
54	984.2	1	6.7	0.68	1	6.7	0	0.0
57	26264.3	48	114.4	0.44	45	110.4	3	4.1
61	76671.6	2	0.0	0.00	0	0.0	2	0.0
63	14235.7	6	10.3	0.07	6	10.3	0	0.0
66	5663.7	3	0.0	0.00	0	0.0	3	0.0
70	9137.7	5	13.1	0.14	4	12.5	1	0.6
73	10969.9	6	88.3	0.80	5	88.0	1	0.3
77	12945.2	11	28.8	0.22	10	27.2	1	1.7
78	18433.0	4	1.8	0.01	2	1.5	2	0.3
80	2667.1	3	4.3	0.16	3	4.3	0	0.0
81	17550.6	3	0.6	0.00	2	0.5	1	0.1

Distribution of Gully Erosion by Soil Landform Units (Continued)								
					Within 20 m buffer		**Outside 20 m buffer**	
landform unit	**unit area**	**gully count**	**gully area hectares**	**% affected**	**gully count**	**gully area (ha)**	**landform unit**	**unit area**
84	707.4	1	1.0	0.14	1	1.0	0	0.0
86	6845.2	5	3.4	0.05	4	3.3	1	0.2
91	1755.2	1	6.9	0.39	0	0.0	1	6.9
92	10355.4	1	1.1	0.01	1	1.1	0	0.0
93	7735.6	3	3.5	0.04	3	3.5	0	0.0
95	8424.6	7	17.9	0.21	6	17.6	1	0.3
96	4488.1	1	0.6	0.01	0	0.0	1	0.6
121	16608.3	2	4.1	0.02	2	4.1	0	0.0
128	1026.0	2	15.6	1.52	2	15.6	0	0.0
133	15246.8	3	2.6	0.02	3	2.6	0	0.0
134	373.5	1	0.2	0.06	1	0.2	0	0.0
136	58381.3	2	0.6	0.00	2	0.6	0	0.0
138	1132.1	2	0.9	0.08	1	0.2	1	0.8
143	4525.6	4	7.0	0.16	4	7.0	0	0.0
153	16767.8	1	3.2	0.02	1	3.2	0	0.0
155	7309.4	8	21.2	0.29	1	1.2	7	20.0
160	7286.3	1	0.6	0.01	0	0.0	1	0.6
161	11099.0	1	0.6	0.01	1	0.6	0	0.0
164	7905.3	3	6.9	0.09	3	6.9	0	0.0
166	14823.7	3	4.6	0.03	2	4.3	1	0.3
167	1481.6	1	2.1	0.14	0	0.0	1	2.1
171	14716.6	7	13.3	0.09	7	13.3	0	0.0
174	3772.9	1	0.6	0.02	1	0.6	0	0.0
179	602.8	2	17.5	2.90	2	17.5	0	0.0
180	8171.6	5	19.3	0.24	5	19.3	0	0.0
184	1330.0	1	0.6	0.04	1	0.6	0	0.0
186	748.7	2	1.8	0.24	2	1.8	0	0.0
190	7550.4	2	6.9	0.09	2	6.9	0	0.0
197	5193.6	3	11.5	0.22	3	11.5	0	0.0
199	1223.3	4	13.9	1.14	4	13.9	0	0.0
200	7173.5	1	6.0	0.08	1	6.0	0	0.0
203	730.9	3	5.8	0.80	2	4.3	1	1.5
204	3444.2	12	47.2	1.37	11	44.9	1	2.3

Land Use (LU)

Distribution of landslides by Land Use

LU code	unit area	landslides count	landslides area (hectares)	% unit affected
1.1.1	10262.9	2	0.0	0.00
1.1.3	43009.9	84	440.5	1.02
1.1.4	4466.8	27	27.1	0.61
1.1.7	38640.4	76	66.0	0.17
1.2.0	5901.0	1	17.3	0.29
1.3.0	10312.7	45	44.1	0.43
1.3.3	2338.4	4	23.6	1.01
2.1.0	62648.4	201	453.1	0.72
2.2.0	150220.5	273	317.8	0.21
3.1.0	1812.5	9	0.7	0.04
3.1.1	5612.6	16	0.4	0.01
3.1.2	27729.5	149	175.4	0.63
3.2.0	764200.2	937	7727.7	1.01
3.3.0	88867.2	5	16.5	0.02
4.4.4	648.0	1	0.0	0.00
5.3.0	3429.3	1	0.0	0.00
5.4.1	17028.0	19	18.8	0.11
5.4.2	21706.9	2	1.0	0.00
5.5.3	4871.1	10	25.6	0.53
5.8.2	4749.0	8	24.2	0.51

Distribution of Gully Erosion by Land Use

LU code	area	gully count	gully area(hectares)	% unit affected
1.1.3	43009.9	1	6.9	0.02
1.1.4	4466.8	15	29.9	0.67
1.3.0	10312.7	11	12.8	0.12
2.1.0	62648.4	34	42.0	0.07
2.2.0	150220.5	5	52.3	0.03
3.1.1	5612.6	11	10.4	0.19
3.1.2	27729.5	1	1.8	0.01
3.2.0	764200.2	596	1005.4	0.13
3.3.0	88867.2	19	17.6	0.02
3.3.1	4362.1	5	19.2	0.44
3.3.4	3066.1	1	6.9	0.22
5.4.1	17028.0	1	0.0	0.00
5.5.3	4871.1	4	22.5	0.46
5.5.5	901.4	7	28.6	3.18
5.8.0	701.2	9	21.8	3.11
5.8.2	4749.0	3	23.1	0.49
6.1.1	41345.8	1	3.2	0.01

Distribution of Sheet Erosion by Land Use

LU code	area	sheet count	sheet area (hectares)	% unit affected
1.1.1	10262.9	2	1.1	0.01
1.1.3	43009.9	6	28.8	0.07
1.1.4	4466.8	10	35.8	0.80
1.1.5	4661.4	1	1.9	0.04
1.1.7	38640.4	28	58.6	0.15
1.3.0	10312.7	17	23.0	0.22
2.1.0	62648.4	89	114.4	0.18
2.2.0	150220.5	27	119.9	0.08
3.1.1	5612.6	10	5.9	0.11
3.1.2	27729.5	8	4.7	0.02
3.2.0	764200.2	610	940.5	0.12
3.3.0	88867.2	28	51.8	0.06
3.3.1	4362.1	5	7.5	0.17
3.3.3	69.9	1	0.4	0.55
3.3.4	3066.1	2	5.7	0.19
4.4.4	648.0	2	0.6	0.09
4.5.4	2169.5	3	2.2	0.10
5.3.0	3429.3	2	0.5	0.01
5.4.1	17028.0	1	0.1	0.00
5.4.2	21706.9	16	18.4	0.08
5.5.2	1980.1	3	1.4	0.07
5.5.3	4871.1	8	25.1	0.52
5.5.5	901.4	29	53.9	5.98
5.8.0	701.2	8	30.2	4.30
5.8.2	4749.0	14	93.9	1.98
6.1.1	41345.8	1	3.2	0.01

Ecological Vegetation Class (EVC)

Distribution of land degradation by ecological vegetation classes (EVC)

evc number	evc description	count landslides	count sheet erosion	count gully erosion
1	Coastal Dune Scrub / Coastal Dune Grassland Mosaic	32	2	1
3	Damp Sands Herb-rich Woodland	30	4	3
6	Sands Heathland	7	4	7
8	Wet Heathland	8	0	3
9	Coastal Saltmarsh	0	0	0
10	Estuarine Wetland	2	1	2
16	Lowland Forest	360	25	19
17	Riparian Scrub / Swampy Riparian Woodland Complex	44	7	44
18	Riparian Forest	62	8	2
20	Heathy Dry Forest	1	75	67
21	Shrubby Dry Forest	18	3	18
22	Grassy Dry Forest	2	81	80
23	Herb-rich Foothill Forest	305	0	2
30	Wet Forest	338	18	3
31	Cool Temperate Rainforest	56	3	56
45	Shrubby Foothill Forest	352	26	3
47	Valley Grassy Forest	0	87	82
48	Heathy Woodland	53	19	1
53	Swamp Scrub	10	5	10
55	Plains Grassy Woodland	6	55	34
56	Floodplain Riparian Woodland	10	11	10
57	Conifer Plantation	147	10	147
58	Cleared / severely disturbed	102	100	87
68	Creekline Grassy Woodland	0	3	1
71	Hills Herb-rich Woodland	0	30	8
72	Granitic Hills Woodland	1	12	3
83	Swampy Riparian Woodland	1	4	2
121	Hardwood Plantation	1	1	1
125	Plains Grassy Wetland	0	0	0
128	Grassy Forest	3	6	8
132	Plains Grassland	6	8	6
161	Coastal Headland Scrub	167	10	1
162	Coastal Headland Scrub / Coastal Tussock Grassland Mosaic	8	0	8
163	Coastal Tussock Grassland	31	2	31
164	Creekline Herb-rich Woodland	1	29	41
165	Damp Heath Scrub	14	0	14

Distribution of land degradation by ecological vegetation classes (EVC) (continued)				
evc number	**evc description**	**count landslides**	**count sheet erosion**	**count gully erosion**
175	Grassy Woodland	20	32	33
178	Herb rich Foothill / Shrubby Foothill Forest Complex	27	1	27
181	Coastal Gully Thicket	6	0	6
198	Sedgy Riparian Woodland	12	0	12
201	Shrubby Wet Forest	317	15	2
233	Wet Sands Thicket	2	0	2
641	Riparian Woodland	0	1	5
851	Stream Bank Shrubland	2	9	7
858	Coastal Alkaline Shrub	1	0	1
894	Scoria Cone Woodland	10	0	10
895	Escarpment Shrubland	1	1	1
897	Plains Grassland / Plains Grassy Woodland Mosaic	0	8	11
987	Plantation (undefined)	71	8	4
992	Water body - fresh	0	1	0
995	Ocean	18	0	18
997	Private land - no tree cover	1571	953	729
998	Water body - natural or man made	34	10	7

Slope Aspect

Distribution of landslides by Slope Aspect

slope aspect (azimuth)	direction	count landslides	% of total landslides
0 -22.5	north	55	3%
22.5 - 67.5	north east	171	9%
67.5 - 112.5	east	148	8%
112.5 - 157.5	south east	323	17%
157.5 - 202.5	south	348	18%
202.5 - 247.5	south west	394	20%
247.5 - 292.5	west	260	13%
292.5 - 337.5	north west	187	10%
337.5 - 360	north	61	3%

Distribution of Gully and Sheet Erosion by Slope Aspect

slope aspect (azimuth)	direction	count gully	% of total gully	count sheet	% of total sheet
0 - 90	north east	138	19%	221	24%
90 - 180	south east	196	27%	198	21%
180 - 270	south west	208	29%	258	27%
270 - 360	north west	174	24%	262	28%

Annual Rainfall

Distribution of landslides by Annual Rainfall (mm)

rainfall (mm)	count landslides
500 - 700	89
700 - 900	405
900 - 1100	717
1100 - 1300	482
1300 - 1500	163
1500 - 1700	34
1700 - 1900	22

Distribution of Gully and Sheet Erosion by Annual Rainfall (mm)

rainfall (mm)	count gully	count sheet
470 – 700	667	782
700 – 1000	48	83
1000 – 1900	7	77

Appendix C

Landslide Parameter Sets from Other Australian Susceptibility Mapping Projects

Location	Wollongong
Researcher	Dr Phil Flentje

Factors	Existing landslides Geology Pore water pressure Rainfall Soil and rock strength parameters Depth of colluvium Slope angle Profile Curvature Vegetation Aspect Activities of man such as filling and excavation

Pixel resolution	10 x10
ArcInfo	TOPOGRID used for DEM production

GIS layers Used in See5 Analysis

Landslides	507 mapped instances including type area, volume
Geology	1:50,000 but field mapped onto 1:4,000
Vegetation	Landsat imagery analysed at 25 x 25 m pixels
Flow Accumulation	number of pixels contributing flow to each pixel
Slope Inclination	3 degree increments based on a 3 x 3 pixel window
Slope aspect	Cardinal points
Profile curvature	Rate of change of gradient
Plan or contour curvature	Rate of change of aspect
DEM	
wetness index	

Location	Maroochy Shire QLD
Researcher	Golder Associates
Factors	Existing landslides Geology Soil Type land Cover (Vegetation) Rainfall Upstream Catchment Area Slope Aspect Slope Angle
Pixel resolution	
ArcvIew GIS	

GIS layers Used in IntraParameter Weighted method

Geology	1:100,000
Soils	Horticultural land suitability study for the Qld DPI
Land cover	IKONOS satellite imagery
Precipitation Intensity	12 hr intensity with a 50 year ARI
Topography	1:25,000 state topo maps
slope Angle	window of 9 pixels (3x39) to determine average angle
Slope aspect	8 direction of compass (N NE E SE S SW W NW)
Upstream catchment	PCI command DWCON- 50 x 50 m area 5 classes 0-2, 2-5, 5-10, 20-50 and 50+
Testing Data	previous landslip maps with 320 entries

Location	Hobart MRT
Researcher	Colin Mazengarb

Factors	Existing landslides
	Landslide type
	Geology
	Geomorphology
	land Cover (Vegetation)
	Rainfall
	Upstream Catchment Area
	Slope Aspect
	Slope Angle

Pixel resolution		
AcrMap ArcView GIS		Spatial Analyst and 3D Analyst
SHALSTAB	Debris flow source prediction	

GIS layers Used in Spatial Analyst

Geology	1:25,000
Regolith thickness	
geomorphic features	1:5000 form ortho photographs
mapped landslides	TIGER system database
DEM	TOPOGRID using 1:5000 and 1:25000 maps
hillshade	shadow effect
slope angle	in degrees
aspect	maximum direction in degrees
flow direction	8 cardinal directions
flow accumulation	upstream catchment area

Appendix D

Intra Parameter Rankings for Landslide, Sheet and Gully

Rainfall Rankings

RAINFALL

Category mm	Landslide Ranking
< 500	0.0
500 - 700	2.0
700 - 900	6.0
900 - 1100	10.0
1100 - 1300	10.0
1300 - 1500	10.0
1500 - 1700	10.0
1700 - 1900	10.0

Category mm	Sheet Ranking	Gully Ranking
< 470	0.0	0.0
470-700	10.0	10.0
700 - 1000	1.0	1.0
1000-1900	1.0	0.0

Geology Rankings

GEOLOGY

Category tag	Landslide Ranking	Sheet Ranking	Gully Ranking
-Ca		5.0	10.0
-Cxv		6.1	
Dgl	0.2	6.1	5.0
Ko		5.8	3.7
Ko01	4.0		
Ko02	4.0		
Ko03	4.0		
Ko04	8.7		
Ko05	4.0		
Ko06	10.0		
Ko07	4.0		
Ko08	7.4		
Na	1.7	5.7	3.7
Nbh	4.9	8.5	6.5
Nh		4.6	1.9
Nh01	5.0		
Nh02	5.0		
Nh03	9.8		
Nh04	5.0		
Nhp	6.0	0.1	0.2
Oc	0.2	5.2	4.1
Ocd		10.0	8.0
Ocl	0.3	10.0	10.0
Pa		2.7	
-Pnd	5.0	7.4	1.9
-Po	0.2	0.8	1.8
-Pon	1.5	1.8	
-Pwd	5.0	0.8	0.6
-Pwe	1.1	5.0	5.3
-Pwp	1.1	0.5	
Qa	5.8	6.9	5.3
Qdl	0.4	0.6	0.4
Qn	1.9	7.9	5.6
Qns	1.1	0.3	

3rd Tier Geomorphic Unit Rankings

GEOMORP UNITS

Category Unit i.d.	Landslide Ranking	Sheet Ranking	Gully Ranking
2.1.1	0.2	10.0	10.0
2.1.2	0.0	0.7	2.3
2.1.3	0.0	6.0	7.0
2.1.4	0.1	2.7	5.0
2.1.5	0.3	2.5	3.3
3.1.1	3.2	1.4	0.0
3.1.2	10.0	5.0	0.3
3.2.2	5.0	3.4	1.3
3.3.1	1.7	1.3	2.6
3.3.2	5.5	3.2	1.4
3.3.3	5.0	3.4	1.0
6.1.1	0.5	0.1	0.0
6.1.3	0.6	5.7	0.7
6.1.4	0.2	3.3	1.4
6.1.5	0.5	5.2	1.9
6.2.2	8.7	0.6	1.2
6.2.3	0.7	0.0	0.1
6.2.4	0.6	6.1	3.3
6.2.5	1.8	5.3	3.3
6.3.1	0.0	3.8	1.8

Soil Landform Rankings

SOIL LANDFORM

Category Unit i.d.	Landslide Ranking	Sheet Ranking	Gully Ranking (total)	Gully Within 20 m	Gully outside 20 m
1	0.2		1.8	1.8	0.5
2	0.2	10.0	10.0	10.0	0.9
4	0.4	0.9	1.8	1.8	0.5
5		5.1	0.5	0.5	0.0
6		5.3	5.0	5.0	0.0
7		1.3			
8		7.4	10.0	10.0	3.6
9		5.2	6.7	6.7	0.8
11		5.4	5.5	5.5	0.9
12		1.6	3.3	3.3	0.0
14		5.1	5.3	5.3	0.4
15		5.5	5.7	5.7	1.1
16		1.8	0.5	0.5	0.0
17			0.5	0.5	0.5
18			0.5	0.5	0.0
19			3.2	3.2	0.0
21		1.7	3.2	3.2	0.5
22		1.5	3.6	3.6	0.0
23		5.7	5.7	5.7	0.3
26		6.0	7.1	7.1	0.0
27		0.7	4.1	4.1	1.4

SOIL LANDFORM (Continued)	Category Unit i.d.	Landslide Ranking	Sheet Ranking	Gully Ranking (total)	Gully Within 20 m	Gully outside 20 m
	28		5.0			
	32	0.2	1.8			
	43		2.0			
	47		1.5	1.8	1.8	0.0
	50	0.2	0.9	5.1	5.1	1.4
	53		5.4	2.7	2.7	0.0
	54			5.4	5.4	0.0
	57	4	7.2	6.2	6.2	0.4
	59	2.5				
	60	5.6	4.7			
	61	10	5.2	0.9	0.9	0.9
	62	3.3	3.2			
	63	5.6	2.1	2.7	2.7	0.0
	64	8.2	2.2			
	65	2.5				
	66	5.4		1.4	1.4	1.4
	67	2.3				
	68	2.9				
	70	0.8	3.1	3.5	3.5	0.7
	72	3.1				
	73	5.5	5.4	5.9	5.9	1.0
	75	1.7	1.7			
	76	5.0	0.9			
	77	1.3	1.8	5.1	5.1	0.5
	78	2.9	0.6	1.8	1.8	0.9
	79	1.9	3.0			
	80	0.2		2.0	2.0	0.0
	81	8.7	2.2	1.4	1.4	0.5
	84	0.6		1.8	1.8	0.0
	85	2.1	5.7			
	86	2.1		2.3	2.3	0.5
	87	6.6				
	88	0.4				
	89	4.6	5.2			
	90	5.3	0.7			
	91	7.2	5.2	5.0	5.0	5.0
	92	1.9		0.5	0.5	0.0
	93	4	4.5	1.4	1.4	0.0
	94	0.6	2.3			
	95	5.5	5.5	4.7	4.7	0.7
	96	5	5.0	0.5	0.5	0.5
	98	0.2				
	107	1.7				
	110	0.6				
	117	0.4	4.2			
	118		1.1			
	121	0.6	3.7	1.1	1.1	0.0
	122	0.4				

SOIL LANDFORM (Continued)	Category Unit i.d.	Landslide Ranking	Sheet Ranking	Gully Ranking (total)	Gully Within 20 m	Gully outside 20 m
	125		3.7			
	128		6.6	6.5	6.5	0.0
	133		0.9	1.4	1.4	0.0
	134			0.8	0.8	0.0
	136			0.9	0.9	0.0
	138	0.6		1.0	1.0	0.5
	143		1.7	2.0	2.0	0.0
	153		0.9	0.8	0.8	0.0
	155	1.7	5.5	5.0	5.0	4.4
	157	0.4				
	160	6.8		0.5	0.5	0.5
	161	5.6	0.7	0.5	0.5	0.0
	162	0.6				
	163	0.4				
	164	10		1.8	1.8	0.0
	165	6.7				
	166	6		1.4	1.4	0.5
	167	5.0		1.8	1.8	1.8
	169	0.4	4.3			
	170	0.4				
	171	0.2	5.2	3.5	3.5	0.0
	172		1.8			
	173		5.1			
	174		1.2	0.5	0.5	0.0
	178		3.3			
	179		7.9	8.3	8.3	0.0
	180					
	181	2.3		5.0	5.0	0.0
	184			0.5	0.5	0.0
	186	0.2	2.0	3.0	3.0	0.0
	189	0.4				
	190	0.2	0.7	1.8	1.8	0.0
	193	0.2				
	197			3.0	3.0	0.0
	198	3.5	1.3			
	199	1.5	6.0	6.0	6.0	0.0
	200			1.6	1.6	0.0
	203	0.2	10.0	5.5	5.5	1.8
	204		6.0	6.3	6.3	0.5
	205	1.0				

Vegetation Rankings

VEGETATION	Category EVC No.	Landslide Ranking	Sheet Ranking	Gully Ranking
	1	1.7	0.3	0
	3	1.6	0.7	0
	6	0.4	0.7	1.1
	8	0.4	0.0	0
	9	0	0.0	0
	10	0.1	0.2	0
	16	6.3	4.2	3.1
	17	2.4	1.2	5.3
	18	3.3	1.3	0
	20	0.1	6.8	5.9
	21	1.0	0.5	2.9
	22	0.1	6.8	6.3
	23	6.1	0.0	0
	30	6.2	3.0	0
	31	3.0	0.5	5.6
	45	6.3	4.3	0
	47	0	6.6	6.3
	48	2.9	3.2	0
	53	0.5	0.8	1.6
	55	0.3	6.2	5.1
	56	0.5	1.8	1.6
	57	5.6	1.7	8.0
	58	5.5	7.0	6.4
	68	0	0.5	0
	71	0	5.0	1.3
	72	0.1	2.0	0
	83	0.1	0.7	0
	121	0.1	0.2	0
	125	0	0.0	0
	128	0.2	1.0	1.3
	132	0.3	1.3	1.0
	161	5.7	1.7	0
	162	0.4	0.0	1.3
	163	1.7	0.3	5.0
	164	0.1	4.8	5.3
	165	0.8	0.0	2.3
	175	1.1	5.7	5.1
	178	1.5	0.2	4.4
	181	0.3	0.0	1.0
	198	0.6	0.0	1.9
	201	6.2	2.5	0
	233	0.1	0.0	0
	641	0	0.2	0.8
	851	0.1	1.5	1.1
	858	0.1	0.0	0
	894	0.5	0.0	1.6
	895	0.1	0.2	0

VEGETATION (continued)

Category EVC No.	Landslide Ranking	Sheet Ranking	Gully Ranking
897	0	1.3	1.8
987	3.8	1.3	0.6
992	0	0.2	0
995	1.0	0.0	2.9
997	10.0	10.0	10.0
998	1.8	1.7	1.1

Land use Rankings

LAND USE

Category LU Code	Landslide Ranking	Sheet Ranking	Gully Ranking
1.1.1	0.1	0.2	
1.1.3	3.9	2.1	0.7
1.1.4	1.3	2.7	5.0
1.1.5		0.1	
1.1.7	3.6	4.4	
1.2.0	0.0		
1.3.0	2.1	1.7	1.6
1.3.3	0.2		
2.1.0	8.0	8.5	5.0
2.2.0	9.0	4.0	5.0
3.1.0	0.4		
3.1.1	0.8	0.8	1.6
3.1.2	7.0	0.6	0.2
3.2.0	10.0	10.0	10.0
3.3.0	0.2	3.8	2.8
3.3.1		0.6	1.8
3.3.3		0.9	
3.3.4		0.4	0.7
4.4.4	0.0	0.2	
4.5.4		0.2	
5.3.0	0.0	0.2	
5.4.1	0.9	0.1	0.1
5.4.2	0.1	1.4	
5.5.2		0.2	
5.5.3	0.5	1.9	2.1
5.5.5		10.0	10.0
5.8.0		7.2	10.0
5.8.2	0.4	7.0	2.2
6.1.1		0.2	0.3

Geologic Boundary Rankings

GEOLOGIC BOUNDARY

Category Range	Landslide Ranking	Sheet Ranking	Gully Ranking
within 20 m	4	2.4	2.4
outside 20m	0	0	0

Geologic Structure Boundary Rankings

GEOLOGIC STRUCTURE

Category Range	Landslide Ranking
within 200 m	5
outside 200m	0

Waterways Buffer Rankings

WATERWAYS BOUNDARY

Category Range	Landslide Ranking	Sheet Ranking	Gully Ranking
within 20 m	4.0	5.5	6.5
outside 20m	0.0		
within 40 m		6.0	7.0
within 60 m		6.4	7.5

Slope Aspect Rankings

SLOPE ASPECT

Category Range	Landslide Ranking	Sheet Ranking	Gully Ranking
N	2.9	9.0	7.5
NE	4.3	8.0	7.0
E	3.8	8.0	8.0
SE	8.2	8.0	9.0
S	8.8	9.0	9.5
SW	10.0	10.0	10.0
W	6.8	10.0	9.0
NW	4.7	10.0	8.0

Geology Slope Angle Rankings (Landslide)

SLOPE

Nh1, Nh4
Pwe

Category Slope Range	Landslide Ranking
0-2	1
2-7	3
7-15	6
15-30	8
30-90	10

SLOPE

Pnd and Qa
Nbh

Category Slope Range	Landslide Ranking
0-2	1
2-7	3
7-15	6
15-30	8
30-90	10

SLOPE

Pwd
Nhp and Na

Category Slope Range	Landslide Ranking
0-2	1
2-8	3
8-18	6
18-35	8
35-90	10

SLOPE

Pon

Category Slope Range	Landslide Ranking
0-2	2
2-5	5
5-10	8
10-20	9
20-90	10

SLOPE

Nh2 and Nh3

Category Slope Range	Landslide Ranking
0-2	1
2-6	5
6-10	8
10-20	9
20-90	10

SLOPE

All Ko
sub classes

Category Slope Range	Landslide Ranking
0-9	
9-14	
14-21	
21-27	
27-45	
45-90	10

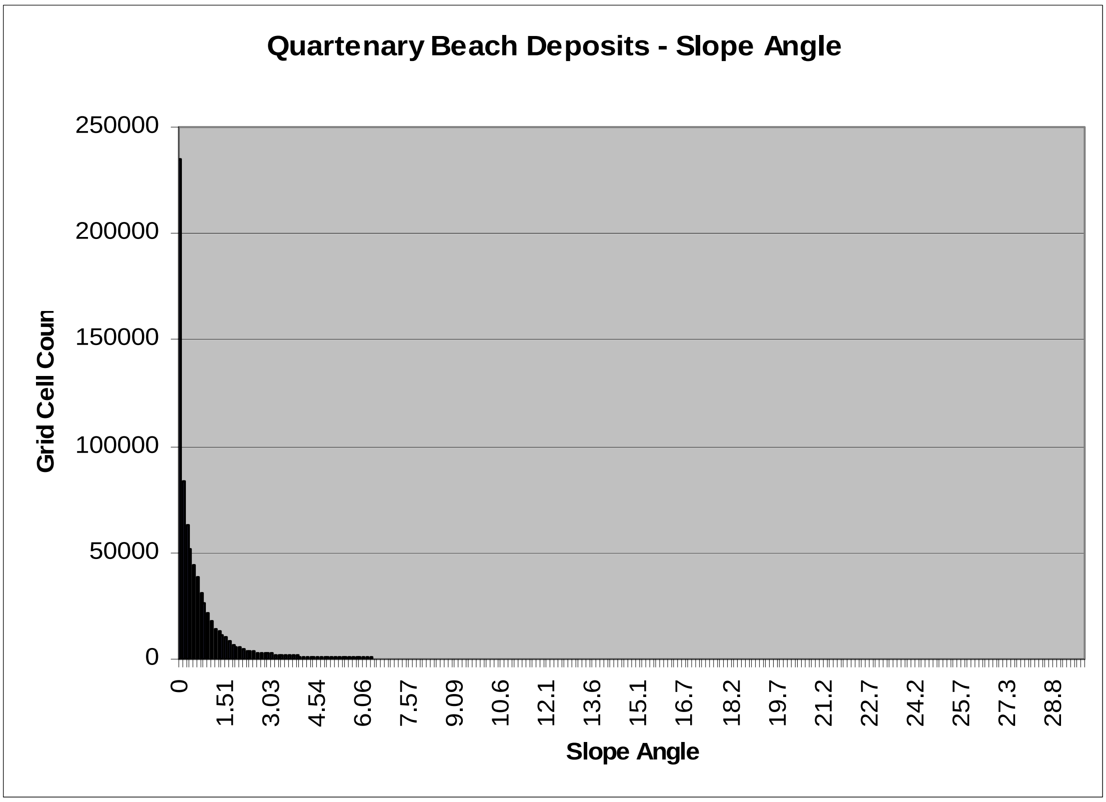
Geology Slope Angle Rankings (erosion)

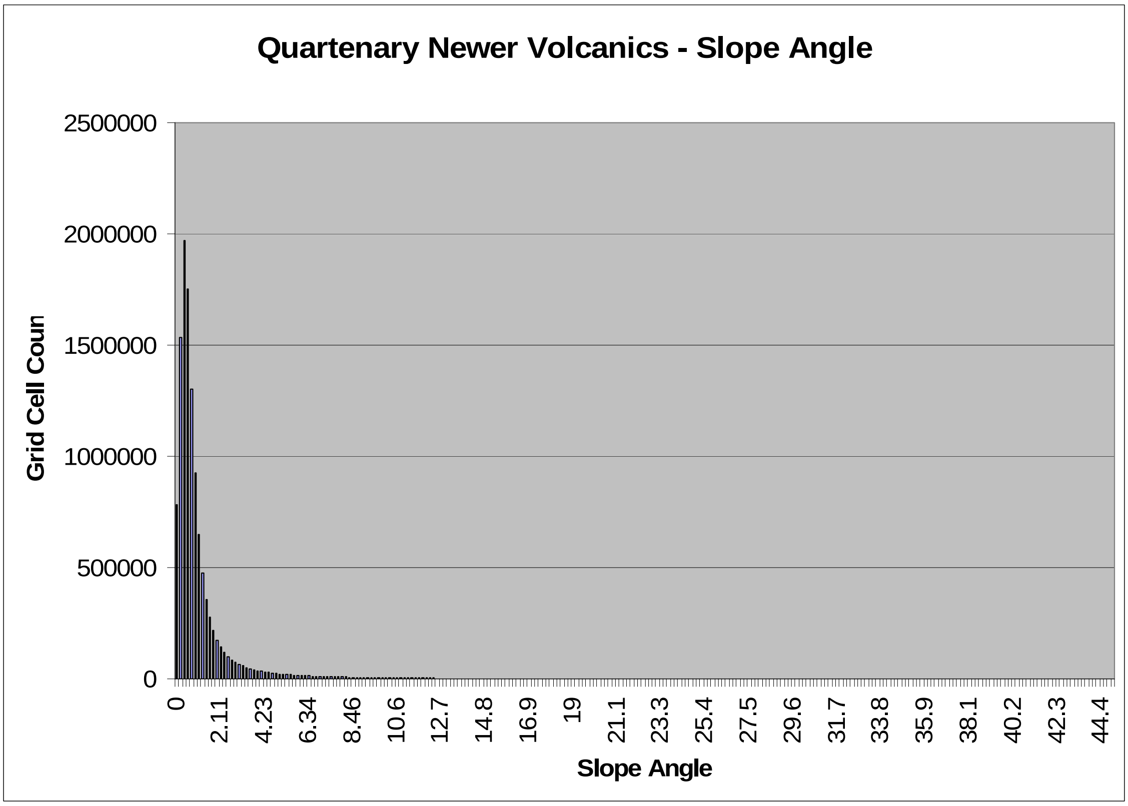
	Category	Group	Sheet Rankings for each slope range (in degrees)								
GEOLOGY	Geol tag		0 to 2	2 to 5	5 to 10	10 to 15	15 to 20	20 to 25	25 to 30	30 to 35	35 to 40
SLOPE	Ocl, Ocd, Oc	Ordovician Marine sedimentary	2.3	3.8	10.0	6.9	2.1	0.3	0.1		
	Nbh	neogene fluvial	7.0	10.0	3.5	1.1	0.2				
	Qn Qns	Quaternary Newer Volcanics	10.0	2.7	3.4	1.4	0.4	0.1			
	Qa Na	Quaternary Non Marine	10.0	2.3	2.8	3.0	0.8	0.2			
	Ko	Cretaceous Otway Group	2.8	5.5	10.0	7.6	3.8	2.4	1.4		0.3
	Nh	Neogene Gellibrand Marl	3.7	5.9	10.0	8.9	5.9	2.2	0.4		
	Dgl Dge	Devonian Granitic Rocks	3.6	10.0	3.4	0.9	0.0				
	Pnd, Pwd,Pon,Pwp	Palaeogene Marine	2.9	5.2	10.0	8.1	8.6	9.0	2.9		
	Ca	Cambrian	5.2	4.1	7.9	10.0	6.2	1.0			
	Pwe Pa Pxh	Paelaoegene Non Marine	6.7	9.4	10.0	1.7					
	Po	Palaeogene Older Volcanics	0.0	3.3	10.0	7.4	3.8	1.0			
	Qdl	Quaternary Beach Deposits	4.3	8.6	9.0	4.3	8.6	10.0	2.9		
	Nhp	Neogene Pt Campbell Limestone									
	Cxv	Cambrian Volcanics									

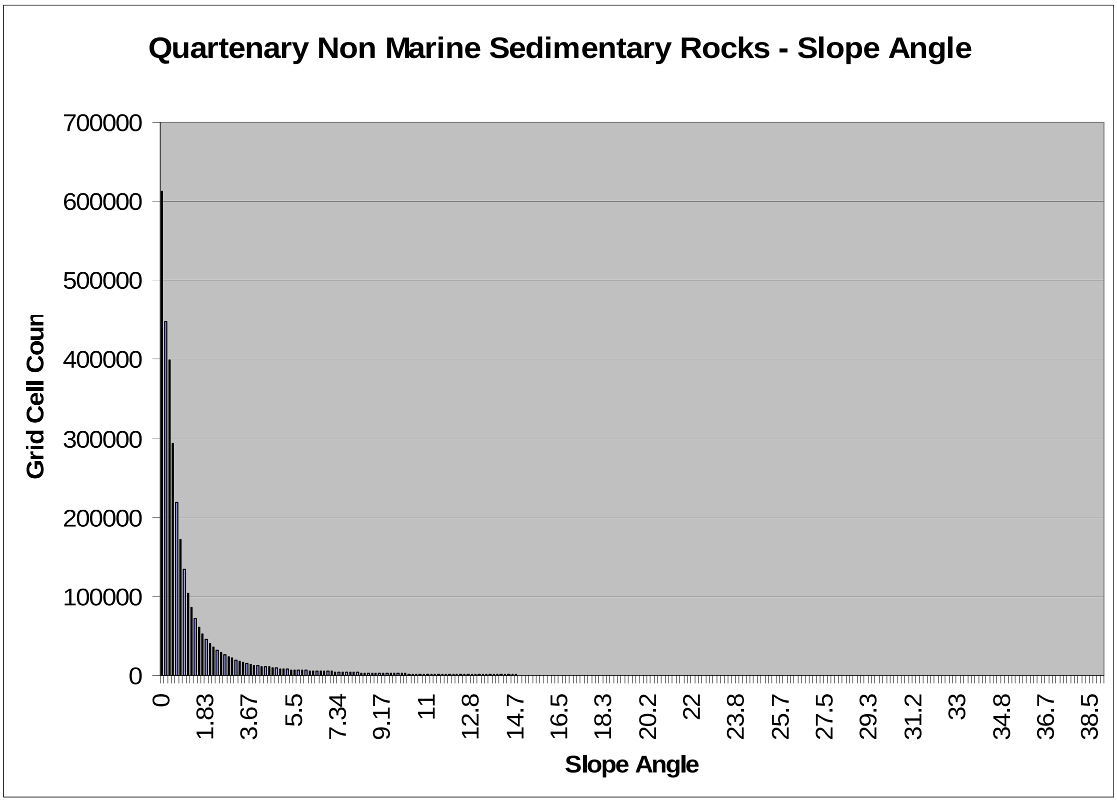
	Category	Group	Gully Rankings for each slope range (in degrees)							
GEOLOGY										
SLOPE	Geol tag		0 to 2	2 to 5	5 to 10	10 to 15	15 to 20	20 to 25	25 to 30	30 to 35
	Oc, Ocd, Oci	Ordovician Marine sediments	3.3	6.7	10.0	6.3	1.7	0.2	0.2	
	Nbh	Neogene Fluvial sediments	8.1	10.0	5.1	1.3	0.1	0.0	0.2	
	Qn, Qns	Quaternary newer Volcanics	9.8	10.0	7.3	2.3	0.1	0.0		
	Na, Qa	Quaternary Non marine Sediments	10.0	6.7	5.1	2.4	0.8	0.2	0.2	
	Ca	Cambrian sedimentary	1.6	5.8	10.0	5.0	1.0	0.0	0.0	
	Dgl	Devonian Granitic Rocks	3.4	10.0	2.0	0.6				
	Nh	Neogene Gellibrand Marl	8.7	10.0	9.4	2.6	1.3	0.3		
	Ko	Cretaceous	6.7	10.0	6.7	3.6	2.7	0.6		
	Pwe	Palaeogene Non Marine	5.9	10.0	7.6	0.7				
	Po	Palaeogene Older Volcanics	0.5	10.0	9.5	0.2	2.0	0.5		
	Nhp	Neogene Port Campbell	10.0	1.2	2.2	0.4	0.9			
	Qdl	Quaternary Beach deposits	0.0	5.0	5.4	4.3	8.2	10.0	2.9	

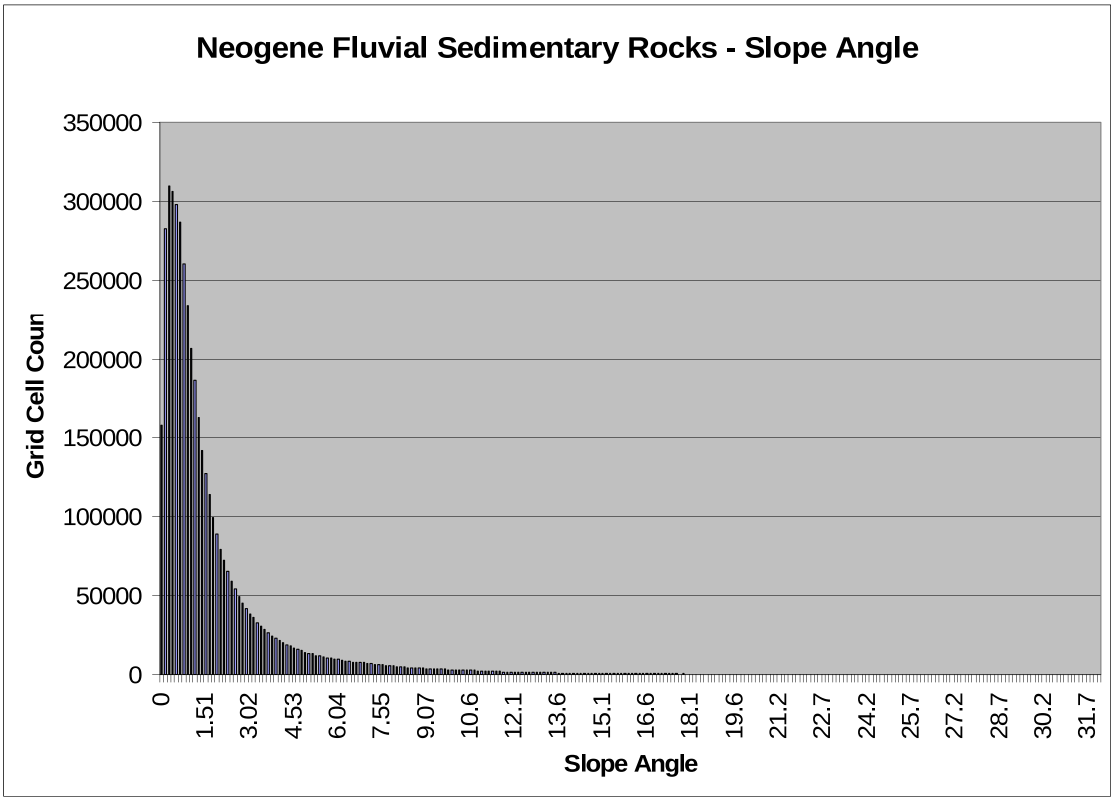
Appendix E

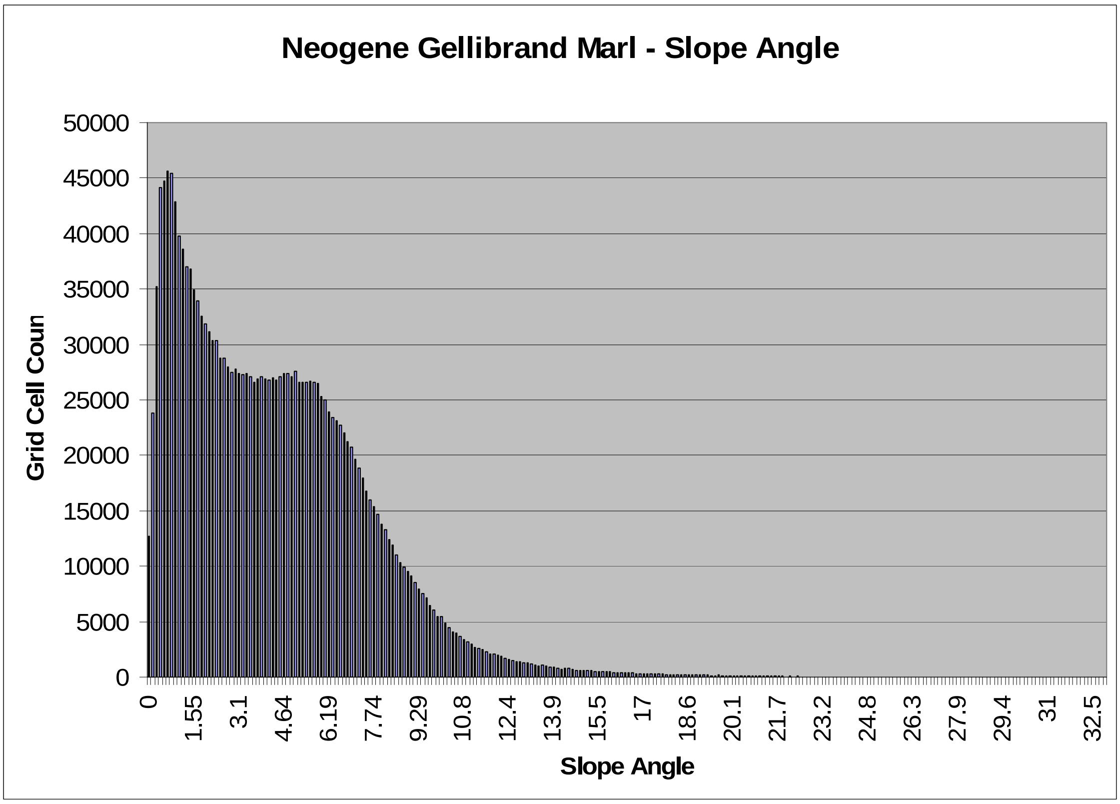
Slope Angle Frequency Histograms

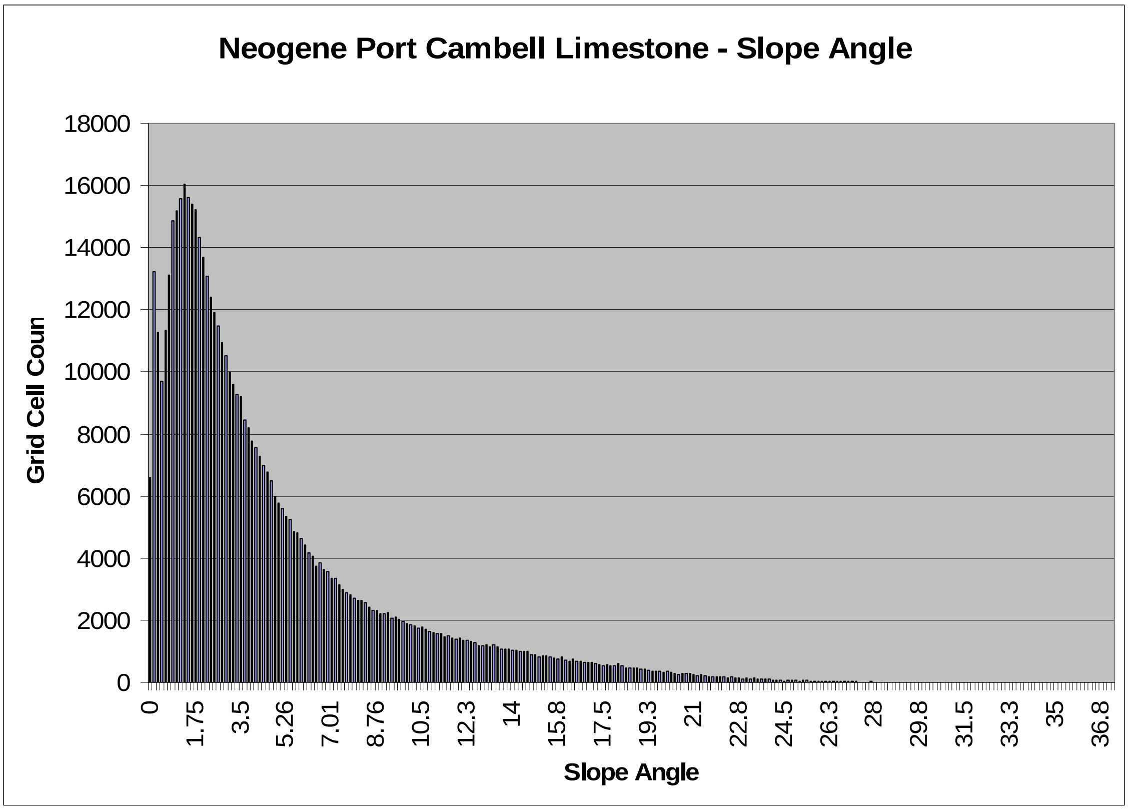

Quartenary Beach Deposits - Slope Angle
Grid Cell Coun
250000
200000
150000
100000
50000
0
0
1.51
3.03
4.54
6.06
7.57
9.09
10.6
12.1
13.6
15.1
16.7
18.2
19.7
21.2
22.7
24.2
25.7
27.3
28.8
Slope Angle

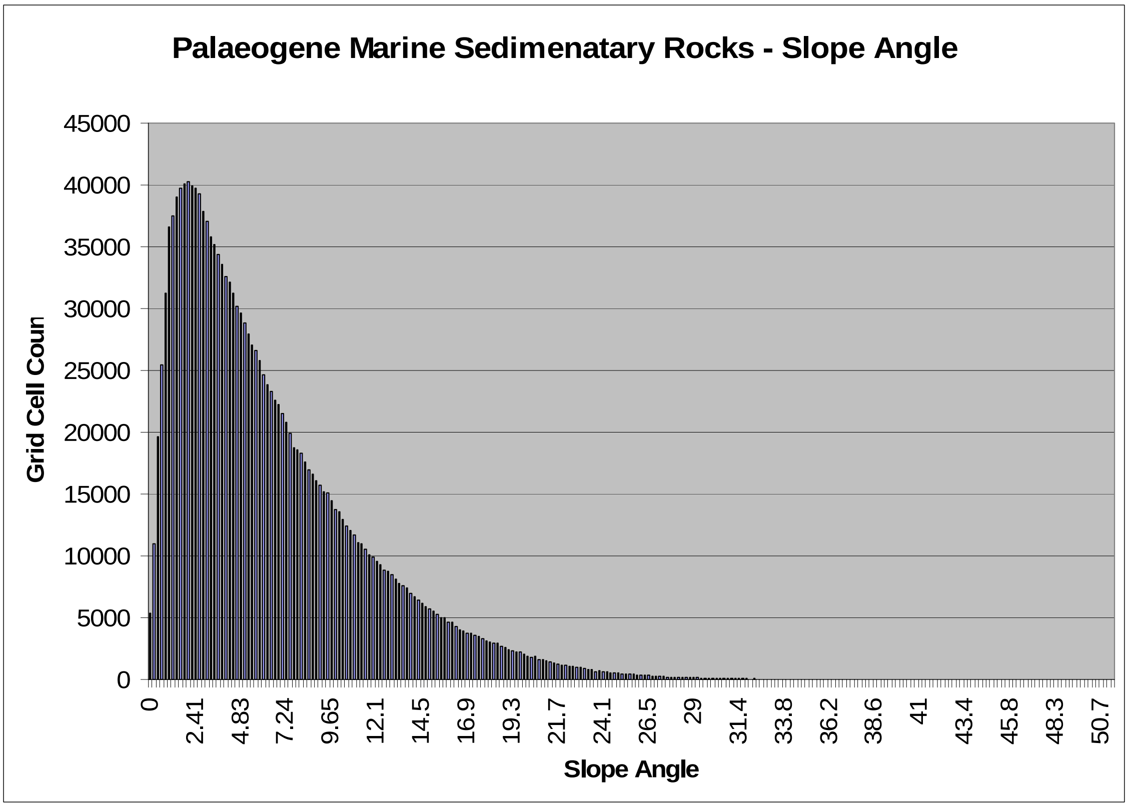

Quartenary Newer Volcanics - Slope Angle
Grid Cell Coun
2500000
2000000
1500000
1000000
500000
0
0
2.11
4.23
6.34
8.46
10.6
12.7
14.8
16.9
19
21.1
23.3
25.4
27.5
29.6
31.7
33.8
35.9
38.1
40.2
42.3
44.4
Slope Angle


Quartenary Non Marine Sedimentary Rocks - Slope Angle
700000
600000
500000
400000
300000
200000
100000
0
Grid Cell Coun
0
1.83
3.67
5.5
7.34
9.17
11
12.8
14.7
16.5
18.3
20.2
22
23.8
25.7
27.5
29.3
31.2
33
34.8
36.7
38.5
Slope Angle

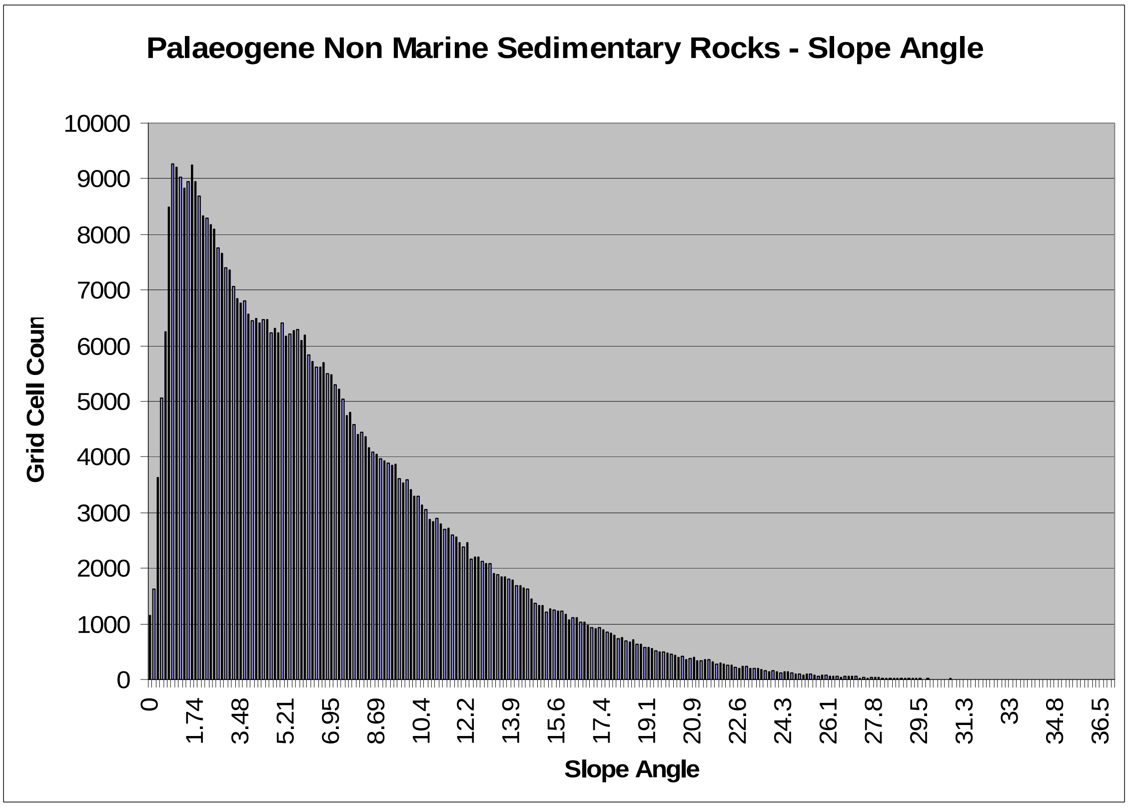

Neogene Fluvial Sedimentary Rocks - Slope Angle
350000
300000
250000
200000
150000
100000
50000
0
Grid Cell Coun
0
1.51
3.02
4.53
6.04
7.55
9.07
10.6
12.1
13.6
15.1
16.6
18.1
19.6
21.2
22.7
24.2
25.7
27.2
28.7
30.2
31.7
Slope Angle


Neogene Gellibrand Marl - Slope Angle
Grid Cell Coun
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
0
1.55
3.1
4.64
6.19
7.74
9.29
10.8
12.4
13.9
15.5
17
18.6
20.1
21.7
23.2
24.8
26.3
27.9
29.4
31
32.5
Slope Angle

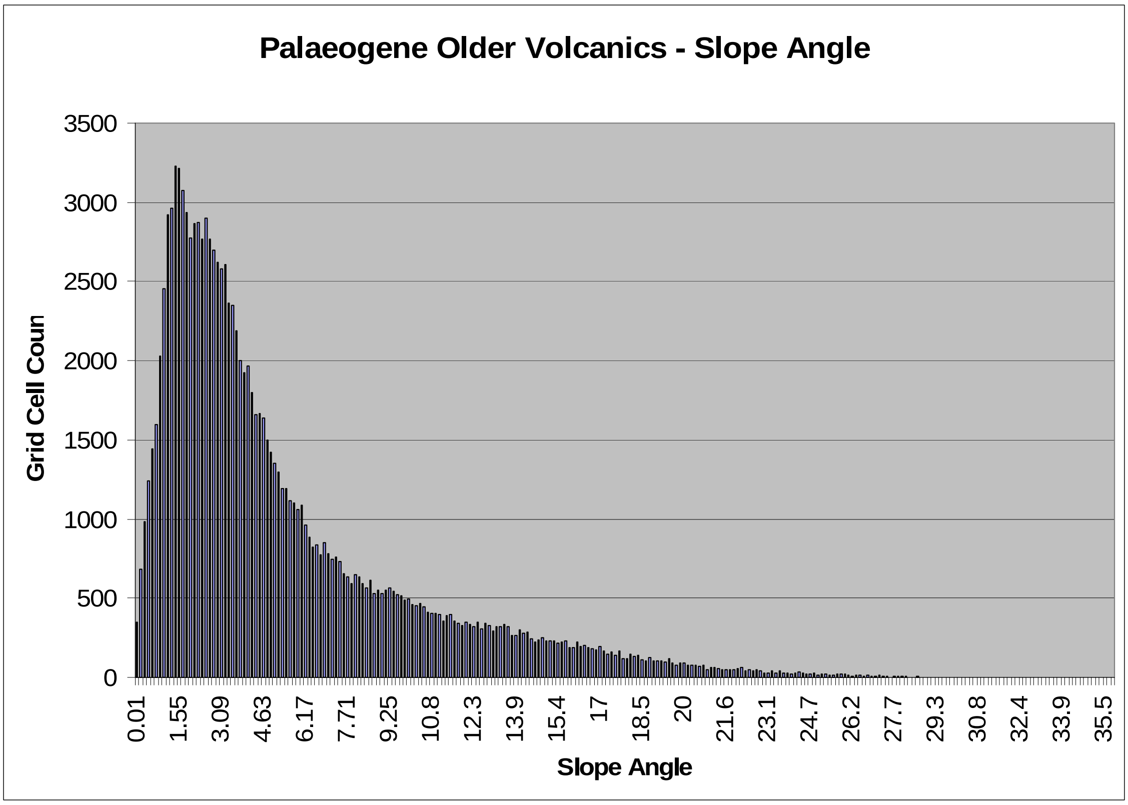

Neogene Port Cambell Limestone - Slope Angle
Grid Cell Coun
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0
1.75
3.5
5.26
7.01
8.76
10.5
12.3
14
15.8
17.5
19.3
21
22.8
24.5
26.3
28
29.8
31.5
33.3
35
36.8
Slope Angle

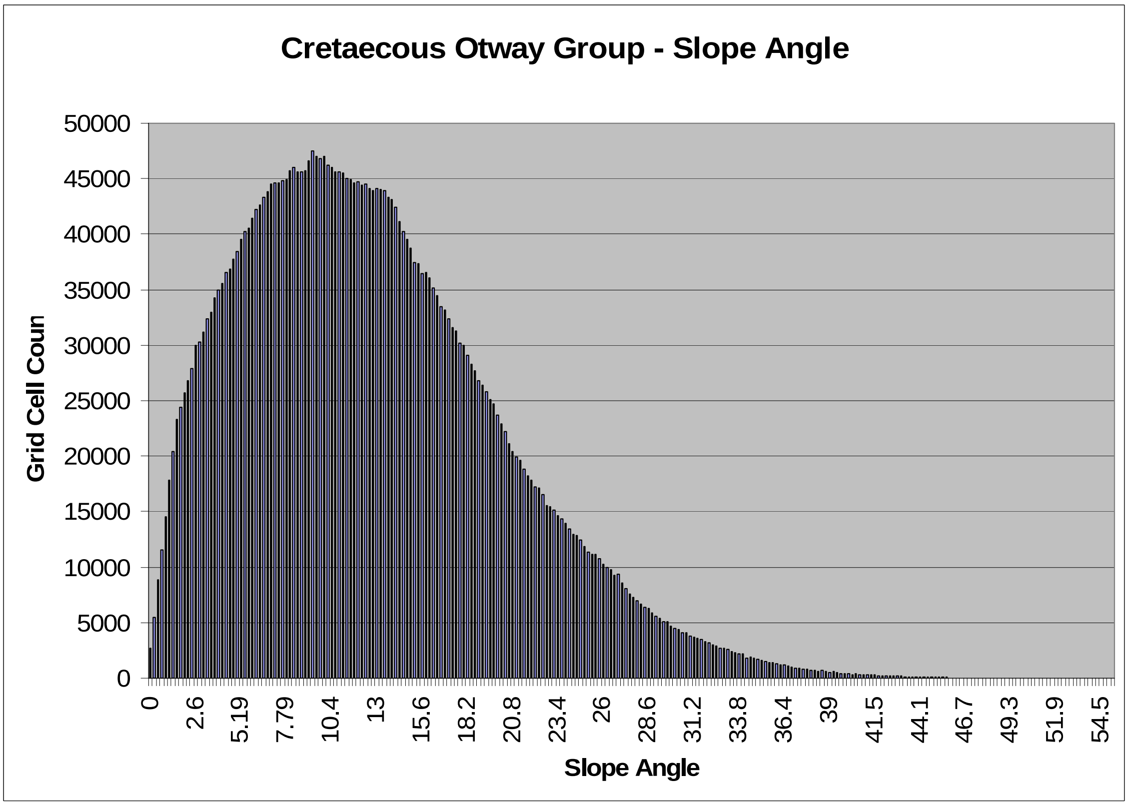


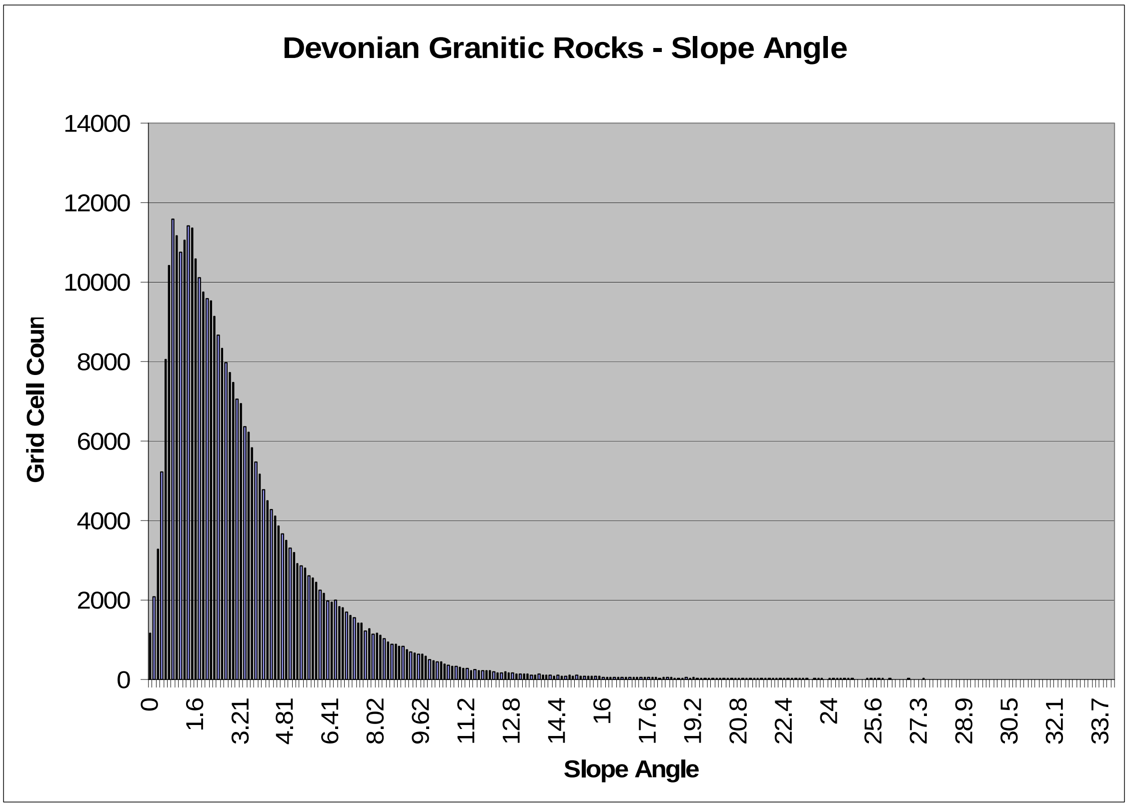
Palaeogene Marine Sedimenatary Rocks - Slope Angle
Grid Cell Coun
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
0
2.41
4.83
7.24
9.65
12.1
14.5
16.9
19.3
21.7
24.1
26.5
29
31.4
33.8
36.2
38.6
41
43.4
45.8
48.3
50.7
Slope Angle

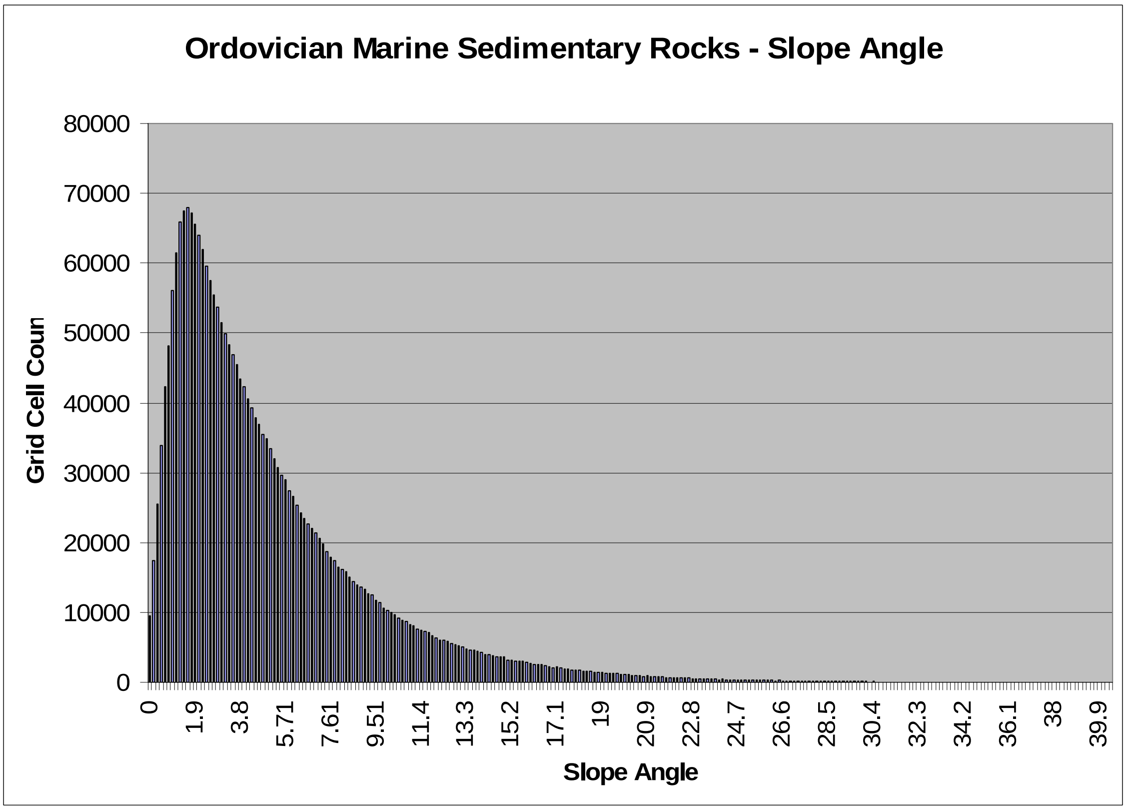


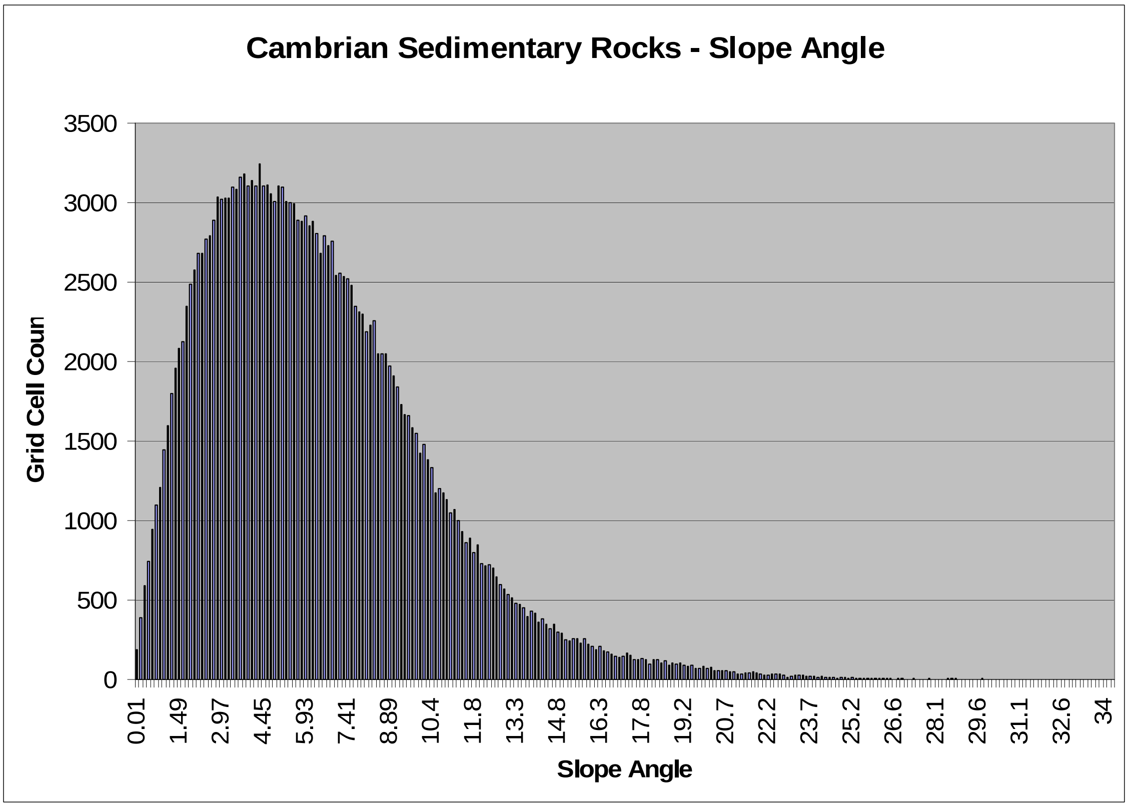
Palaeogene Non Marine Sedimentary Rocks - Slope Angle
Grid Cell Coun
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
1.74
3.48
5.21
6.95
8.69
10.4
12.2
13.9
15.6
17.4
19.1
20.9
22.6
24.3
26.1
27.8
29.5
31.3
33
34.8
36.5
Slope Angle

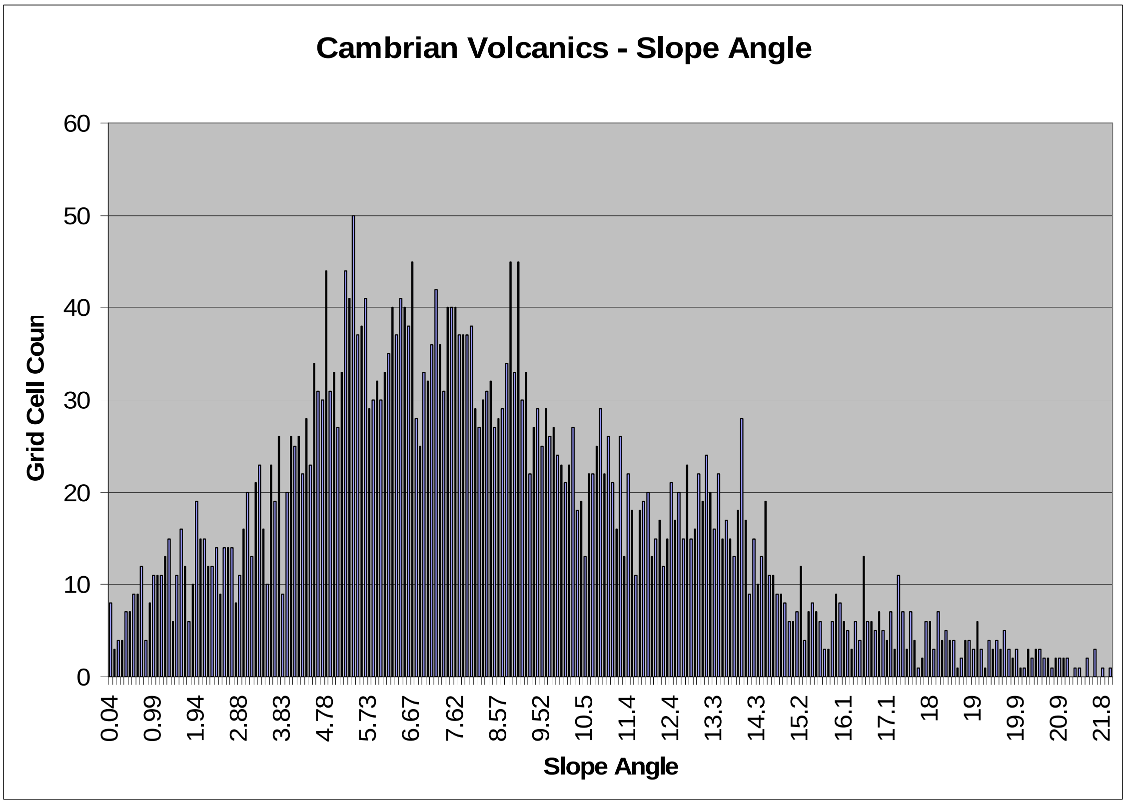

Palaeogene Older Volcanics - Slope Angle
3500
3000
2500
2000
1500
1000
500
0
Grid Cell Coun
0.01
1.55
3.09
4.63
6.17
7.71
9.25
10.8
12.3
13.9
15.4
17
18.5
20
21.6
23.1
24.7
26.2
27.7
29.3
30.8
32.4
33.9
35.5
Slope Angle

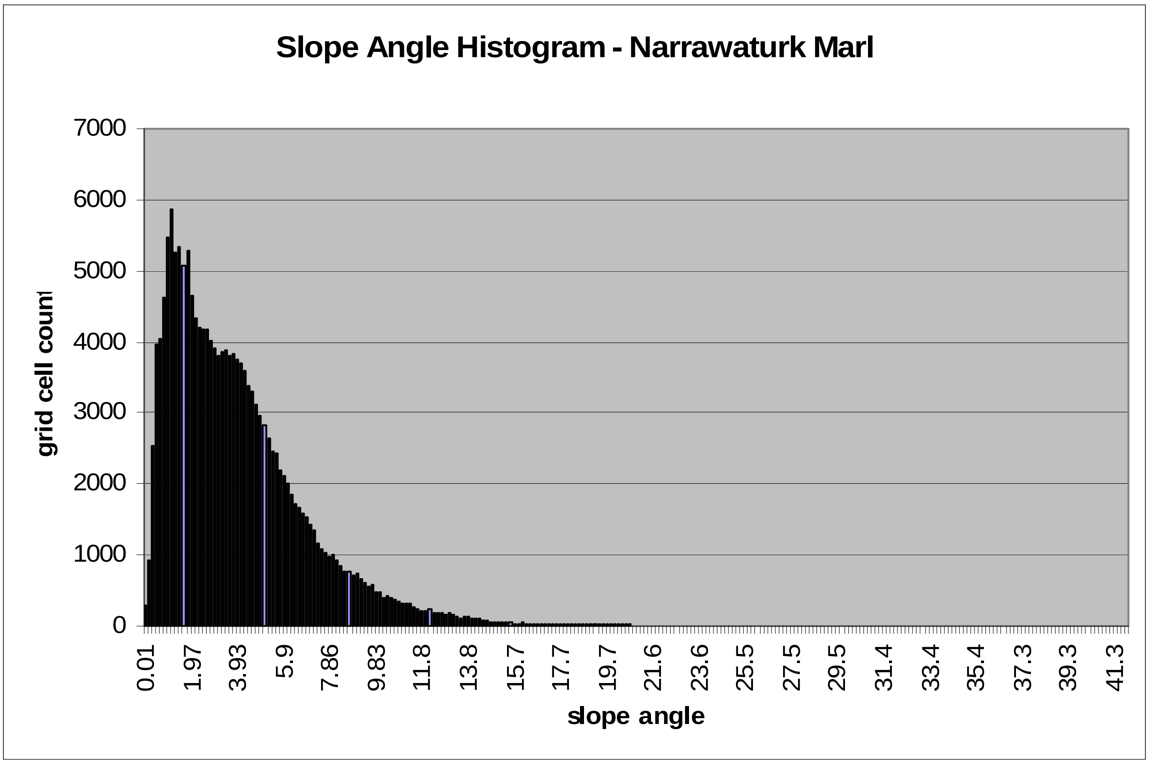

Cretaecous Otway Group - Slope Angle
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Grid Cell Coun
0
2.6
5.19
7.79
10.4
13
15.6
18.2
20.8
23.4
26
28.6
31.2
33.8
36.4
39
41.5
44.1
46.7
49.3
51.9
54.5
Slope Angle

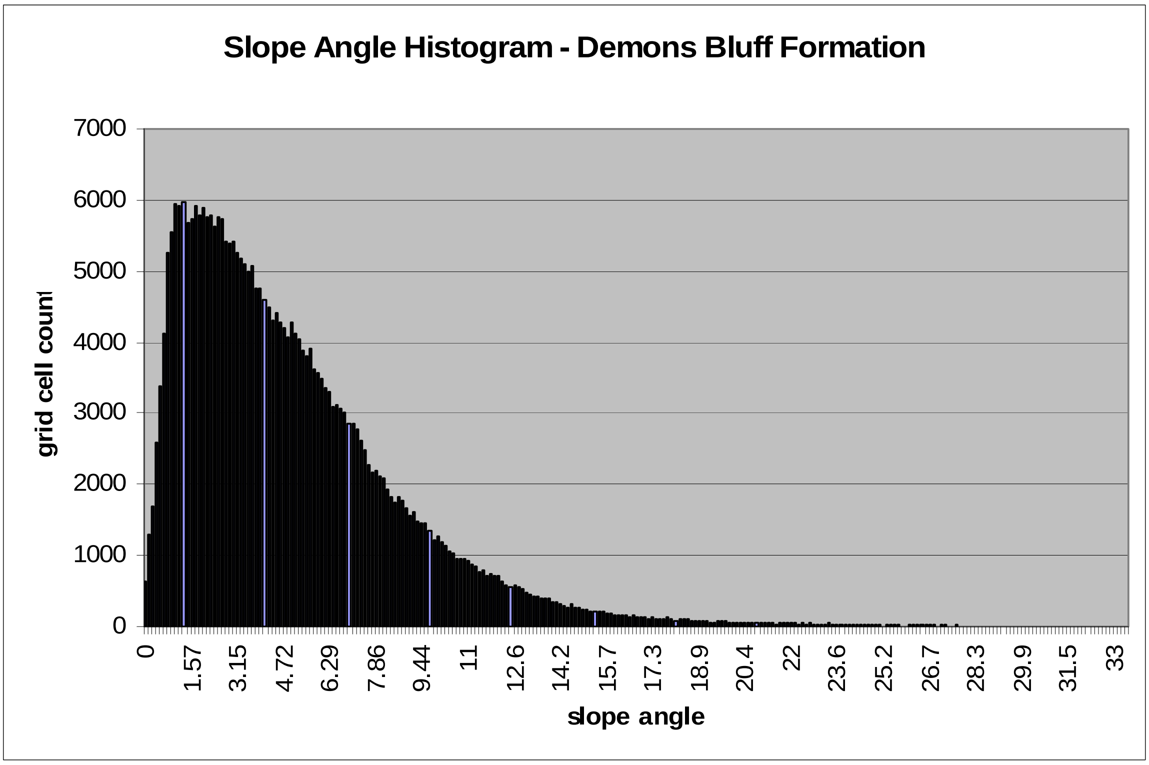

Devonian Granitic Rocks - Slope Angle
14000
12000
10000
8000
6000
4000
2000
0
Grid Cell Coun
0
1.6
3.21
4.81
6.41
8.02
9.62
11.2
12.8
14.4
16
17.6
19.2
20.8
22.4
24
25.6
27.3
28.9
30.5
32.1
33.7
Slope Angle

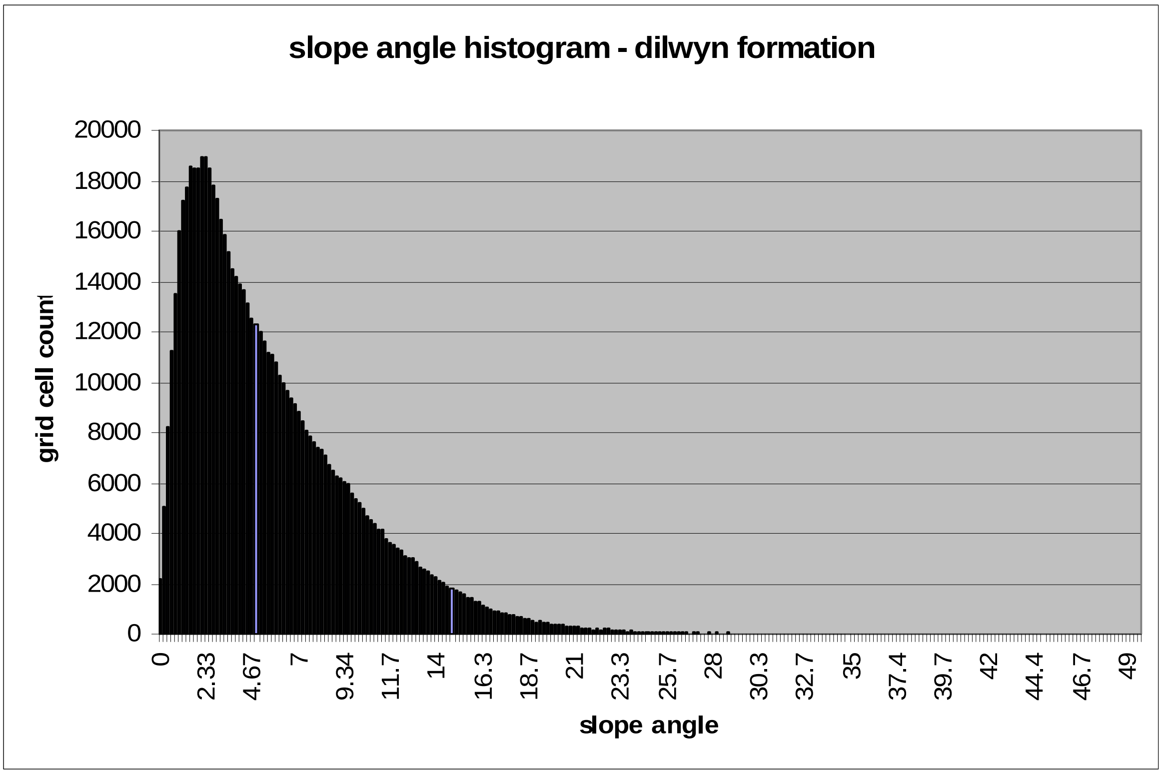

Ordovician Marine Sedimentary Rocks - Slope Angle
80000
70000
60000
50000
40000
30000
20000
10000
0
Grid Cell Coun
0
1.9
3.8
5.71
7.61
9.51
11.4
13.3
15.2
17.1
19
20.9
22.8
24.7
26.6
28.5
30.4
32.3
34.2
36.1
38
39.9
Slope Angle

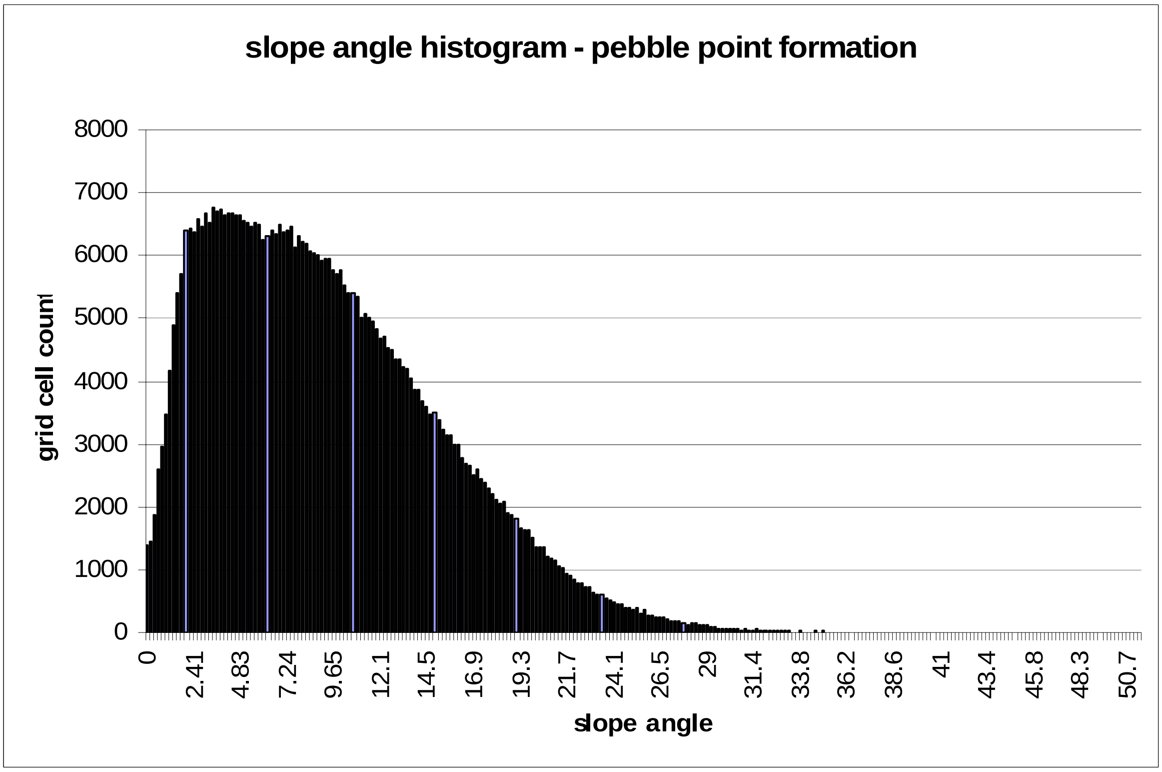

Cambrian Sedimentary Rocks - Slope Angle
Grid Cell Coun
3500
3000
2500
2000
1500
1000
500
0
0.01
1.49
2.97
4.45
5.93
7.41
8.89
10.4
11.8
13.3
14.8
16.3
17.8
19.2
20.7
22.2
23.7
25.2
26.6
28.1
29.6
31.1
32.6
34
Slope Angle


Cambrian Volcanics - Slope Angle
Grid Cell Coun
60
50
40
30
20
10
0
0.04
0.99
1.94
2.88
3.83
4.78
5.73
6.67
7.62
8.57
9.52
10.5
11.4
12.4
13.3
14.3
15.2
16.1
17.1
18
19
19.9
20.9
21.8
Slope Angle

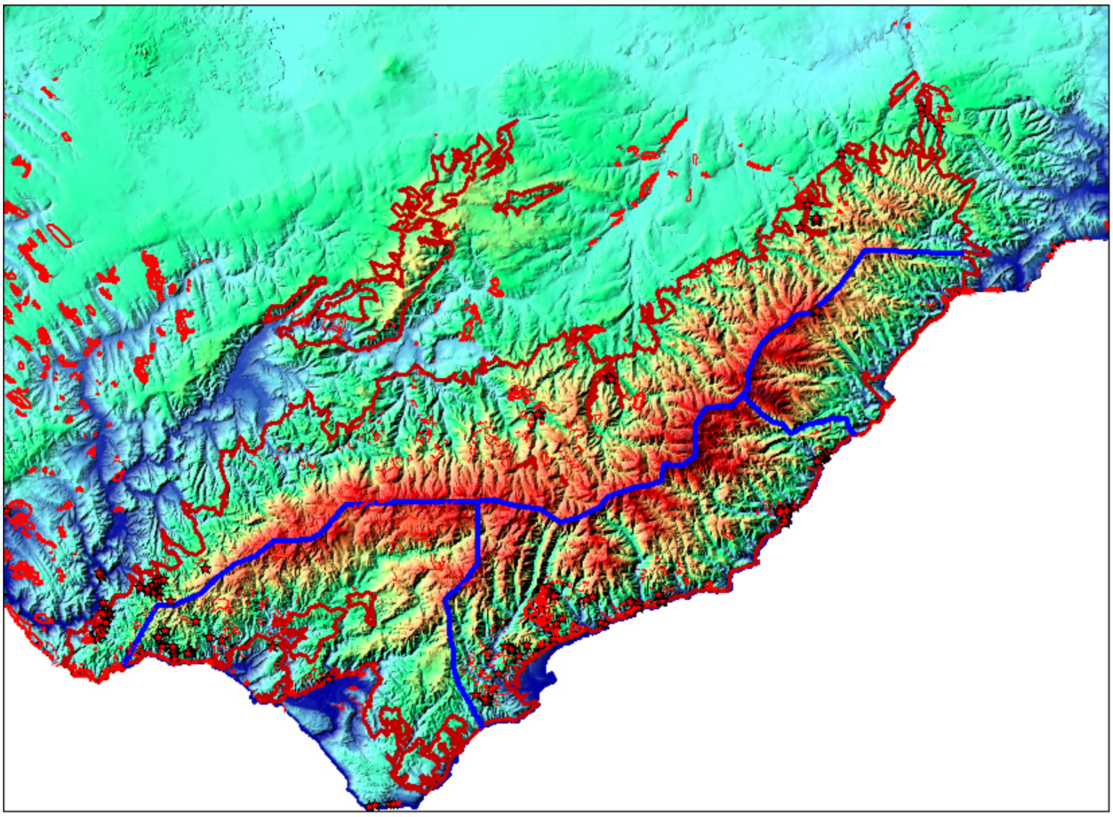

Slope Angle Histogram - Narrawaturk Marl
grid cell count
7000
6000
5000
4000
3000
2000
1000
0
0.01
1.97
3.93
5.9
7.86
9.83
11.8
13.8
15.7
17.7
19.7
21.6
23.6
25.5
27.5
29.5
31.4
33.4
35.4
37.3
39.3
41.3
slope angle


Slope Angle Histogram - Demons Bluff Formation
grid cell count
7000
6000
5000
4000
3000
2000
1000
0
0
1.57
3.15
4.72
6.29
7.86
9.44
11
12.6
14.2
15.7
17.3
18.9
20.4
22
23.6
25.2
26.7
28.3
29.9
31.5
33
slope angle


slope angle histogram - dilwyn formation
grid cell count
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0
2.33
4.67
7
9.34
11.7
14
16.3
18.7
21
23.3
25.7
28
30.3
32.7
35
37.4
39.7
42
44.4
46.7
49
slope angle

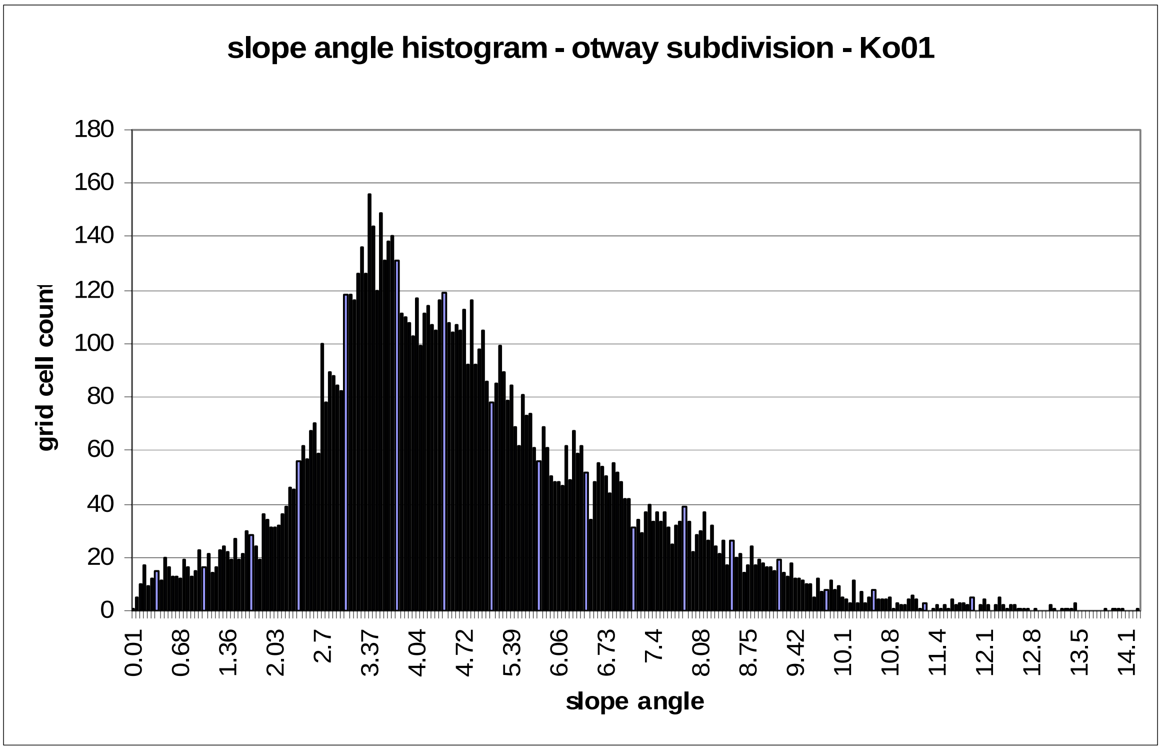

slope angle histogram - pebble point formation
grid cell count
8000
7000
6000
5000
4000
3000
2000
1000
0
0
2.41
4.83
7.24
9.65
12.1
14.5
16.9
19.3
21.7
24.1
26.5
29
31.4
33.8
36.2
38.6
41
43.4
45.8
48.3
50.7
slope angle

Initial Iteration of Cretaceous Otway Group Subdivision

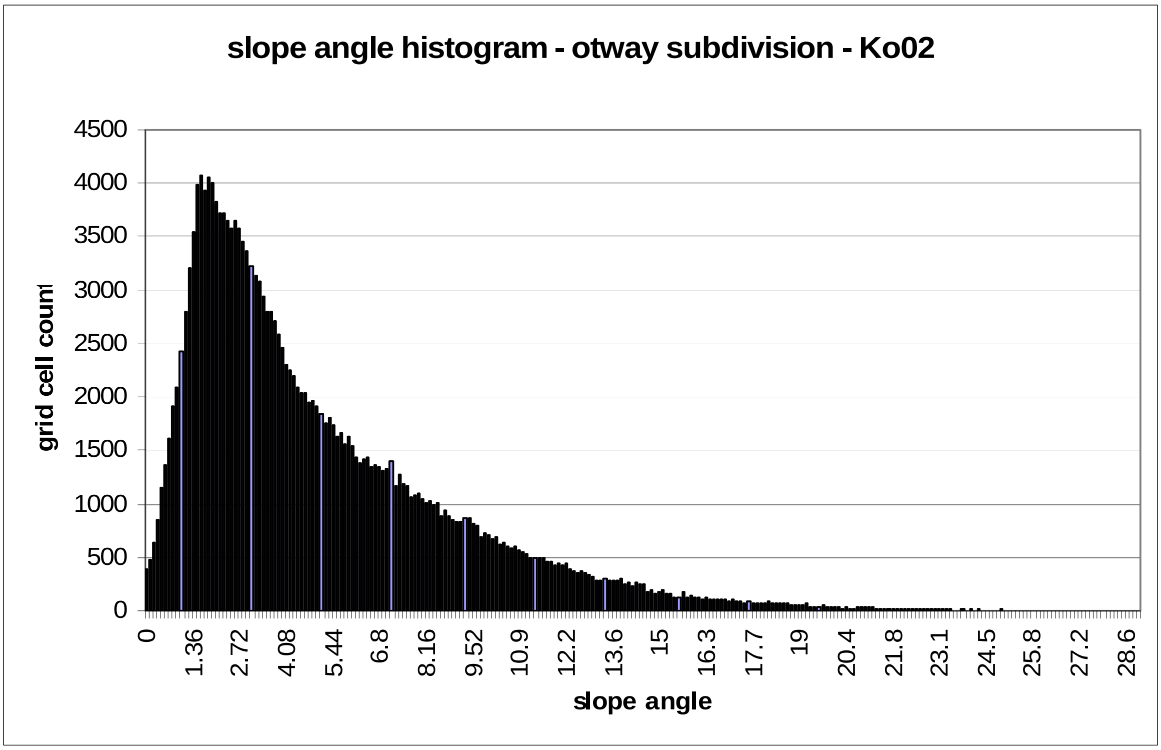


Ko subdivision

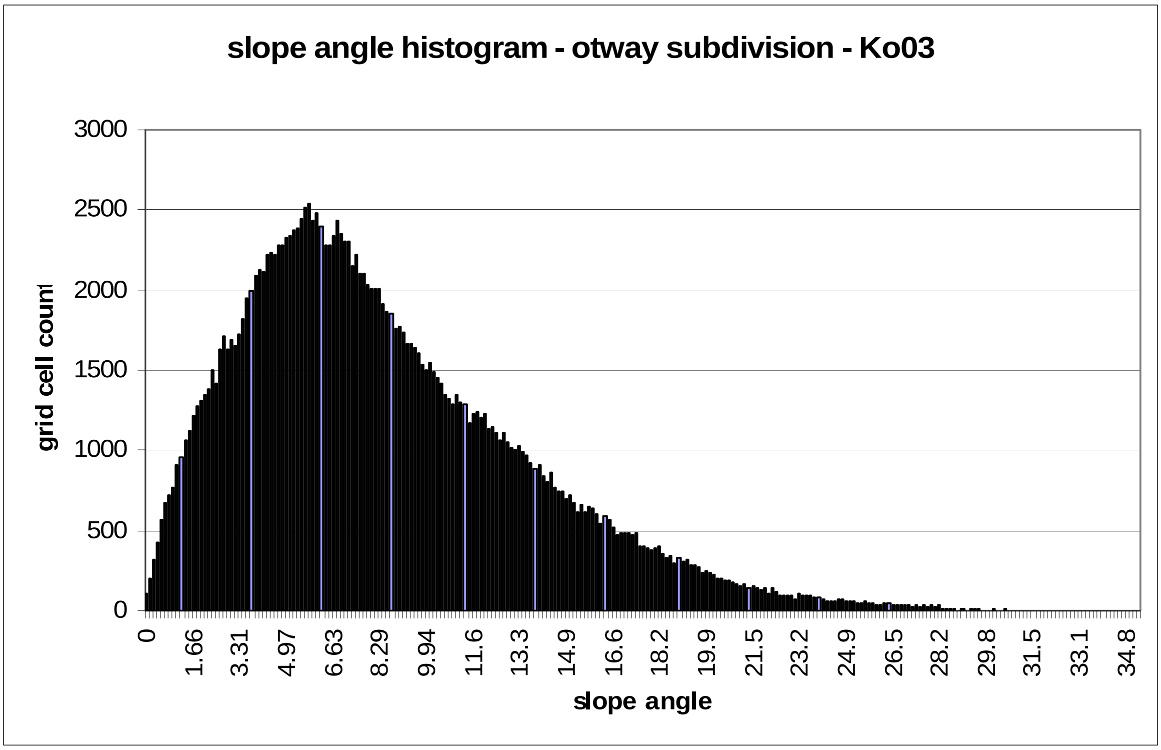
Ko01 Bellarine peninsula
Ko02 Geelong
Ko03 north western outcrop
Ko04 northern ranges
Ko05 Lorne
Ko06 Apollo bay
Ko07 Johanna

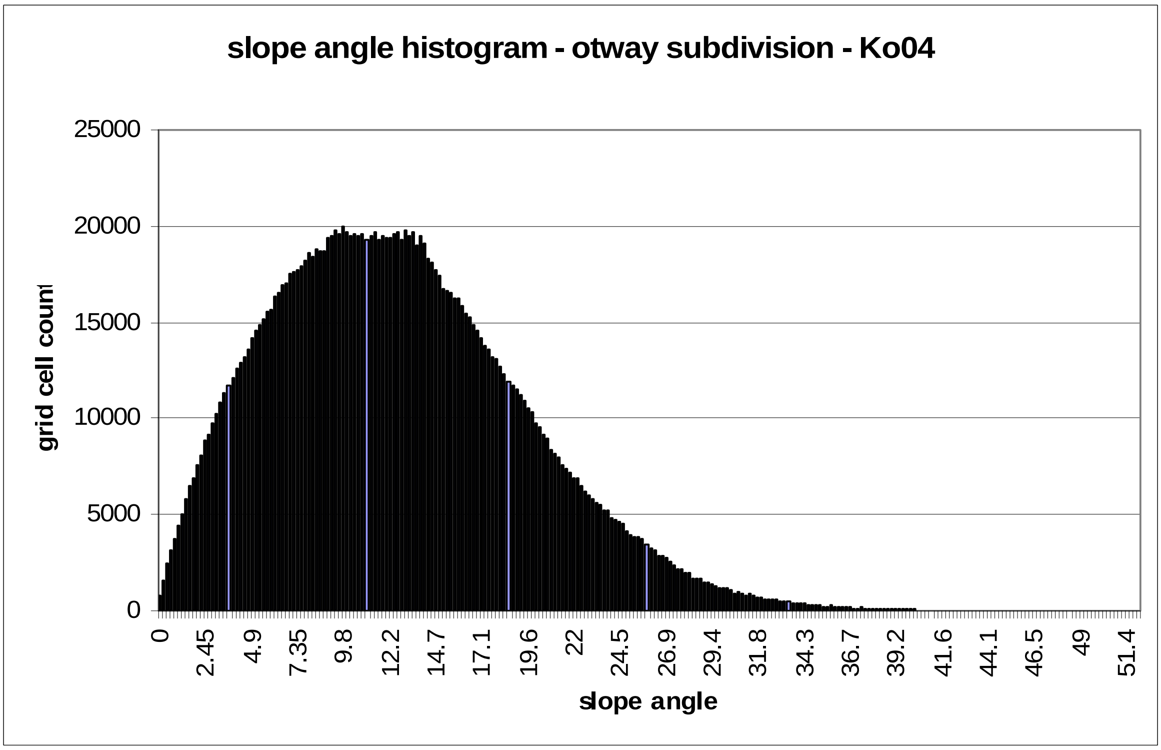


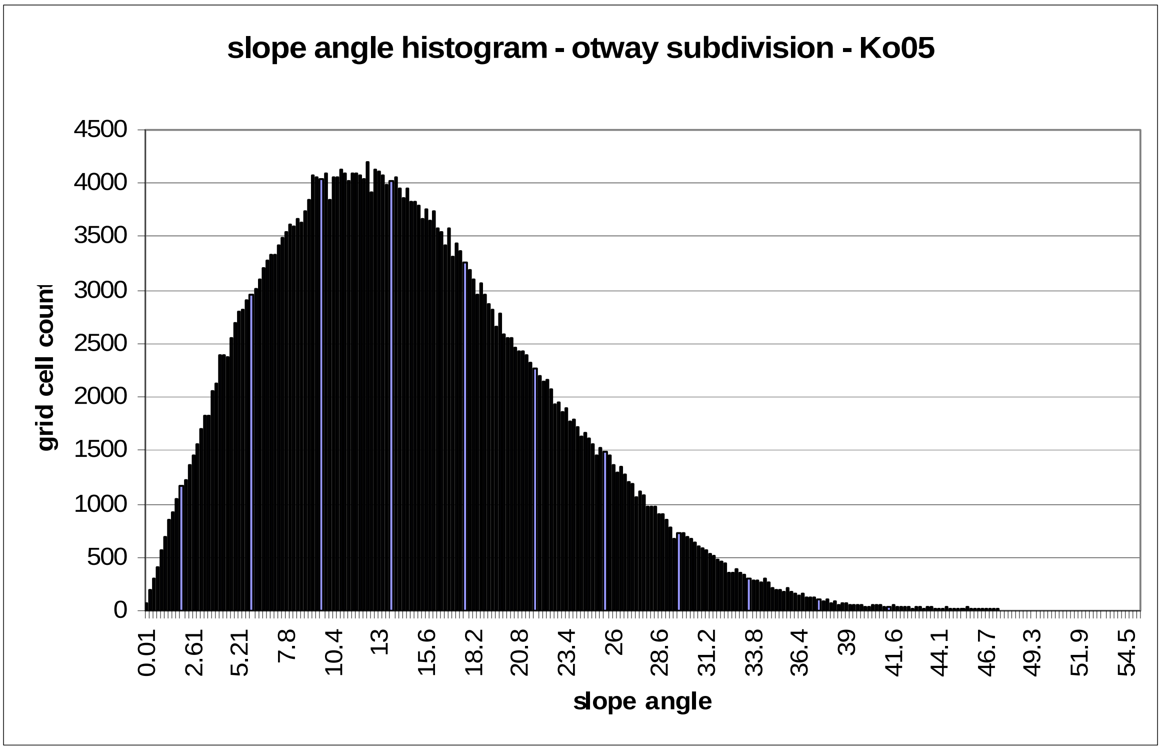
slope angle histogram - otway subdivision - Ko01
grid cell count
180
160
140
120
100
80
60
40
20
0
0.01
0.68
1.36
2.03
2.7
3.37
4.04
4.72
5.39
6.06
6.73
7.4
8.08
8.75
9.42
10.1
10.8
11.4
12.1
12.8
13.5
14.1
slope angle

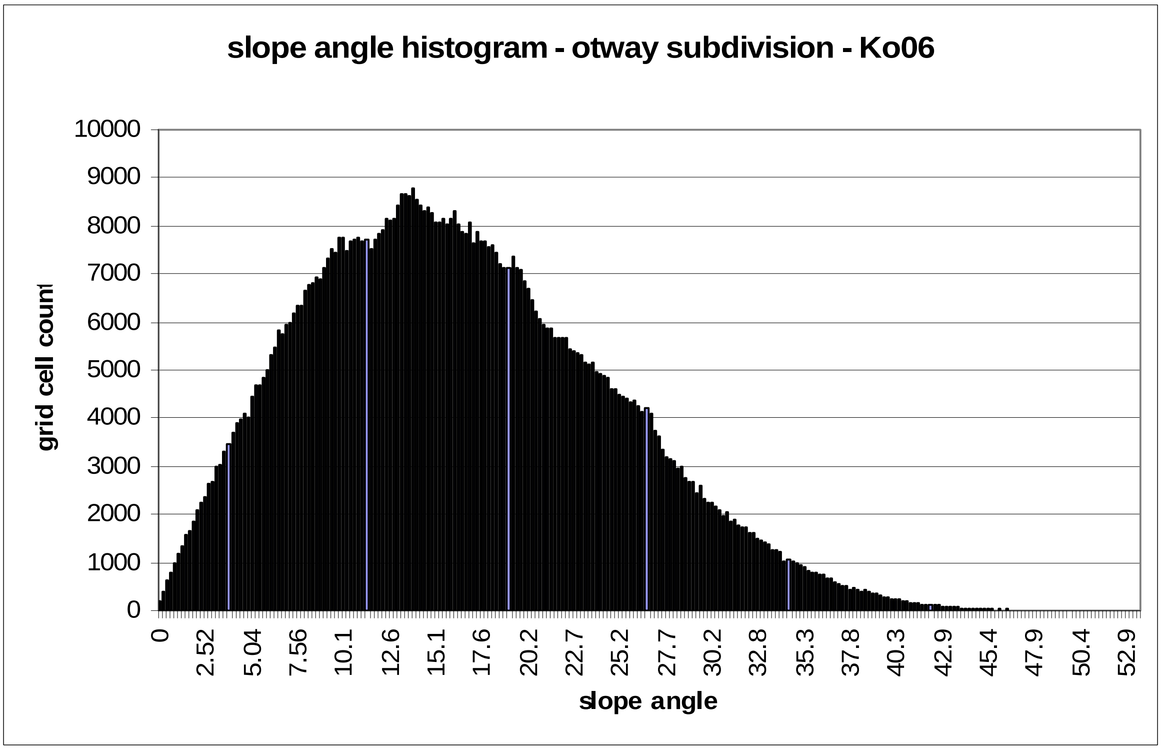


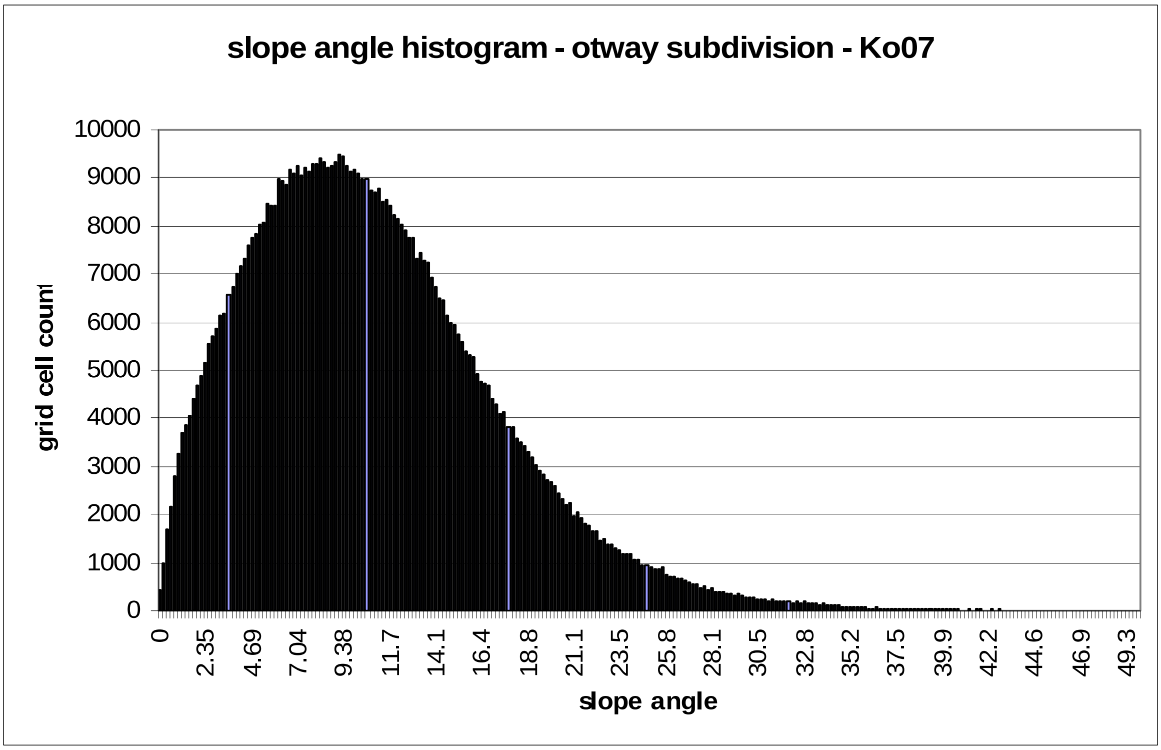
slope angle histogram - otway subdivision - Ko02
grid cell count
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
1.36
2.72
4.08
5.44
6.8
8.16
9.52
10.9
12.2
13.6
15
16.3
17.7
19
20.4
21.8
23.1
24.5
25.8
27.2
28.6
slope angle


slope angle histogram - otway subdivision - Ko03
grid cell count
3000
2500
2000
1500
1000
500
0
0
1.66
3.31
4.97
6.63
8.29
9.94
11.6
13.3
14.9
16.6
18.2
19.9
21.5
23.2
24.9
26.5
28.2
29.8
31.5
33.1
34.8
slope angle


slope angle histogram - otway subdivision - Ko04
grid cell count
25000
20000
15000
10000
5000
0
0
2.45
4.9
7.35
9.8
12.2
14.7
17.1
19.6
22
24.5
26.9
29.4
31.8
34.3
36.7
39.2
41.6
44.1
46.5
49
51.4
slope angle

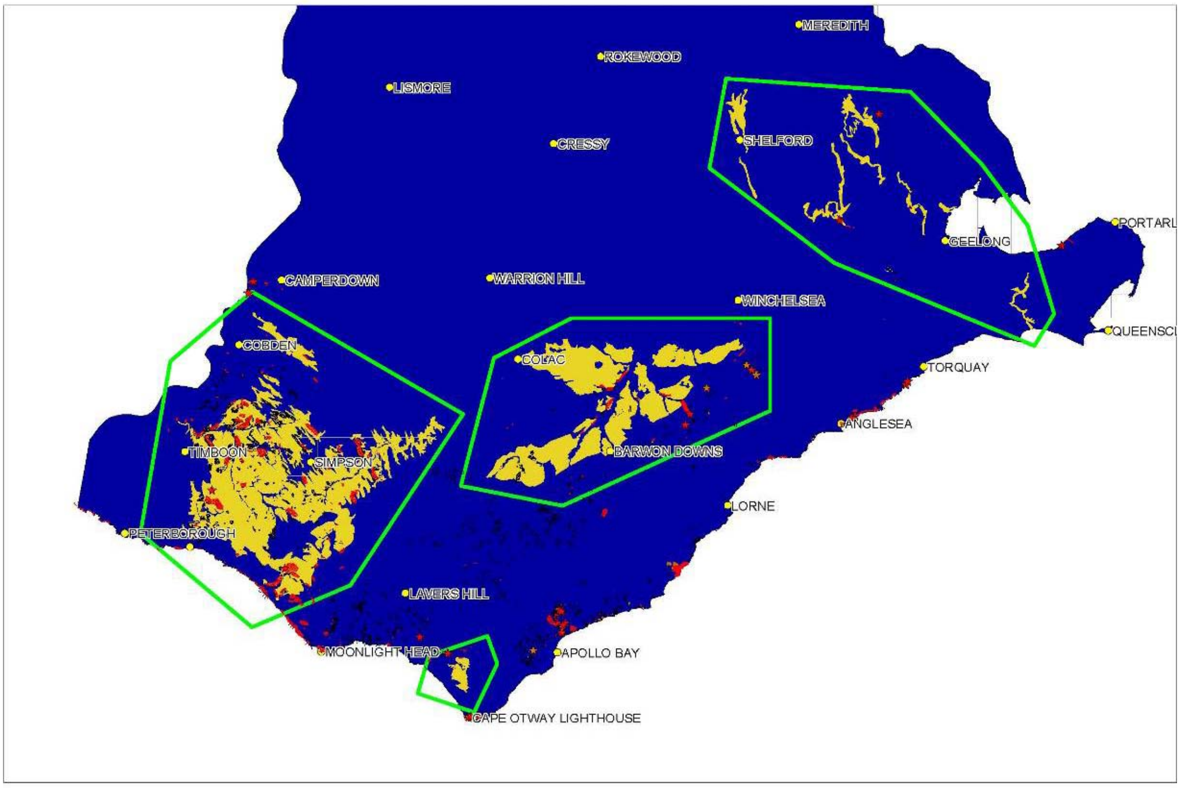

slope angle histogram - otway subdivision - Ko05
grid cell count
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0.01
2.61
5.21
7.8
10.4
13
15.6
18.2
20.8
23.4
26
28.6
31.2
33.8
36.4
39
41.6
44.1
46.7
49.3
51.9
54.5
slope angle


slope angle histogram - otway subdivision - Ko06
grid cell count
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
2.52
5.04
7.56
10.1
12.6
15.1
17.6
20.2
22.7
25.2
27.7
30.2
32.8
35.3
37.8
40.3
42.9
45.4
47.9
50.4
52.9
slope angle



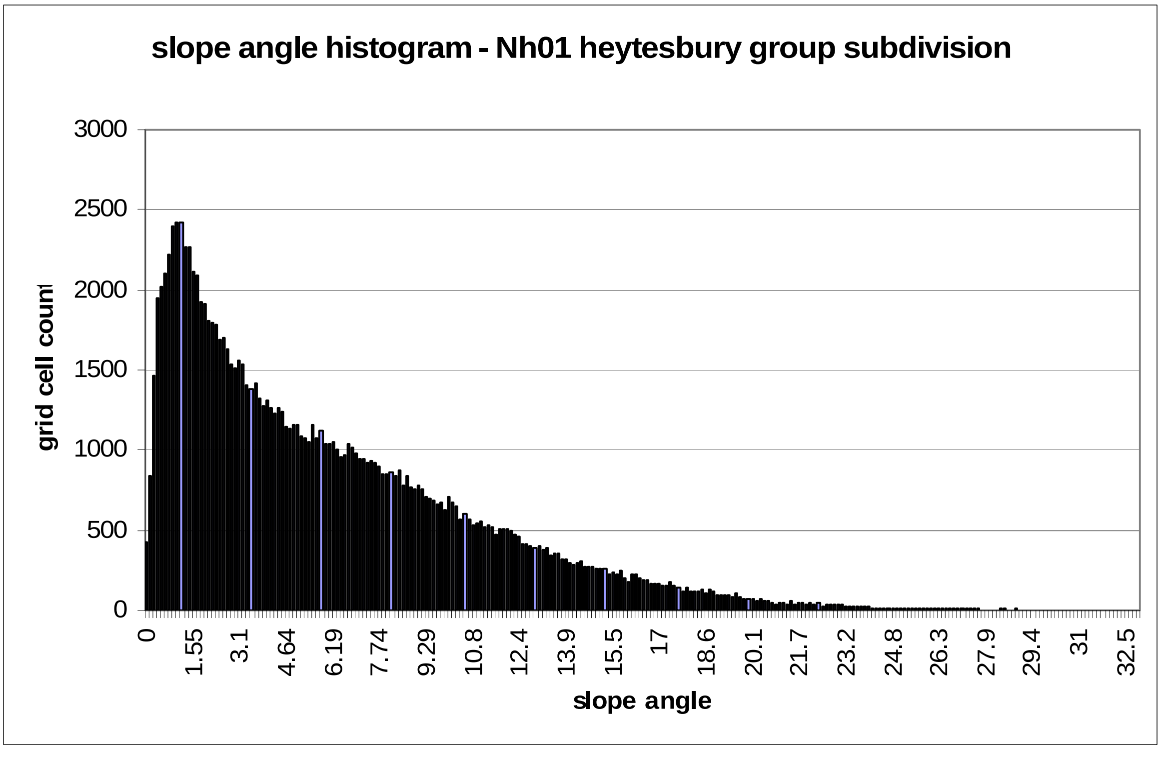
slope angle histogram - otway subdivision - Ko07
grid cell count
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
2.35
4.69
7.04
9.38
11.7
14.1
16.4
18.8
21.1
23.5
25.8
28.1
30.5
32.8
35.2
37.5
39.9
42.2
44.6
46.9
49.3
slope angle

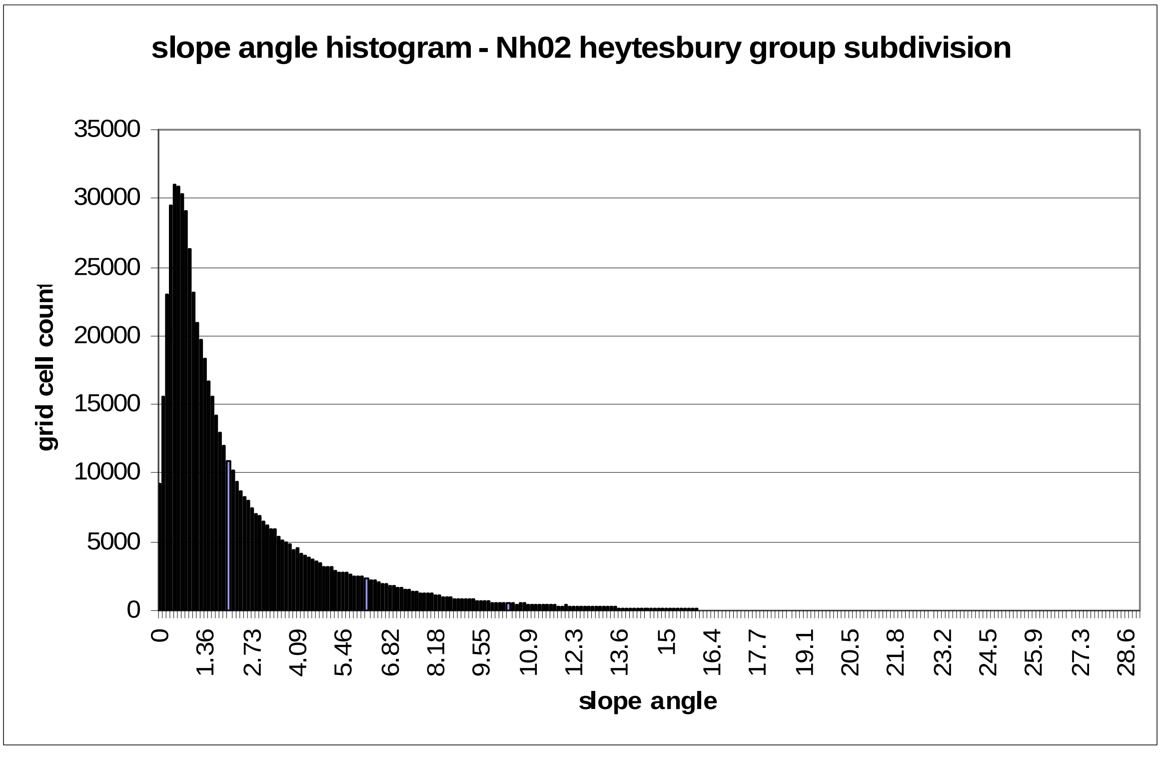
Gellibrand Marl Geology Subdivision

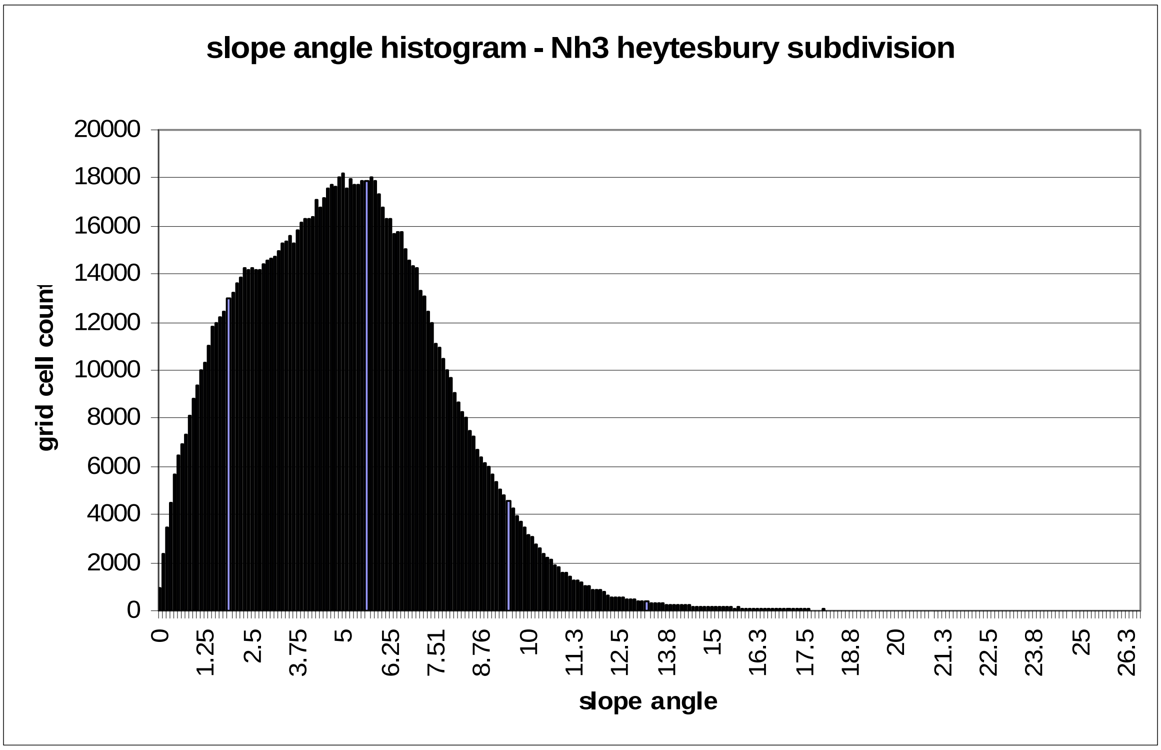


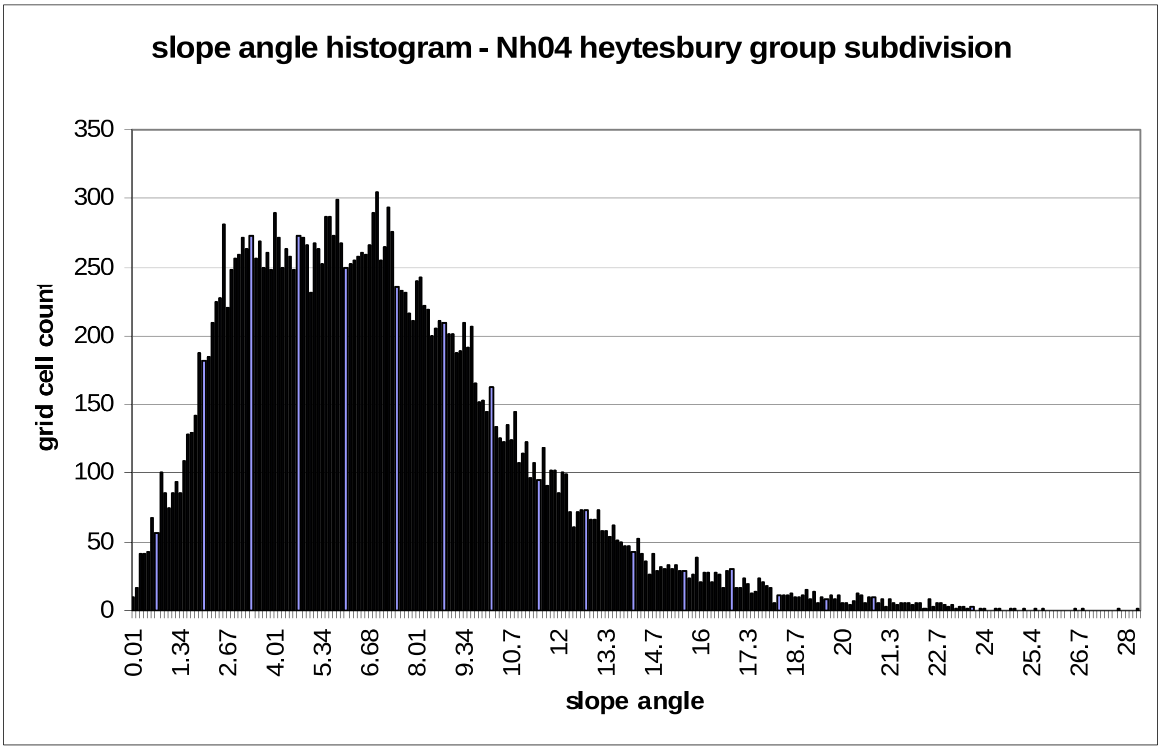
Nh subdivision

Nh01 Geelong Bellarine
Nh02 Kawarren
Nh03 Heytesbury
Nh04 cape Otway


slope angle histogram - Nh01 heytesbury group subdivision
3000
2500
2000
1500
1000
500
0
grid cell count
0
1.55
3.1
4.64
6.19
7.74
9.29
10.8
12.4
13.9
15.5
17
18.6
20.1
21.7
23.2
24.8
26.3
27.9
29.4
31
32.5
slope angle


slope angle histogram - Nh02 heytesbury group subdivision
35000
30000
25000
20000
15000
10000
5000
0
grid cell count
0
1.36
2.73
4.09
5.46
6.82
8.18
9.55
10.9
12.3
13.6
15
16.4
17.7
19.1
20.5
21.8
23.2
24.5
25.9
27.3
28.6
slope angle


slope angle histogram - Nh3 heytesbury subdivision
grid cell count
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0
1.25
2.5
3.75
5
6.25
7.51
8.76
10
11.3
12.5
13.8
15
16.3
17.5
18.8
20
21.3
22.5
23.8
25
26.3
slope angle


slope angle histogram - Nh04 heytesbury group subdivision
grid cell count
350
300
250
200
150
100
50
0
0.01
1.34
2.67
4.01
5.34
6.68
8.01
9.34
10.7
12
13.3
14.7
16
17.3
18.7
20
21.3
22.7
24
25.4
26.7
28
slope angle

Appendix F

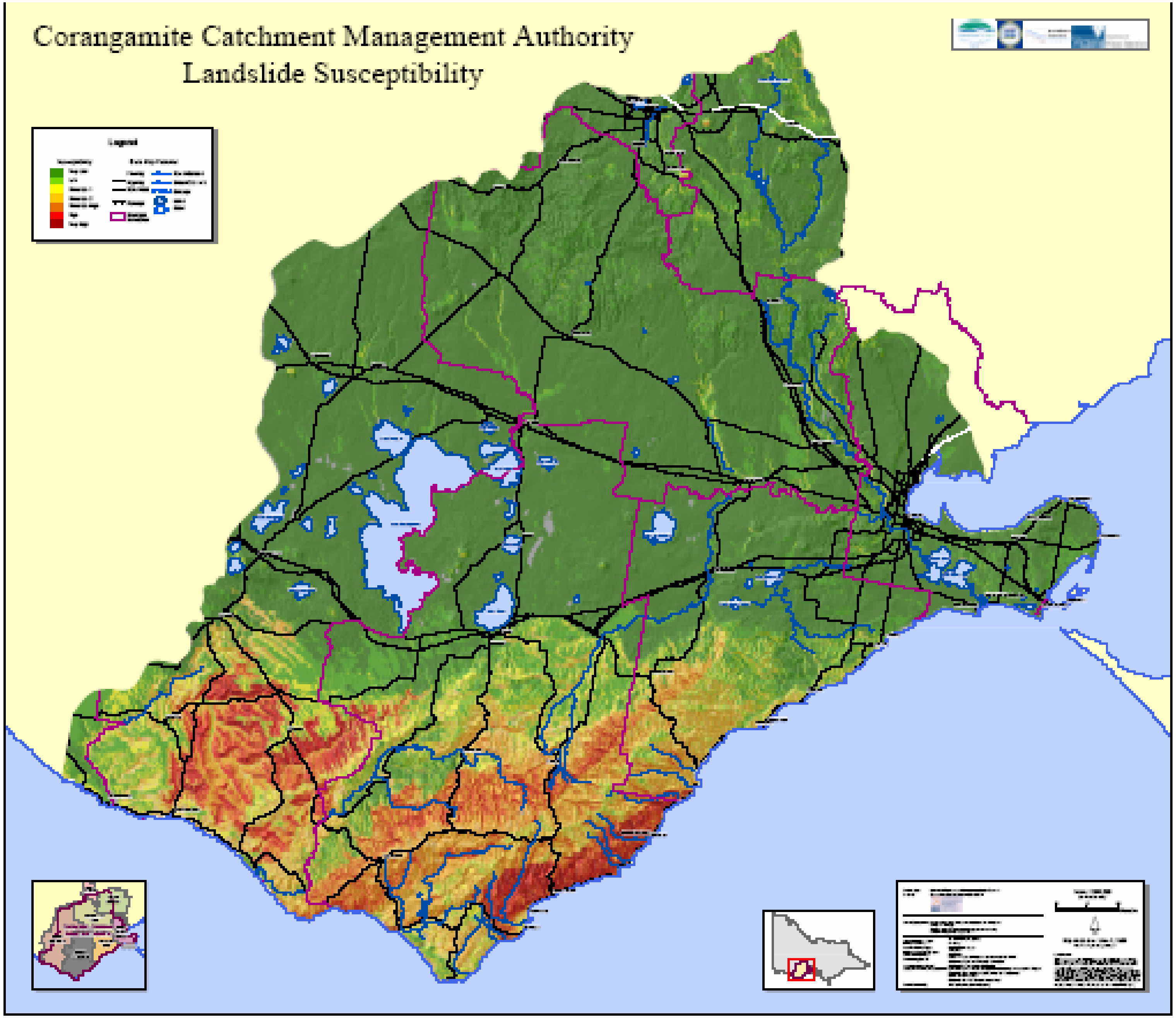
Landslide Susceptibility Maps

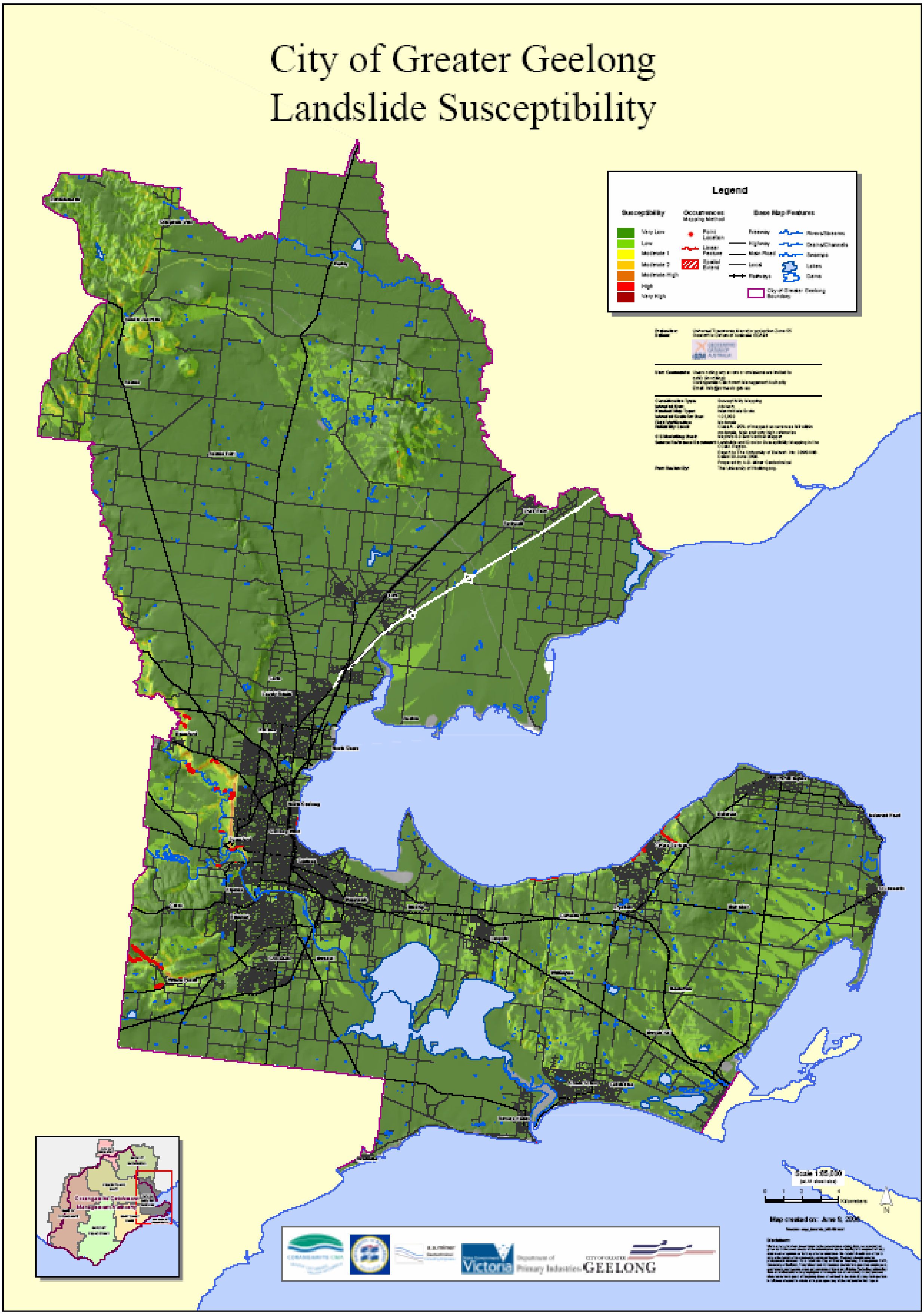
Printed Landslide Susceptibility Maps

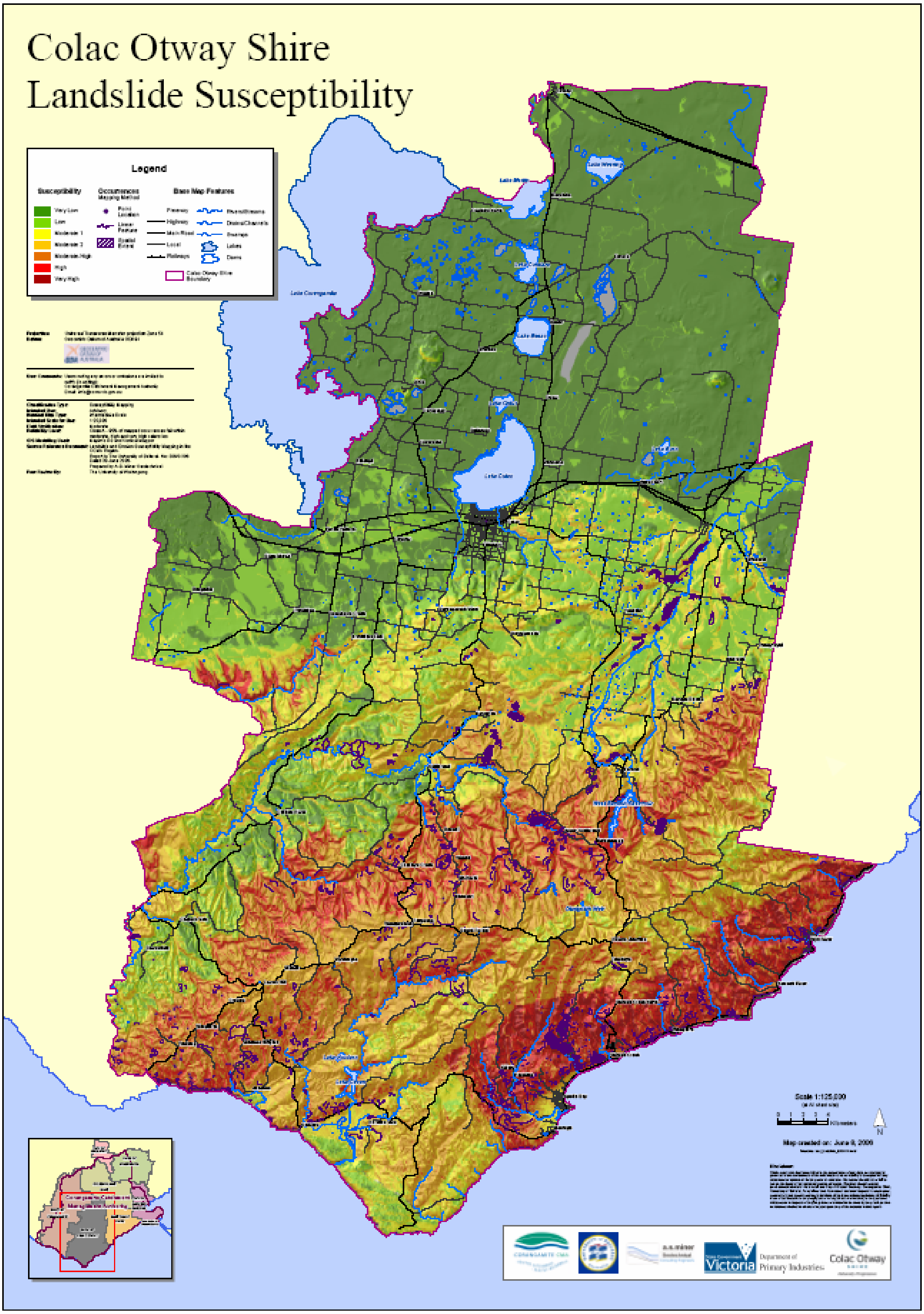
- CCMA Landslide Susceptibility Map 1:250,000 at A0 (printed at A3)
- CoGG Landslide Susceptibility Map 1:85,000 at A1 (printed at A3)
- COS Landslide Susceptibility Map 1:124,000 at A1 (printed at A3)

Additional Maps on the CD as PDF's

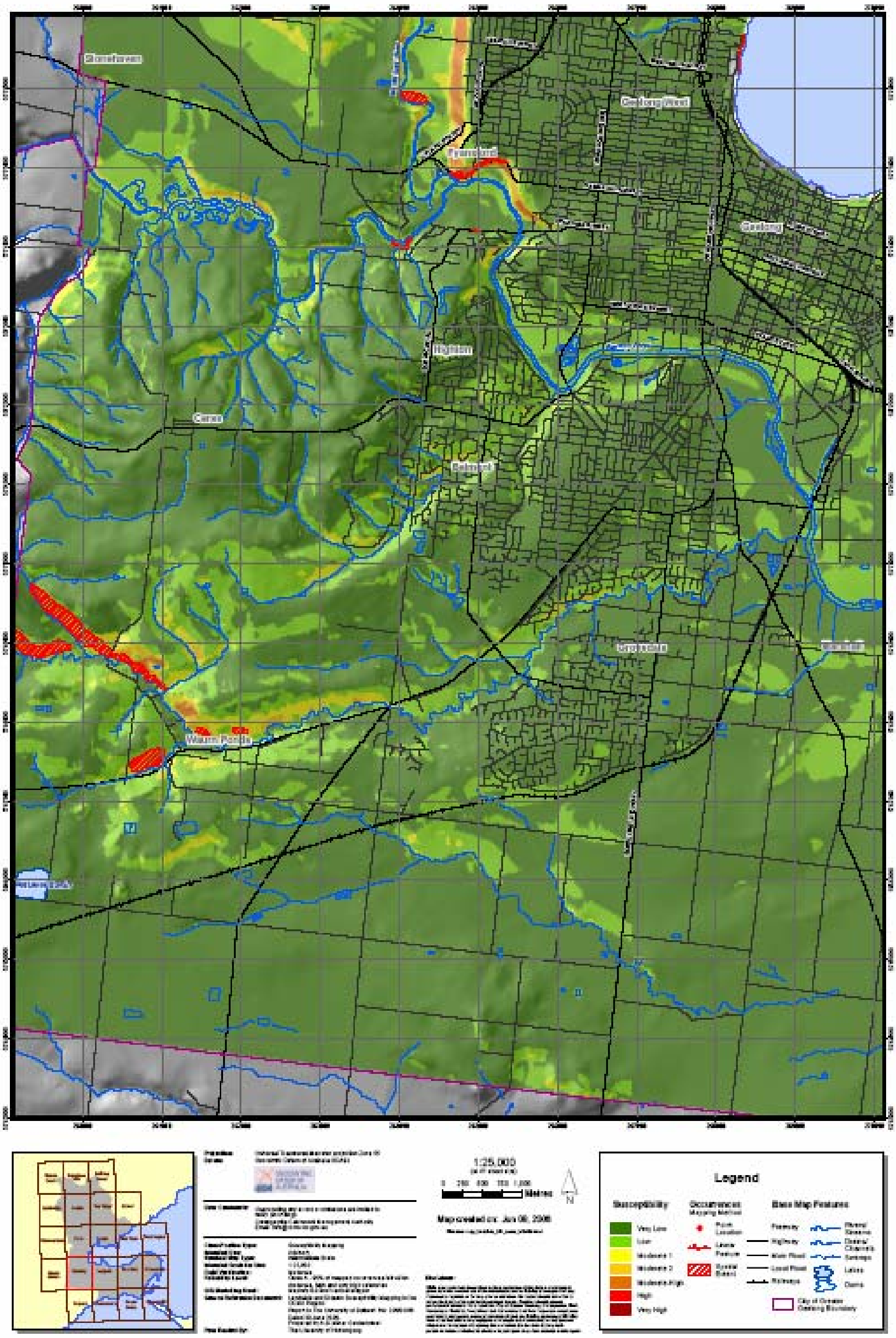
- CoGG 21 x Landslide Susceptibility Maps 1:25,000 at A1 (1 example printed at A3)
- COS 35 x Landslide Susceptibility Maps 1:25,000 at A1 (1 example printed at A3)


Corangamite Catchment Management Authority
Landslide Susceptibility


City of Greater Geelong
Landslide Susceptibility
Legend
GEELONG

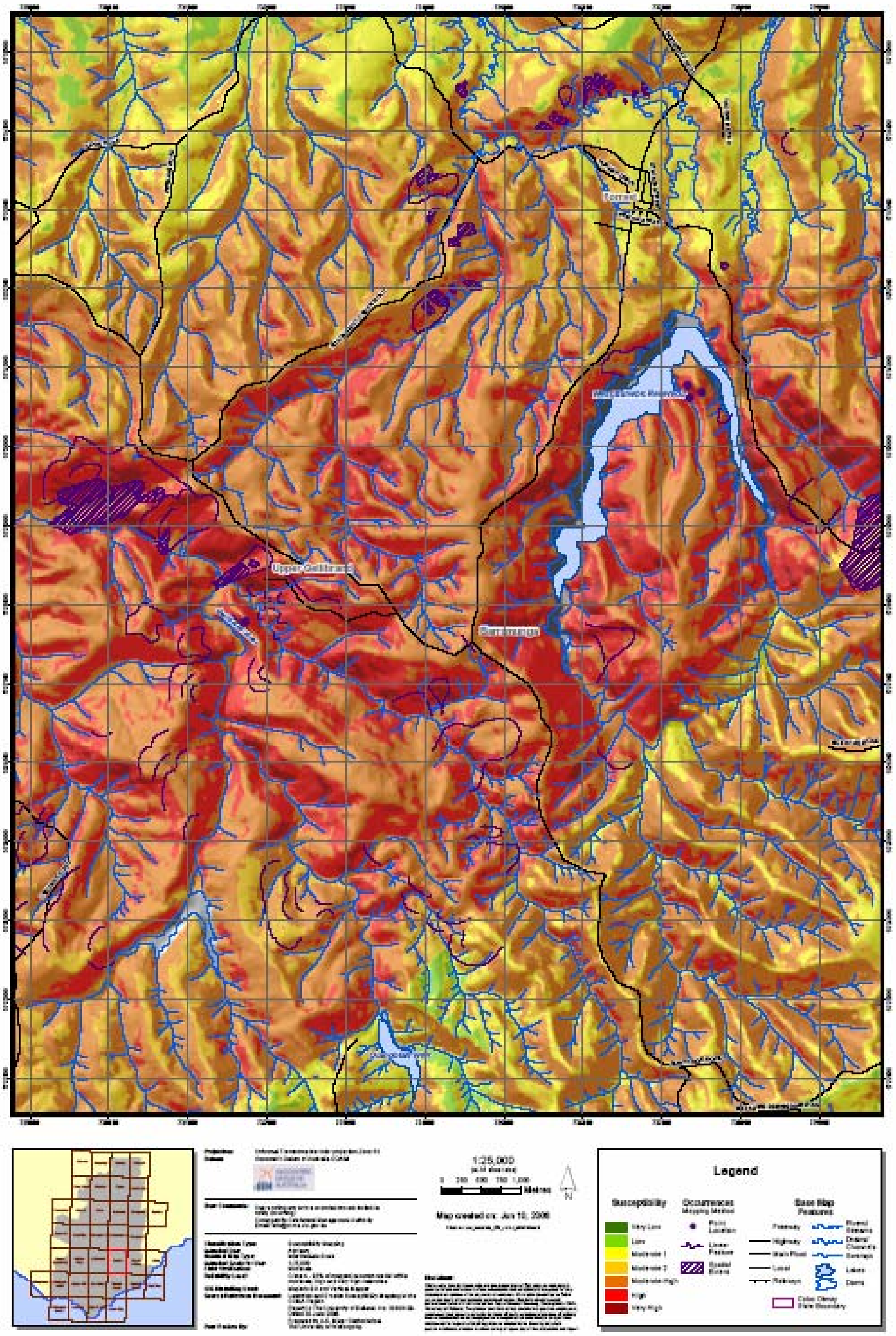

Colac Otway Shire
Landslide Susceptibility
Legend
Susceptibility
Very Low
Low
Moderate 1
Moderate 2
Moderate-High
High
Very High
Base Map Features
Lake Colac

Geelong - Landslide Susceptibility



Colac Otway SHIRE

Forrest - Landslide Susceptibility



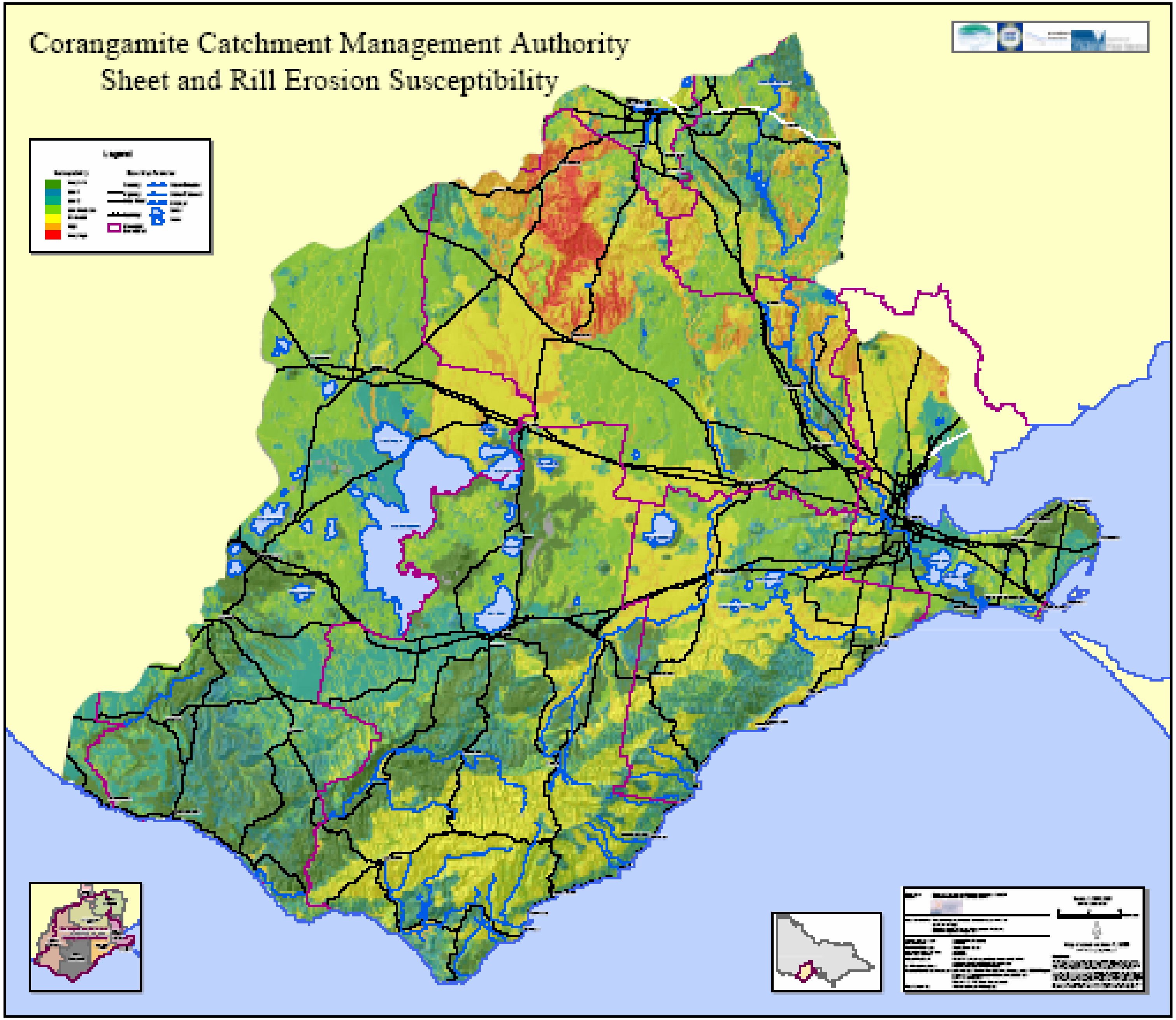
Sheet Erosion Susceptibility Maps

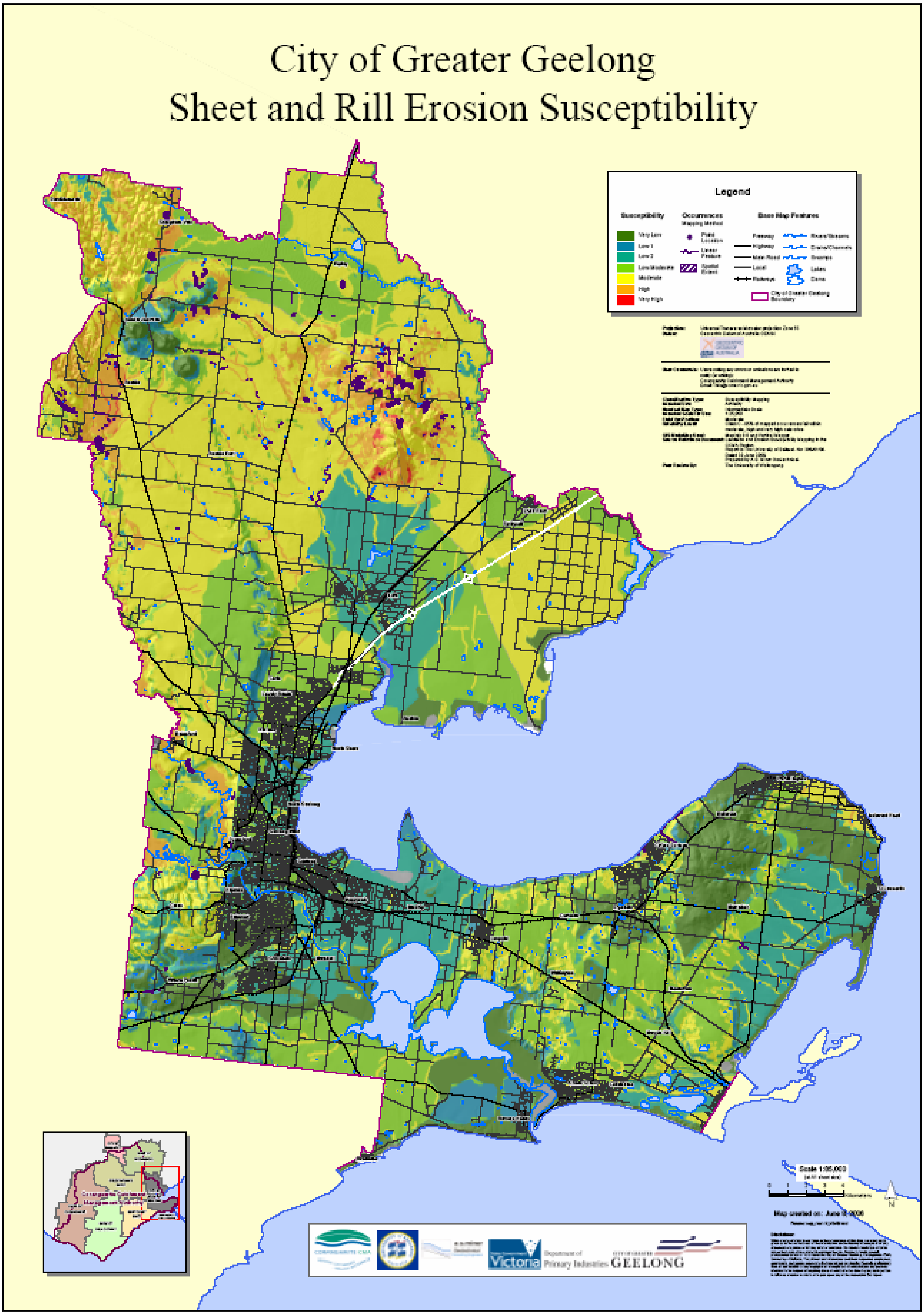
Printed Sheet Erosion Susceptibility Maps

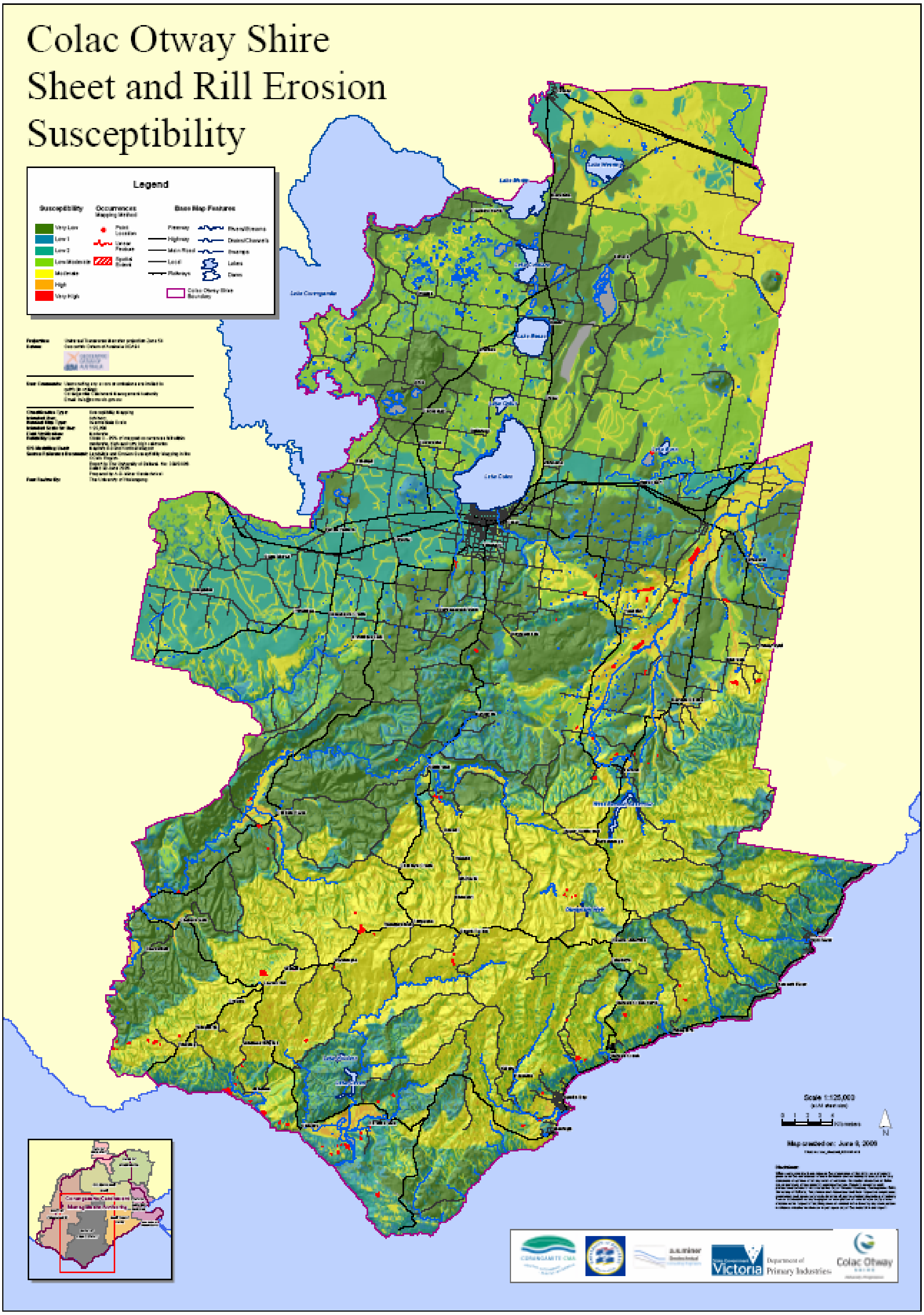
- CCMA Sheet Erosion Susceptibility Map 1:250,000 at A0 (printed at A3)
- CoGG Sheet Erosion Susceptibility Map 1:85,000 at A1 (printed at A3)
- COS Sheet Erosion Susceptibility Map 1:124,000 at A1 (printed at A3)

Additional Maps on the CD as PDF's

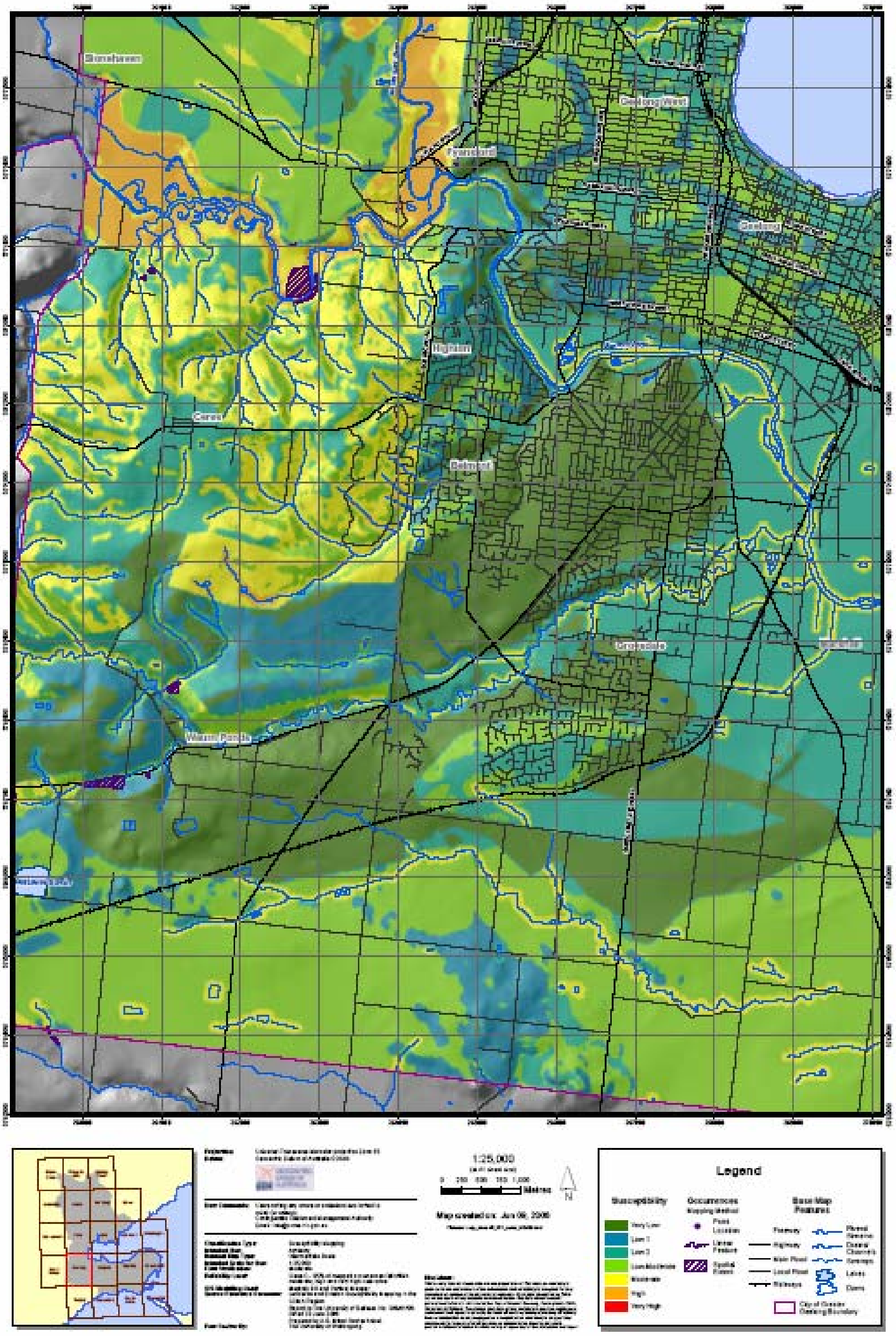
- CoGG 21 x Sheet Erosion Susceptibility Maps 1:25,000 at A1 (1 example printed at A3)
- COS 35 x Sheet Erosion Susceptibility Maps 1:25,000 at A1 (1 example printed at A3)


Corangamite Catchment Management Authority
Sheet and Rill Erosion Susceptibility

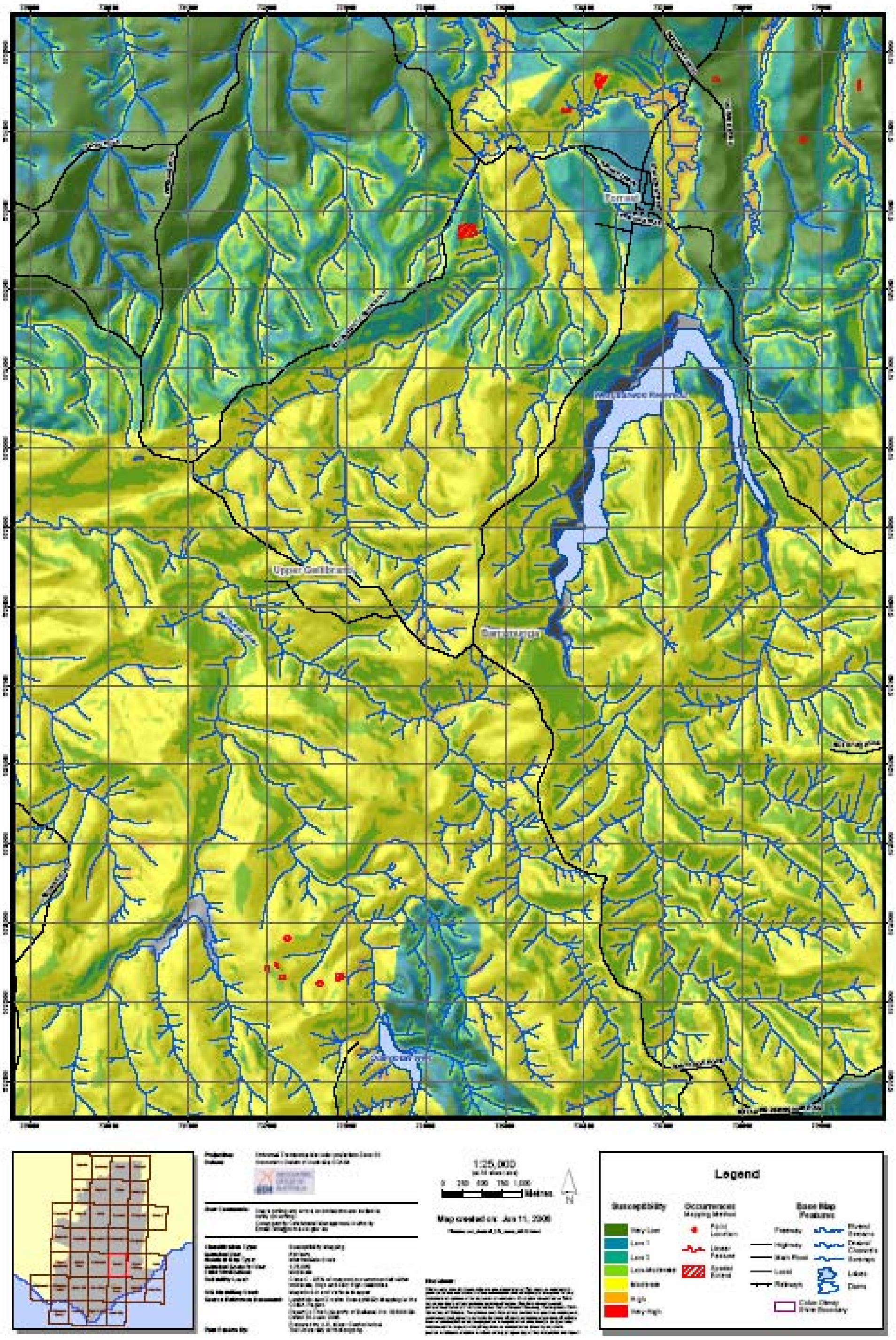

City of Greater Geelong
Sheet and Rill Erosion Susceptibility
Legend
Susceptibility
Occurrences
Mapping Method
Base Map Features
Very Low
Low 1
Low 2
Low-Moderate
Moderate
High
Very High
Point Location
Linear Feature
Spatial Extent
Freeway
Highway
Main Road
Local
Railways
Rivers/Streams
Drains/Channels
Swamps
Lakes
Dams
City of Greater Geelong Boundary
Victoria
Department of Primary Industries
GEELONG


Colac Otway Shire
Sheet and Rill Erosion
Susceptibility
Legend
Susceptibility
Very Low
Low 1
Low 2
Low-Moderate
Moderate
High
Very High
Occurrences Mapping Method
Point Location
Linear Feature
Spatial Extent
Base Map Features
Freeway
Highway
Main Road
Local
Railways
Rivers/Streams
Drains/Channels
Swamps
Lakes
Dams
Colac Otway Shire Boundary
Lake Colac
Scale 1:125,000
Kilometres
N
Colac Otway

Geelong - Sheet and Rill Erosion Susceptibility



Forrest - Sheet and Rill Erosion Susceptibility



Appendix G

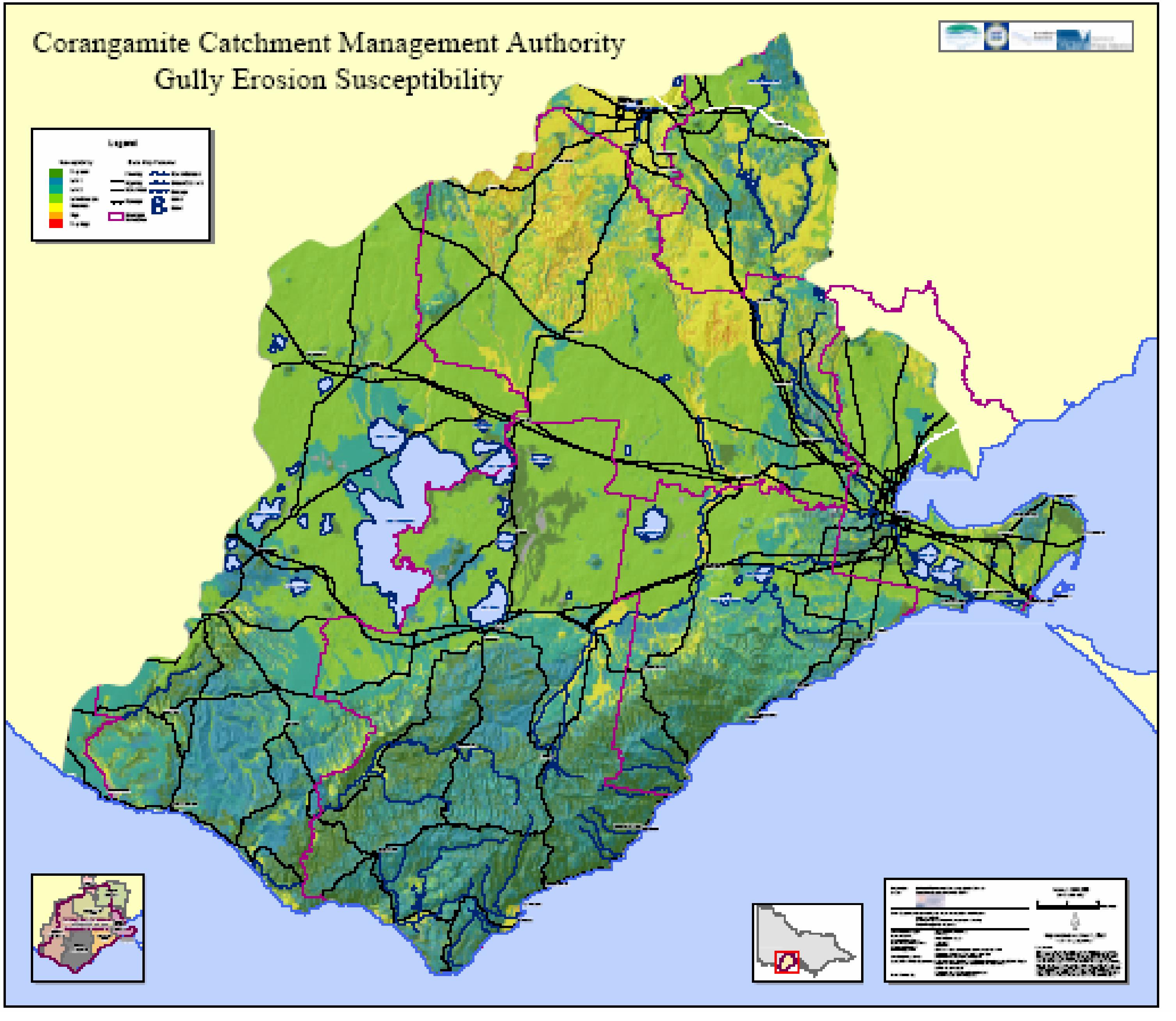
Gully Erosion Susceptibility Maps

Printed Gully Erosion Susceptibility Maps

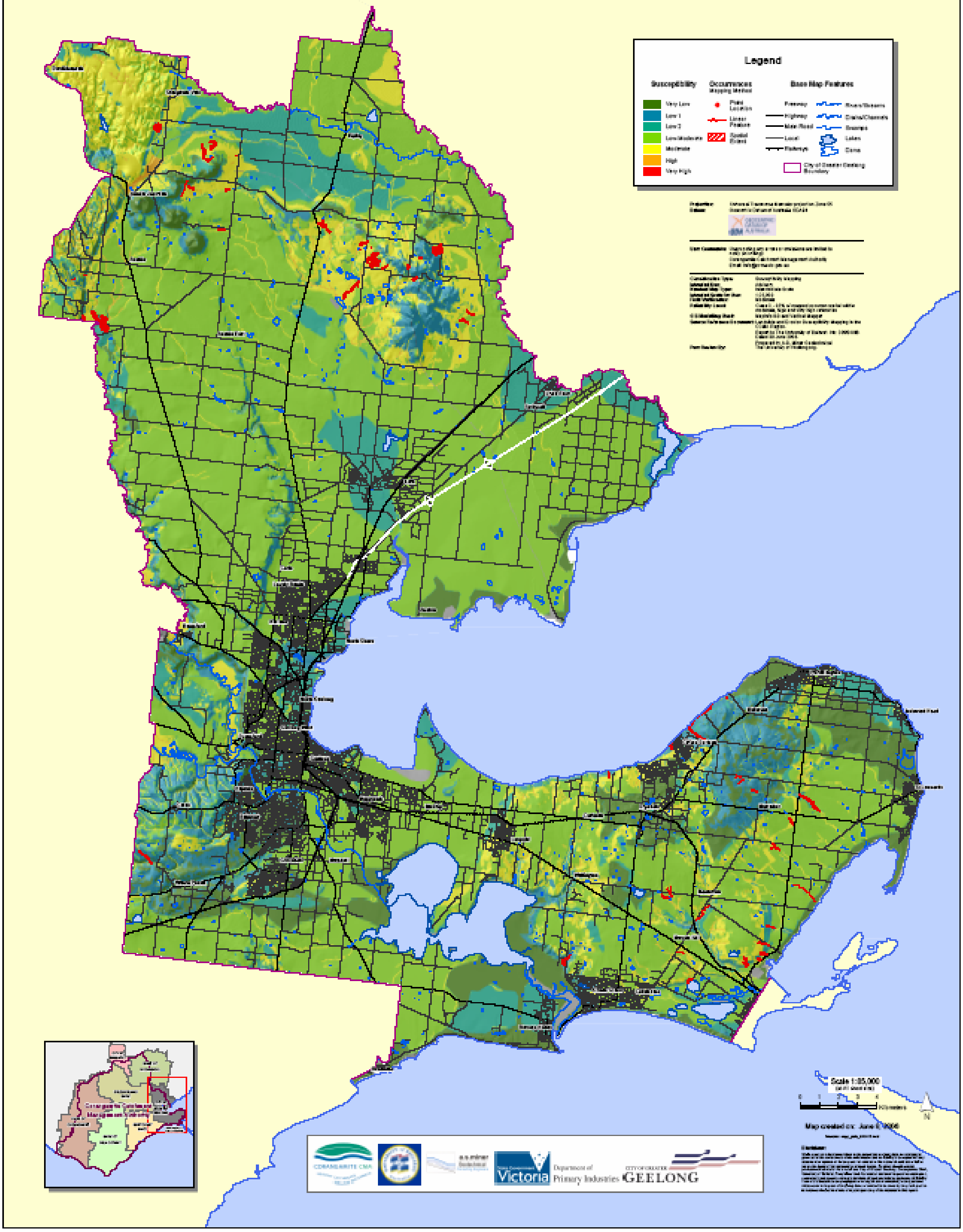
- CCMA Gully Erosion Susceptibility Map 1:250,000 at A0 (printed at A3)
- CoGG Gully Erosion Susceptibility Map 1:85,000 at A1 (printed at A3)
- COS Gully Erosion Susceptibility Map 1:124,000 at A1 (printed at A3)

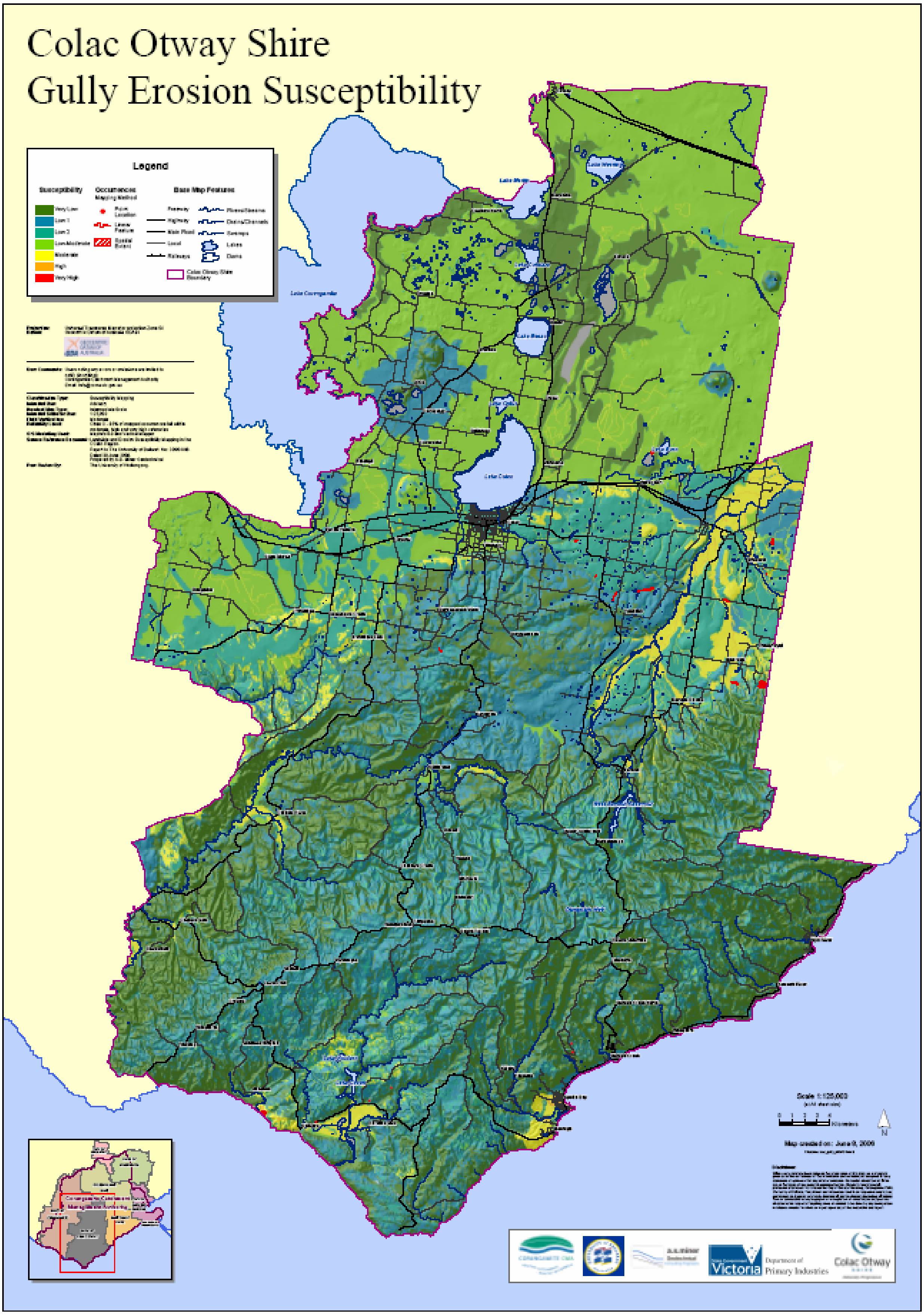
Additional Maps on the CD as PDF's

- CoGG 21 x Gully Erosion Susceptibility Maps 1:25,000 at A1 (1 example printed at A3)
- COS 35 x Gully Erosion Susceptibility Maps 1:25,000 at A1 (1 example printed at A3)

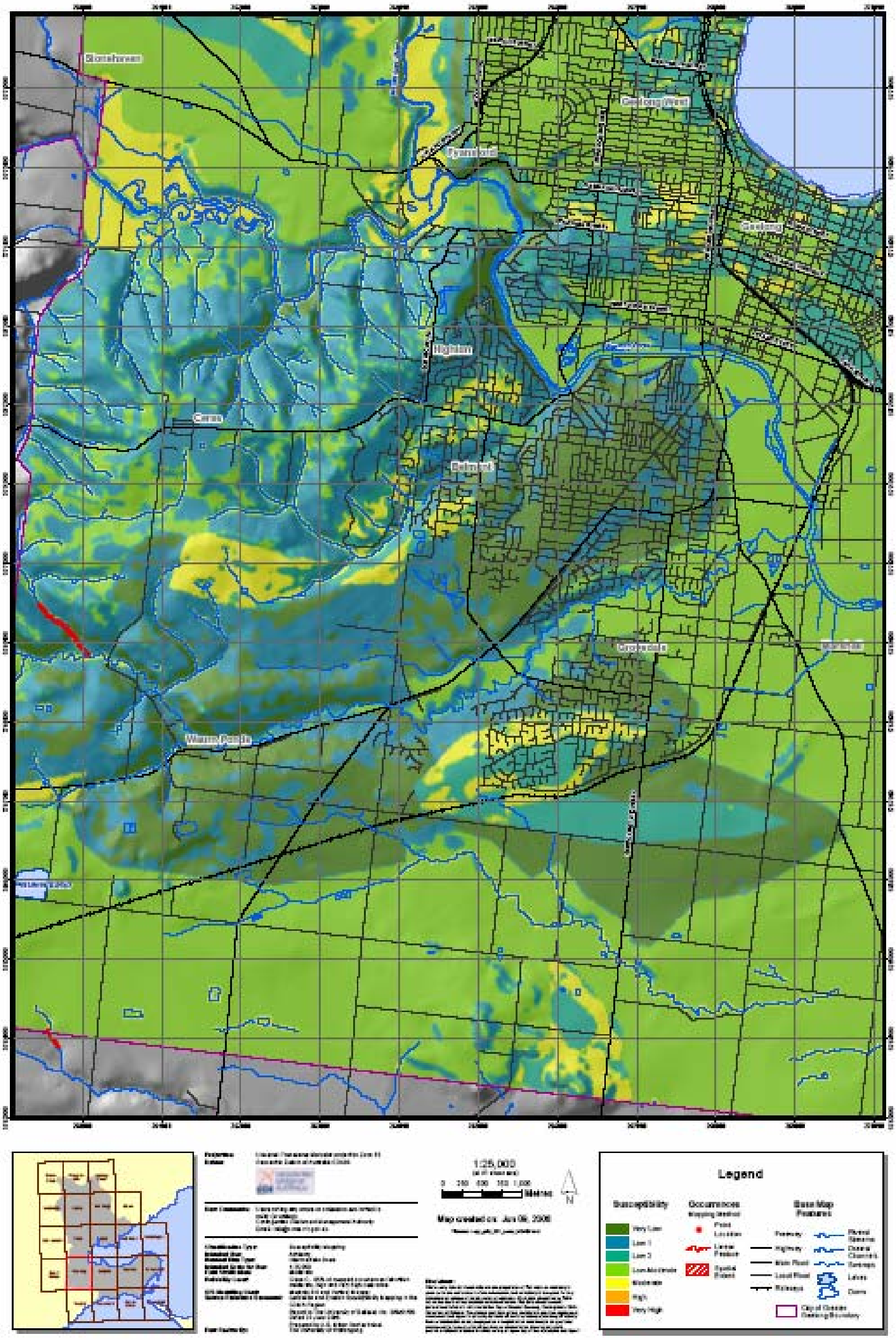

Corangamite Catchment Management Authority
Gully Erosion Susceptibility
Legend

City of Greater Geelong
Gully Erosion Susceptibility

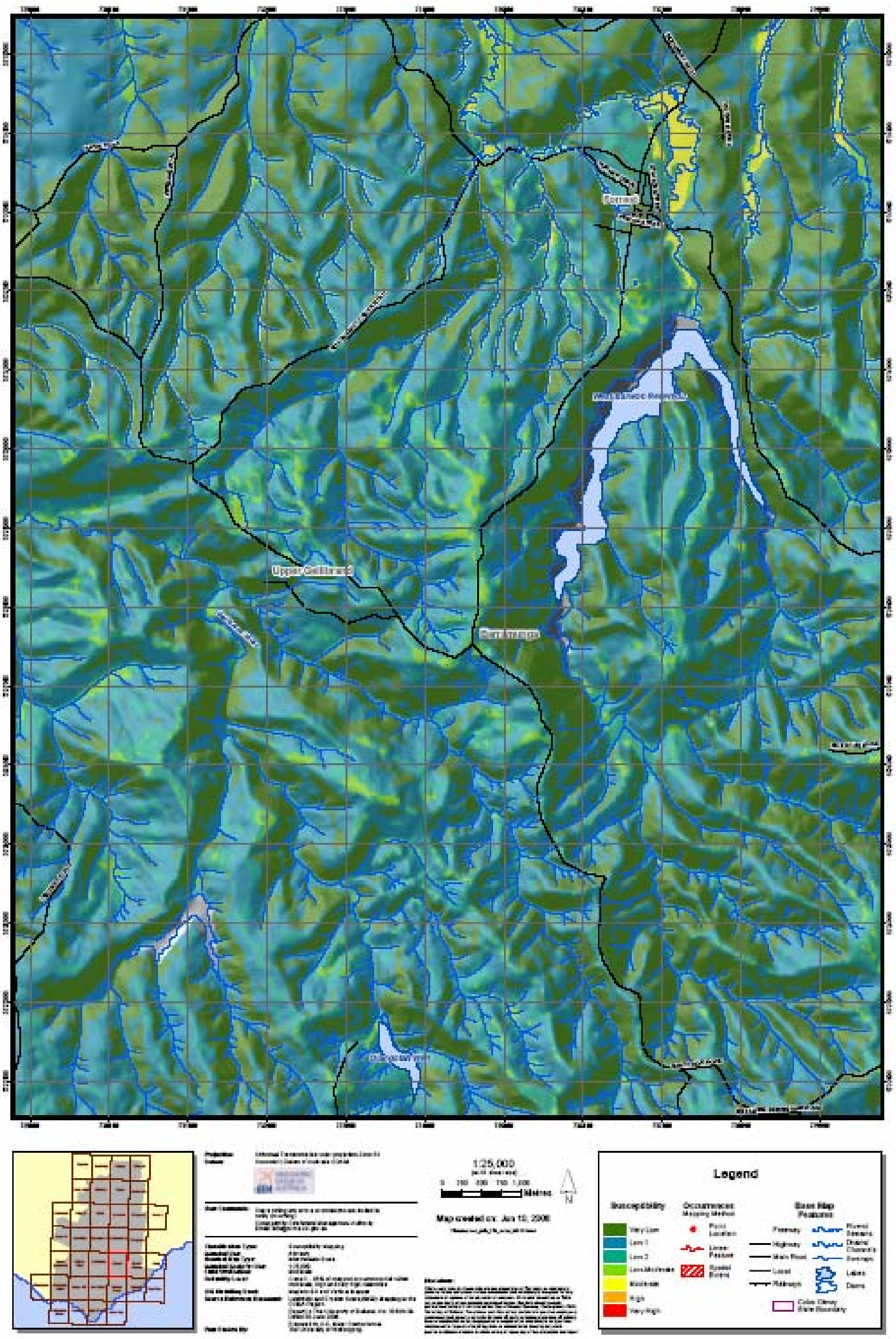



Colac Otway Shire
Gully Erosion Susceptibility
Legend
Susceptibility
Very Low
Low 1
Low 2
Low Moderate
Moderate
High
Very High

Geelong - Gully Erosion Susceptibility



Forrest - Gully Erosion Susceptibility



Appendix H

UoW C5 Trial for Gully Erosion

Data mining Review of the Bellarine region (CCMA) data: towards modeling Erosion Susceptibility.

David Stirling*, Phil Flentje‡

Faculty of Informatics*; Faculty of Engineering‡

University of Wollongong, Wollongong, NSW 2522, Australia

This report covers a brief review of Corangamite Catchment Management Authority (CCMA) data for its suitability and applicability for analysis using data mining. The CCMA project relates to the assessment of erosion and landslide susceptibility. For the purpose of assessing the suitability and applicability of using data mining as a numerical analysis tool, data from the Bellarine Peninsula region near the City of Geelong, a specific sub sectional area within the larger CCMA region, was used. This being a square of some 15 kms along the NS and EW margins, and centered approximately some 20 km and -16° ESE from Geelong in Victoria. This subsection of data comprises 468679 20-meter pixels and relates to erosion potential only. Landslide sites in this region were not supplied.

1. Bellarine Data Cleaning summary

The original file contained 468680 records of ascii data, formatted as comma separated variables of eight fields per record – excluding the three spatial location features X, Y and Z. Table 1 provides a summary of the number of unique values of each attribute.

Table 1. Distributions of all data features formatted as *attribute-value* together with the *count* of instances. These were enumerated from a text processing filter: "gawk -F, -f pass1 bellarine.csv" (468679 records, 8 attributes). These are considered discrete unordered attributes except where "*" indicates a continuous attribute, and "**" indicates the class attribute.

landuse	
0	18530
2	1961
3	287700
4	1882
5	1755
6	254
12	1602
13	37168
14	6296
15	17920
16	4455
17	1029
18	58522
20	2
21	5088
22	193
24	1156
25	892
26	5017
29	144
33	1535
35	3933
36	93
37	1247
40	98
45	236
47	1125
48	31
49	3168
50	284
53	409
55	635
57	1635
60	55
61	808
62	1448
63	206
64	167

geology	
1	849
2	4148
4	73836
5	7398
7	265521
9	43594
11	6096
18	67237
landform_unit	
0	375
77	262699
80	65228
82	43891
83	6362
84	10754
197	68231
199	6661
200	3796
206	682
gmu3	
0	375
3	682
14	82178
15	374690
17	10754
raindays *	
-9999	1826
154	3274
155	9118
156	32601
157	62639
158	64929
159	108379
160	112653
161	68323
162	4937

slope_angle *	
-9999	577
0	43026
1	222467
2	93269
3	48579
4	26780
5	14752
6	8260
7	4771
8	2623
9	1615
10	864
11	450
12	258
13	144
14	80
15	70
16	50
17	28
18	14
19	2
rainfall *	
-9999	1826
564--573	1831
574--583	11001
584--593	18550
594--603	40540
604--613	40902
614--623	75463
614--623	169278
634--643	75923
644--653	23061
654--663	8131
664--668	2173
gully_erosion **	
0	467094
1	1585

As can be seen in Table 1 a number of the categorical features encompass a large number of unordered discrete values, such as **`landuse`** (38), and **`landform_unit`** (here only 10). In fact because this data set represents only a sub region of a greater area, the ranges are some what diminished compared to the population in the parent data. According to the original data specifications, there would be 80 distinct values (0 to 79) for **`landuse`** and 207 (0 to 206) for **`landform_unit`**. Attributes such as this, can pose potential problems for the algorithms processing them, as they can significantly affect the information gain measurements that are use to select and order the delineating features forming the final model. Having a smaller set, or indeed an ordered set of values (reflecting some meaningful precedence) may provide a more reliable and robust model outcome. It is understood, however, that one or both of these were aggregated from several other previous surveys, and that abstraction into a smaller unified set of values was not possible. In contrast the other discrete attributes, ***`geology`*** and ***`gmu3`*** display a more acceptable and consistent (less varied) value profiles.

The continuous features of this data, ***`raindays`***, ***`slope_angle`*** and ***`rainfall`*** are all contaminated by the inclusion of a significant number (1826, 577 and 1826 respectively) of null values "***`-9999`***". Whilst this only represents some 0.1% to 0.4% of the total data, it will have a dramatic effect on the model outcome. Firstly this biased numeric range will affect the inductive inclusion (or not) of any of these features, and secondly, if included the numeric thresholds employed will be erroneous, distorted by the unrelated magnitude of these null artifacts. This arises as a common problem when dealing with spatially framed data sets; attempts to reduce the impact of unknown or missing data by substituting different alternative values only succeeds if the average value for each attribute (column average) is used in each case. For a number of algorithms including C4.5 and C5 this is achieved by substituting question mark symbols (**`?`**) for the arbitrary unknown or null values.

The distribution of the categorical target or class attribute, ***`gully_erosion`*** from Table 1 is further summarized in Table 2. The significant imbalance of cases here will also affect the structure and outcome of any subsequently induced model.

Table 2. Distribution ratio of the target class, ***`gully_erosion`***.

class distribution		class ratio { 0 : 1 }	
0	99.66%	295	1
1	0.34%		

Essentially, for small training data sets as this, such a high proportion of a particular class-value, here being 'no_erosion' (0) will mean that we will require the algorithm to learn from predominantly in this case, negative examples. Despite a finite percentage of positive examples 'erosion' (1) being also present, the algorithm may not be able to generalize enough between these two concepts. If however, any plausible model is induced it will be "brittle" in that any pruning stress it is subjected to, attempting to improve or refine it, may consequently destroy any of the relational associations within it, such that it may ignore the minor class-value entirely – i.e. in this case produce models predicting 'no_erosion' for any spatial context – this was evident in the initial induction result which were also included with the originally supplied data set.

2. Stratified sub-sampling: forming the training set

In order to address the large imbalance of between the classes in the data, a carefully controlled sub sample should be used to replacing instances of the majority class. In doing so, it is important to ensure a stratified sub sample is created. That is, all other attribute distributions in the sub sampled set, apart from the class, bear reasonably similar distribution to the original data. There are several appropriate statistical tools for ensuring such an outcome, however subject to time constraints; a previous developed text filter was adapted and employed to approximate this. Essentially this involved selecting all cases in the data that were of the minor class (*erosion*) and further selecting every *n*[th] case of the majority class (*no_erosion*). Being a simple single pass filter modulo division, was used to select candidate records that were either associated with the minor class, or if not, every nth record in a sequence that are associated with the majority class. In this exercise, n = 200.

As can be seen in the initial and post data distributions of Appendix A, there are no drastic differences between these, for all attributes except that of the class. Here the resultant class ratio (major : minor) has been reduced from 295 : 1 down approximately 1.4 : 1. Using training sets with the class ratios that are low (ideally < 5) provides a higher probability of successfully differentially between the class concepts.

Whilst attempting to balance the class concepts for the training set by reducing the number of majority class values in this fashion, it is also desirable to also ensure an adequate spatial distance exists between them. Here the minority class, erosion, represents known ground truth; however the same cannot be generally said for all of the surrounding alternative data of the majority class – i.e. the same degree of certainty does not apply. Thus to improve the likelihood of differentiating successfully between the classes, a suitable radial buffer layer is employed when selecting the final cohort of majority candidates.

Employing the Easting-Northing coordinate data, one can readily appreciate the sub sampling effect on the spatial dispersion of the majority class as seen in Figure 1.

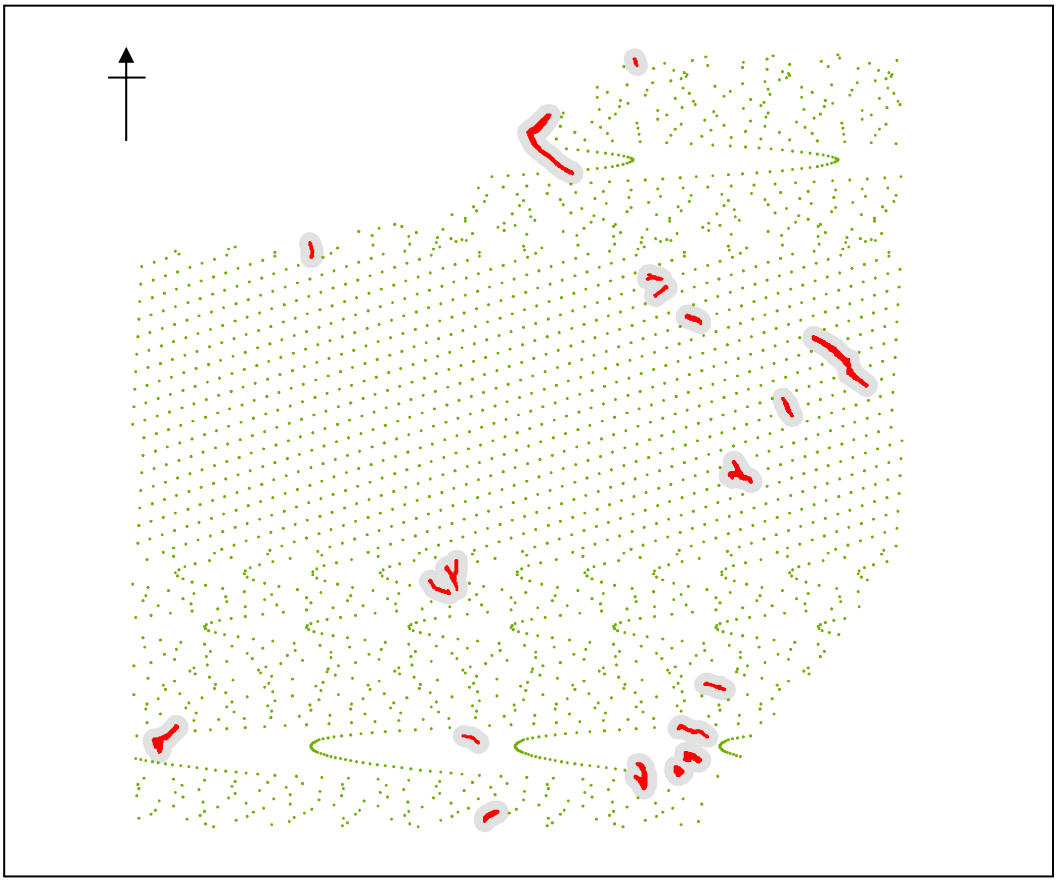


Figure 1. Spatial relationships of final training data set; where colored points represent: green – sub-sampled (ever 200th pixel) majority (no_erosion) cases, red – indicate valid minority (erosion) points, grey – 200 meter buffer exclusion zone.

By re-combining the all of sub sampled negative cases, excluded by the buffer zones, together with all of the original positive cases, a suitable training data set is formed. The final number of majority cases is thus reduced from an original 465,120 down to 2,267 which when combined with the minority (erosion) cases results in a training set of 3,852 records. This essentially equates to down sizing the original full data set by a factor of 121. Appendix A also provides distribution summary details for this sub-sampled training set.

3. Induced models

To further investigate the suitability of the Bellaire data in forming susceptibility models a significant number of different models were induced and evaluated with respect to their sizes and misclassification performances. Utilizing the balanced training set described in Section 2, three sequences of 22 models were induced throughout a range of stopping criterion and data confidence parameter options of the C5 algorithm – these are detailed in Figure 2, were each point represents results from a unique model, or for points on the purple trend line 'xvmc_err', the average of ten (260 models in all). The parameter with the major effect on model size (model pruning) is the minimum cases criterion, *'m'*, this was varied from 600 down to the default of 2 – essentially this limits the size of model that fits the data, also view as a type of pre-pruning. In addition, for all models induced, two levels of data confidence were also employed, $c = 25\%$ (default) and $c = 5\%$. This parameter affects the way that error rates are estimated internally and hence the severity of pruning subsequently applied after the initial model is formed.

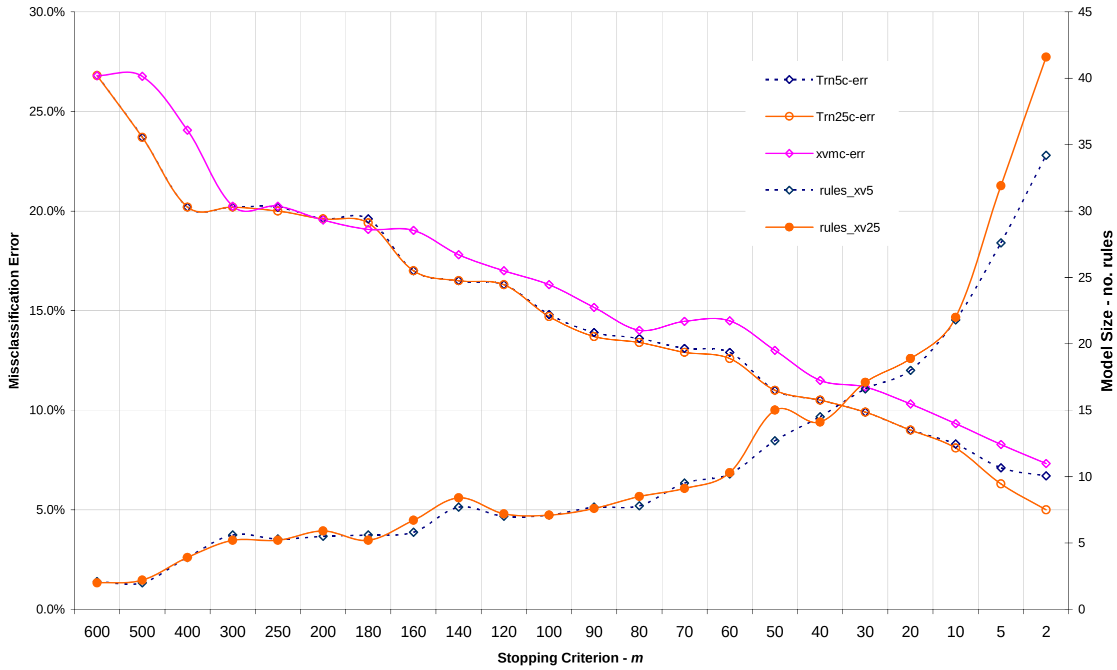


Figure 2. Induction Trials – Bellarine Training Set. The misclassification errors of several rule based models are shown to generally reduce with a decreasing stopping criterion; *m*. The reduction of *m* beyond 180 shows a marked divergence between the training errors and the 10-way cross validation errors.

Also shown in Figure 2 for each 10-way cross validation trial, are the average misclassification error, "xvmc-err", as well as the trend in model size expressed as the average number of rules, "rules_xv5" and "rules_xv25". A number of locations of interest are indicated when the error performances of training and cross validated models are similar – such as for $300 \leq m \leq 180$, $m \cong 80$ or $m \cong 40$. It is understandable that as the pruning constrains are reduced, i.e. the model is allowed to expand and fit additional data, that is complexity rises accordingly through the increasing number of rules.

4. Predictions

After selecting a number candidate models (where m = 200, 40, 2) from the generalized trends of Figure 2, a case data set was prepared derived from the full data set. This is essentially based on the same format as the initial training data, except that the actual class (erosion or otherwise) for each case need not be known or declared in advance. In addition, prior to the generation of any model predictions, the three spatial coordinate features, Easting, Northing and Altitude (X, Y, Z) are partitioned off into a separate vector (csv) file.

RuleQuest , the vendor of See5, also provides various open source code, in this case "See5Sam", that can be modified to read and exercise the classifier models produced. Accordingly this and a number of post-processing filters were used to finally produce a predictive class (erosion or no_erosion) and an associated confidence or certainty factor (CNF ranging from 0 to 1) for all records in the prepared case data file. The derivation of the CNF values are a combined voting process of all rules that apply, or had "fired" in each case. If for a certain case only one rule applied, the CNF would equate to the listed accuracy for the particular rule in question.

Amongst other tasks carried out through the post-processing stage, all confidence factors for majority class (no_erosion) predictions were also converted to lie between 0 to -1. This allows both majority and minority classes to be assessed with respect to their probability on a single numeric continuum – here becoming the susceptibility prediction.

Once the final processing of the raw predictions was complete for a particular model, these were appended to the vector file for GIS visualisation and interpretation. To assist in this a raster hill-shade layer is added underneath the various susceptibility plots in Figures 3 to 5.

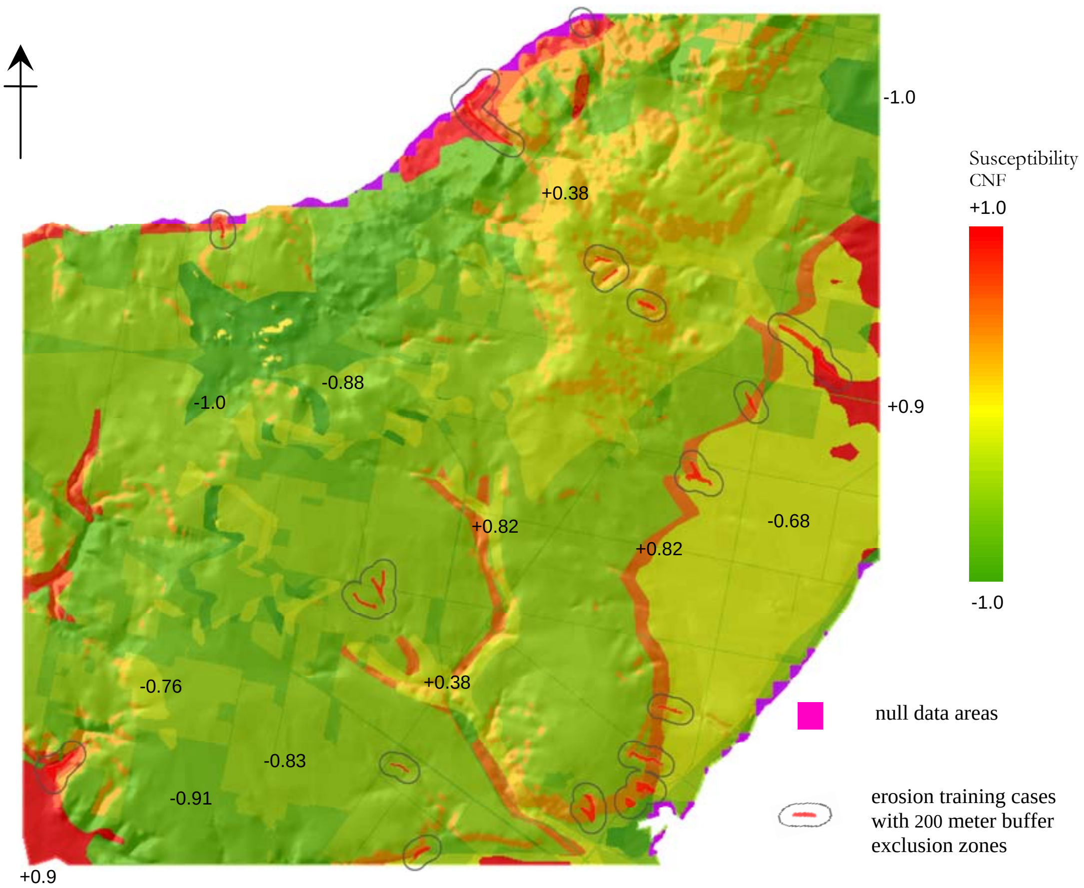


Figure 3. Susceptibility model, c5m200 (9 rules) with several points measured and labeled.

Figure 3 illustrates a conservative end of the prediction spectrum, where the range of susceptibility tessellations are limited in extent and much of which is spatially associated with the pre-existing training areas of known erosion. Of concern are the northern perimeter edges where a significant number of recorded erosion cases are located. This also coincides with areas of missing or null data values, here principally ***slope_angle***, ***rainfall*** as well as ***raindays***. Since there is only a limited extend of the minority class data in this total Bellarine area, it becomes imperative that all ground truth cases are based on complete and verifiable values.

The susceptibility layer of Figure 4 favors the opposite, permissive end of the predictive spectrum. Here a greater extent and percentage of areas are identified as being prone to erosion, the minority class. As the pruning constraints are relaxed from m= 200 (Figure 3) down to m = 2 (Figure 4) the model increases in complexity, that is it becomes less generic and more specific in respect to its predictions.

Whilst a more specific model may provide addition granulation of predictions, it may also tend towards a state of being over trained or over specialized for the data represented in the training set. This is generally signaled by a marked deviation in error performance trends between model training and evaluation. This would mean that its predictions for unseen or new locations may be entirely misleading or biased.

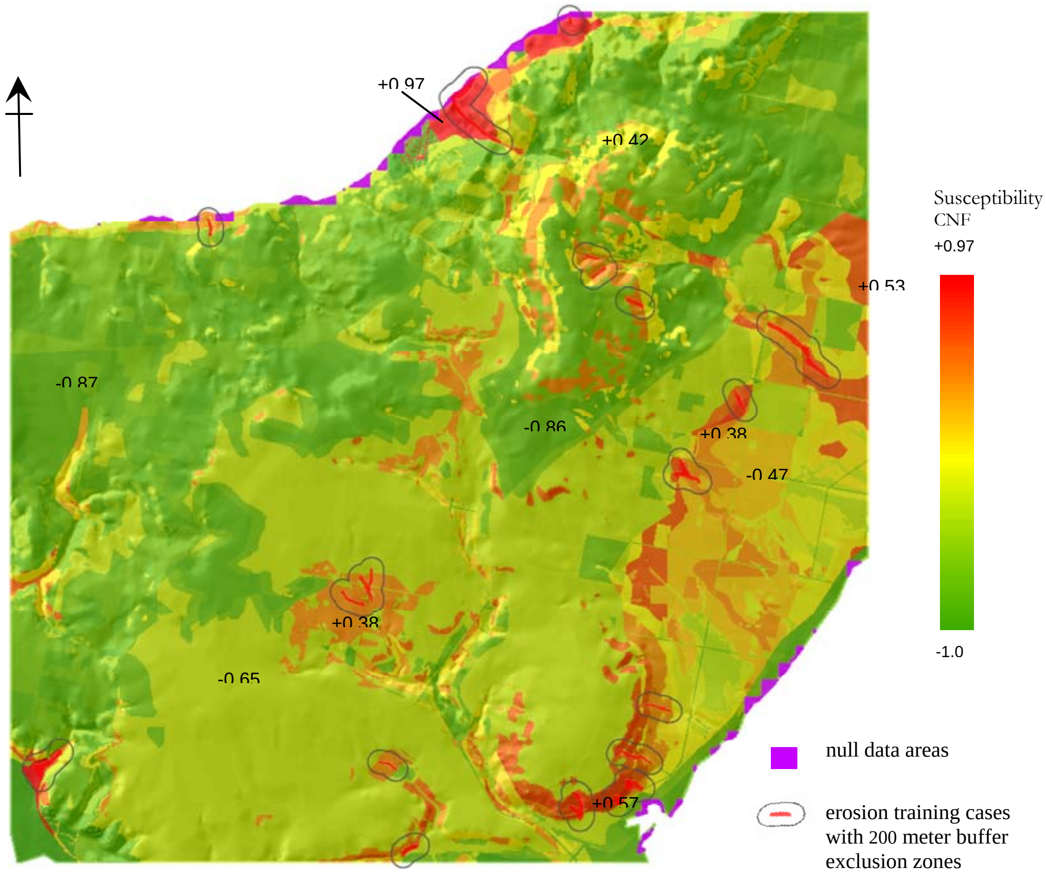


Figure 4. Susceptibility model c5m2 (37 rules) with several points measured and labeled.

Another issue that needs to be considered when deciding on the suitability of a model is its performance in respect to the number of false positive and false negative predictions. In other words, for this application, the level of predicted *no_erosion* cases, that are in fact known to be *erosion* (false negatives), or for the reverse context, false positives. In several other domains were data mining is used, such as medical research, it may be desirable to deliberately bias a model to minimize either of these ‘false’ predictions. Generally judgments by domain experts are required to assess and so guide the resolution for a number of such issues.

6. Susceptibility Maps

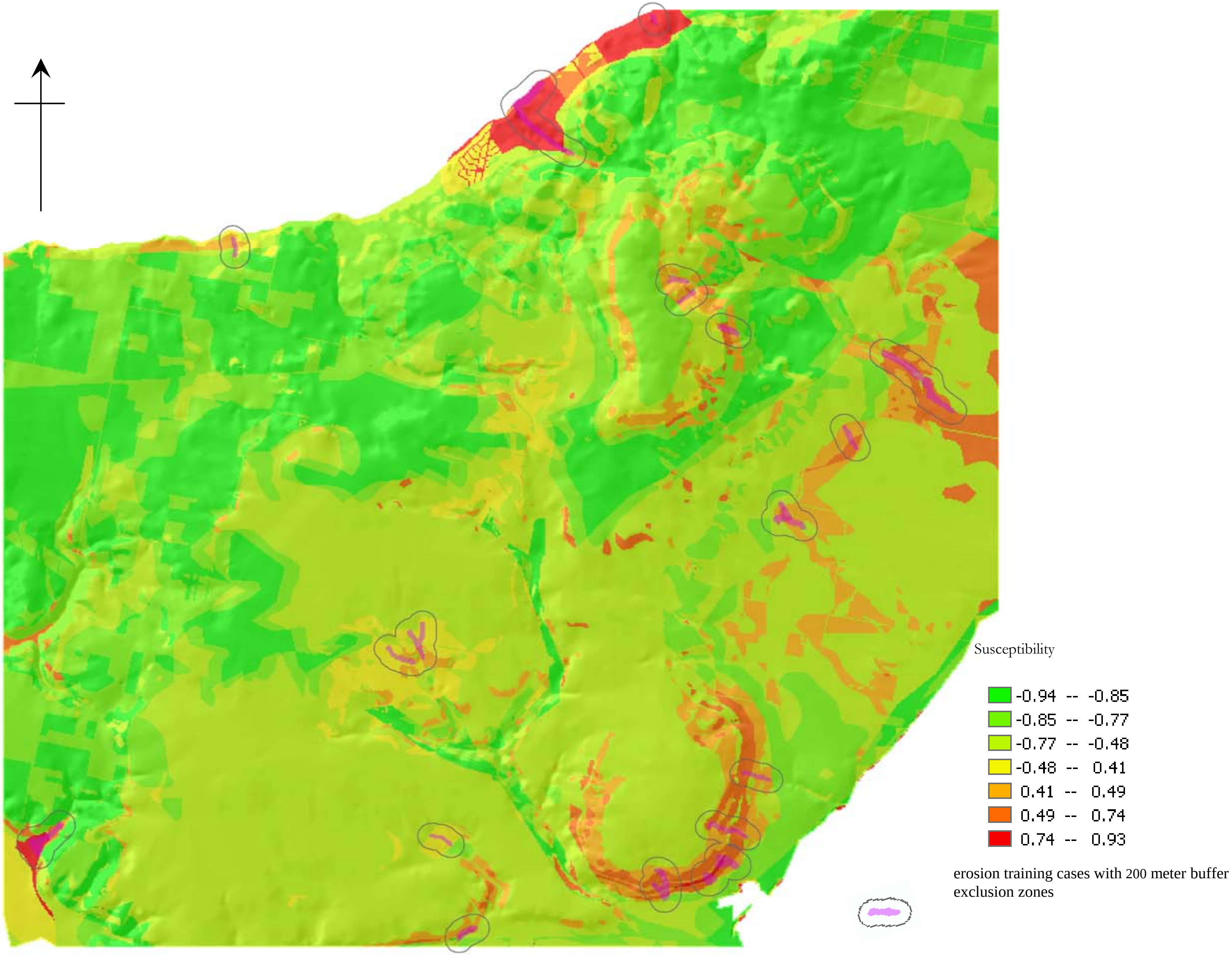
Based on an arbitrary partitioning of the model predictions a series of raster susceptibility map layers were developed as seen in the example of Figures 5 and 6. Using a GIS tool, such as ArcGIS™ the regime of partitions, their colour assignments can be easily and rapidly manipulated.

Conclusion

With some careful data cleaning procedures in place, the multiple hypotheses susceptibly models such as developed in this brief exercise would be entirely applicable, subject the contextual diversity inherent in the data. That is, the robustness of any such models would be predicated on its generalizations of the class concepts across the spectrum of spatial contexts it is likely to encounter– which in turn is constrained by the range of training data employed.

As illustrated in this brief appraisal, a promising spatial differentiation is achieved between */erosion/* and */no_erosion/*, for the Bellarine region. Yet the models providing these localized segmentations may not in themselves be stable enough to predict on other entirely disparate CCMA regions. This would most certainly require model revisions based on a more spatially representative training sets.

Figure 5. Susceptibility map of seven levels.



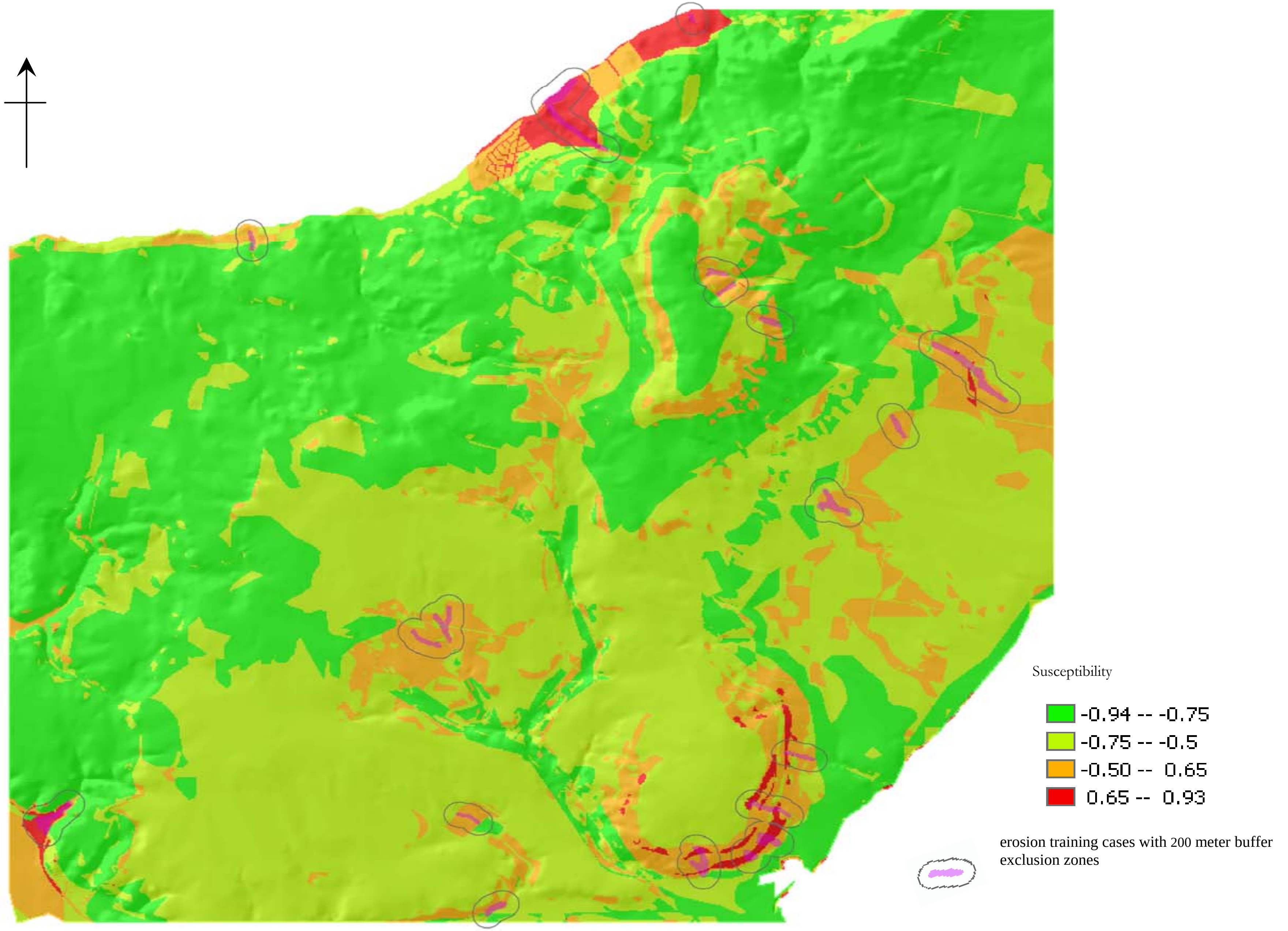
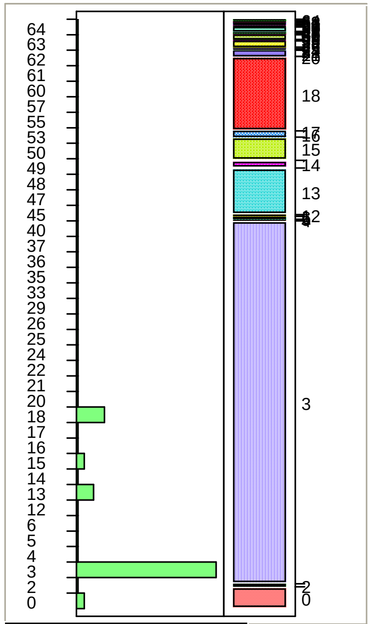


Figure 6. Susceptibility map of four levels.

landuse



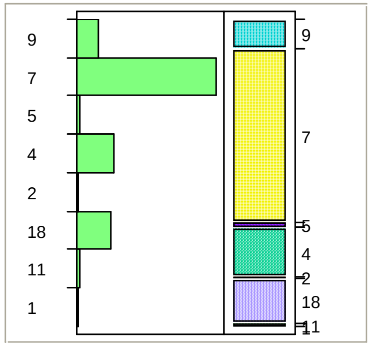
Frequencies

Level	Count	Prob
0	18091	0.03877
2	1936	0.00415
3	287241	0.61554
4	1882	0.00403
5	1638	0.00351
6	254	0.00054
12	1602	0.00343
13	37168	0.07965
14	6121	0.01312
15	17872	0.03830
16	4455	0.00955
17	1029	0.00221
18	58301	0.12494
20	2	0.00000
21	5088	0.01090
22	193	0.00041
24	1156	0.00248
25	656	0.00141
26	4867	0.01043
29	144	0.00031
33	1535	0.00329
35	3933	0.00843
36	93	0.00020
37	1247	0.00267
40	98	0.00021
45	236	0.00051
47	1125	0.00241
48	31	0.00007
49	3168	0.00679
50	284	0.00061
53	409	0.00088
55	635	0.00136
57	1635	0.00350
60	55	0.00012
61	808	0.00173

Level	Count	Prob
	1288	0.00276
	206	0.00044
	167	0.00036
	466649	1.00000

38 Levels

geology

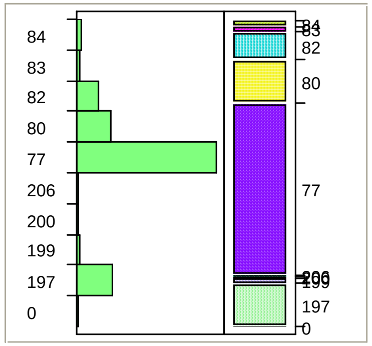


Frequencies

Level	Count	Prob
1	849	0.00182
11	6096	0.01306
18	67237	0.14408
2	3326	0.00713
4	73649	0.15783
5	7398	0.01585
7	265198	0.56830
9	42896	0.09192
Total	466649	1.00000

8 Levels

landform_unit

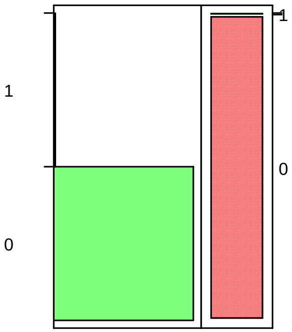


Frequencies

Level	Count	Prob
0	2	0.00000
197	67940	0.14559
199	6028	0.01292
200	3796	0.00813
206	677	0.00145
77	262381	0.56227
80	65175	0.13967
82	43729	0.09371
83	6362	0.01363
84	10559	0.02263
Total	466649	1.00000

10 Levels

gully_erosion

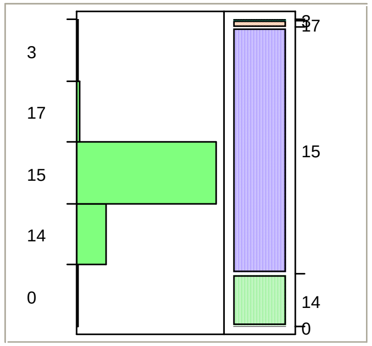


Frequencies

Level	Count	Prob
0	465120	0.99672
1	1529	0.00328
Total	466649	1.00000

2 Levels

gmu3

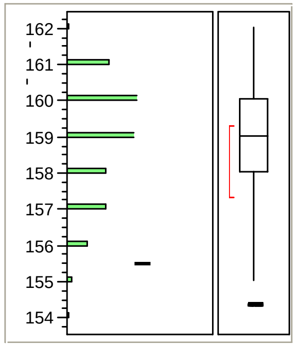


Frequencies

Level	Count	Prob
0	2	0.00000
14	81092	0.17378
15	374319	0.80214
17	10559	0.02263
3	677	0.00145
Total	466649	1.00000

5 Levels

raindays



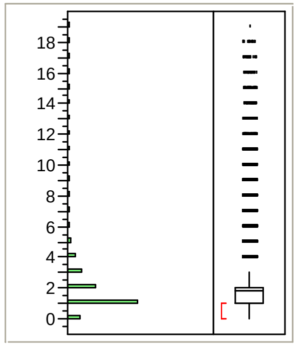
Quantiles

100.0%	maximum	162.00
99.5%		162.00
97.5%		161.00
90.0%		161.00
75.0%	quartile	160.00
50.0%	median	159.00
25.0%	quartile	158.00
10.0%		157.00
2.5%		155.00
0.5%		154.00
0.0%	minimum	154.00

Moments

Mean	158.8368
Std Dev	1.6384
Std Err Mean	0.0024
upper 95% Mean	158.8415
lower 95% Mean	158.8321
N	466649

slope_angle



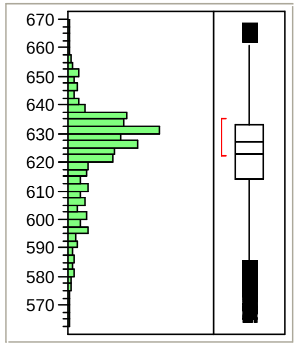
Quantiles

100.0%	maximum	19.000
99.5%		9.000
97.5%		6.000
90.0%		4.000
75.0%	quartile	2.000
50.0%	median	1.000
25.0%	quartile	1.000
10.0%		1.000
2.5%		0.000
0.5%		0.000
0.0%	minimum	0.000

Moments

Mean	1.859706
Std Dev	1.621419
Std Err Mean	0.002374
upper 95% Mean	1.864358
lower 95% Mean	1.855054
N	466649

rainfall



Quantiles

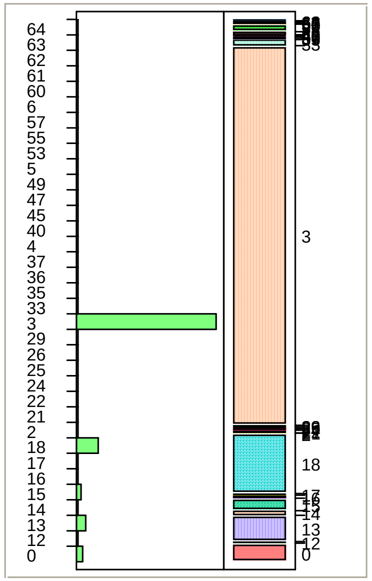
100.0%	maximum	668.00
99.5%		663.00
97.5%		653.00
90.0%		639.00
75.0%	quartile	633.00
50.0%	median	627.00
25.0%	quartile	614.00
10.0%		597.00
2.5%		583.00
0.5%		574.00
0.0%	minimum	564.00

Moments

Mean	622.9183
Std Dev	16.8585
Std Err Mean	0.0247
upper 95% Mean	622.9667
lower 95% Mean	622.8699
N	466649

Appendix A
(full data set)

landuse

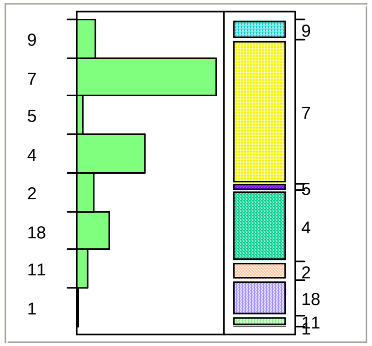


Frequencies

Level	Count	Prob
0	143	0.03712
12	7	0.00182
13	187	0.04855
14	27	0.00701
15	95	0.02466
16	24	0.00623
17	4	0.00104
18	428	0.11111
2	9	0.00234
21	18	0.00467
22	2	0.00052
24	9	0.00234
25	6	0.00156
26	18	0.00467
29	2	0.00052
3	2689	0.69808
33	43	0.01116
35	19	0.00493
36	1	0.00026
37	5	0.00130
4	10	0.00260
40	1	0.00026
45	1	0.00026
47	4	0.00104
49	16	0.00415
5	59	0.01532
53	2	0.00052
55	1	0.00026
57	7	0.00182
6	1	0.00026
60	1	0.00026
61	5	0.00130
62	5	0.00130
63	1	0.00026
64	2	0.00052
Total	3852	1.00000

35 Levels

geology

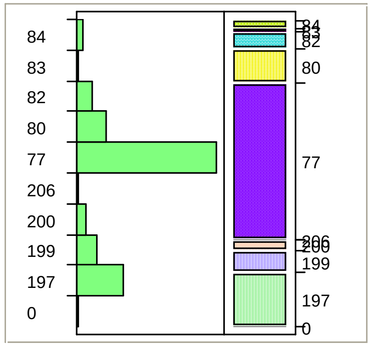


Frequencies

Level	Count	Prob
1	2	0.00052
11	152	0.03946
18	435	0.11293
2	233	0.06049
4	891	0.23131
5	91	0.02362
7	1800	0.46729
9	248	0.06438
Total	3852	1.00000

8 Levels

landform_u

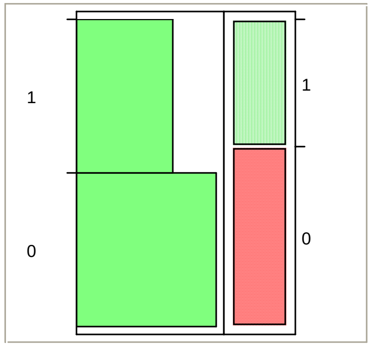


Frequencies

Level	Count	Prob
0	12	0.00312
197	672	0.17445
199	286	0.07425
200	134	0.03479
206	2	0.00052
77	1956	0.50779
80	429	0.11137
82	219	0.05685
83	40	0.01038
84	102	0.02648
Total	3852	1.00000

10 Levels

gully_eros

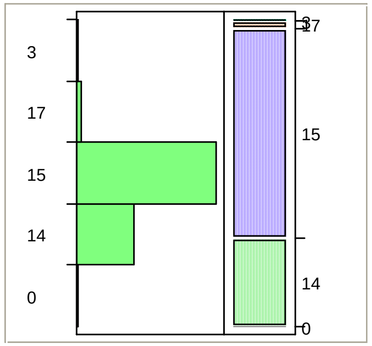


Frequencies

Level	Count	Prob
0	2267	0.58853
1	1585	0.41147
Total	3852	1.00000

2 Levels

gmu3

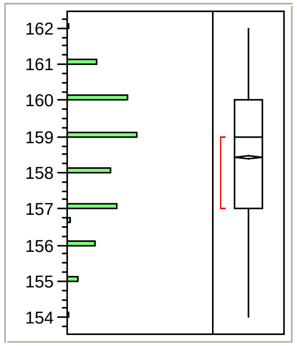


Frequencies

Level	Count	Prob
0	12	0.00312
14	1109	0.28790
15	2627	0.68198
17	102	0.02648
3	2	0.00052
Total	3852	1.00000

5 Levels

raindays



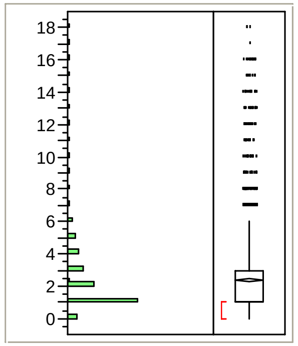
Quantiles

100.0%	maximum	162.00
99.5%		162.00
97.5%		161.00
90.0%		161.00
75.0%	quartile	160.00
50.0%	median	159.00
25.0%	quartile	157.00
10.0%		156.00
2.5%		155.00
0.5%		154.00
0.0%	minimum	154.00

Moments

Mean	158.4399
Std Dev	1.7004
Std Err Mean	0.0274
upper 95% Mean	158.4937
lower 95% Mean	158.3862
N	3852.0000

slope_angl



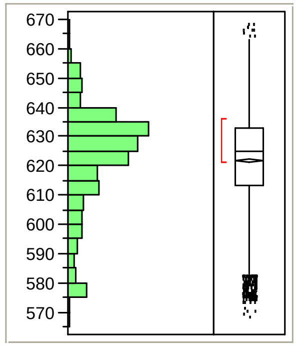
Quantiles

100.0%	maximum	18.000
99.5%		15.000
97.5%		9.000
90.0%		5.000
75.0%	quartile	3.000
50.0%	median	1.000
25.0%	quartile	1.000
10.0%		1.000
2.5%		0.000
0.5%		0.000
0.0%	minimum	0.000

Moments

Mean	2.391394
Std Dev	2.418081
Std Err Mean	0.038961
upper 95% Mean	2.467781
lower 95% Mean	2.315007
N	3852

rainfall



Quantiles

100.0%	maximum	668.00
99.5%		660.74
97.5%		651.00
90.0%		640.00
75.0%	quartile	633.00
50.0%	median	625.00
25.0%	quartile	613.00
10.0%		594.00
2.5%		575.00
0.5%		574.00
0.0%	minimum	568.00

Moments

Mean	621.7660
Std Dev	18.3517
Std Err Mean	0.2957
upper 95% Mean	622.3457
lower 95% Mean	621.1863
N	3852.0000

Appendix A
(training data se

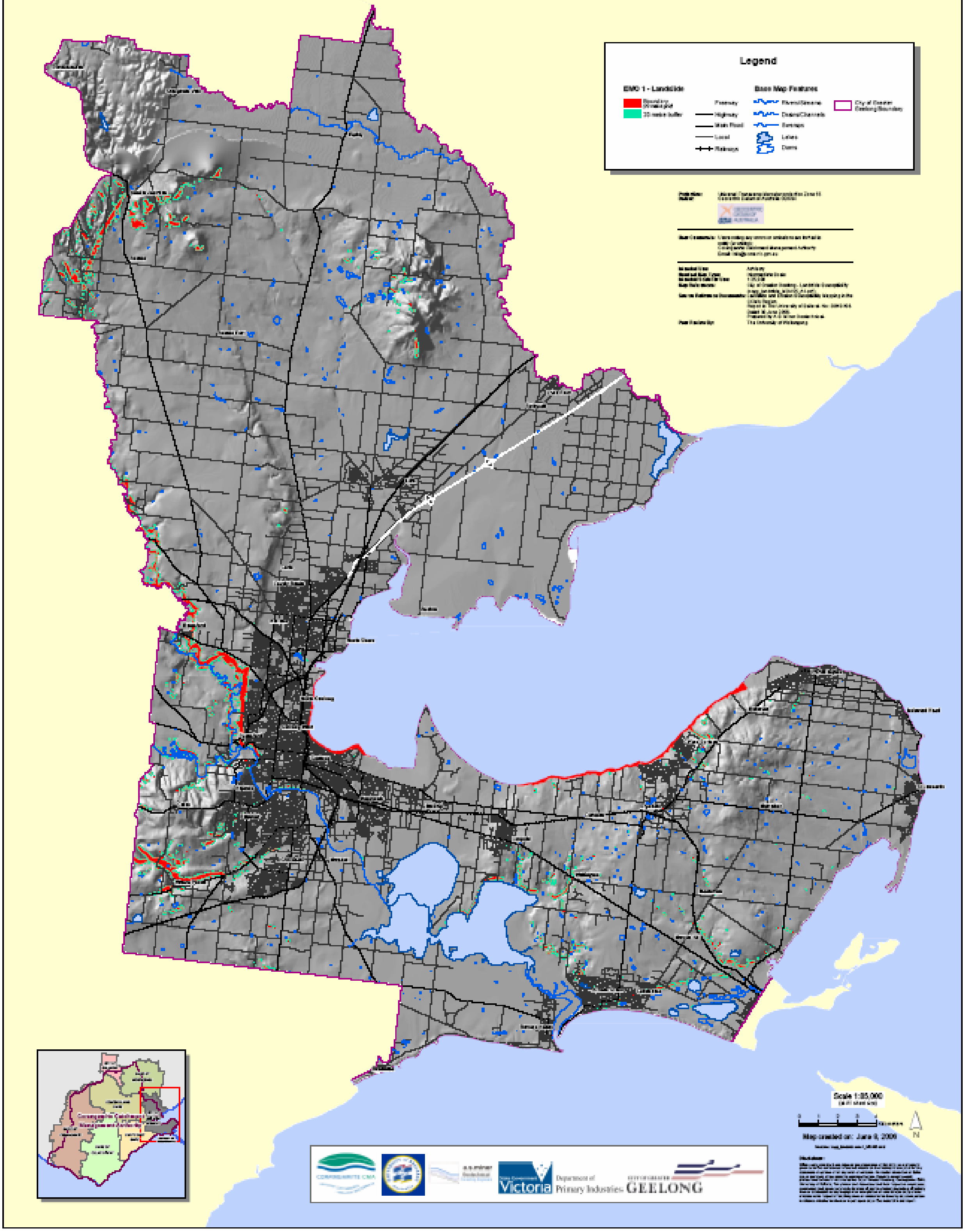
Appendix I

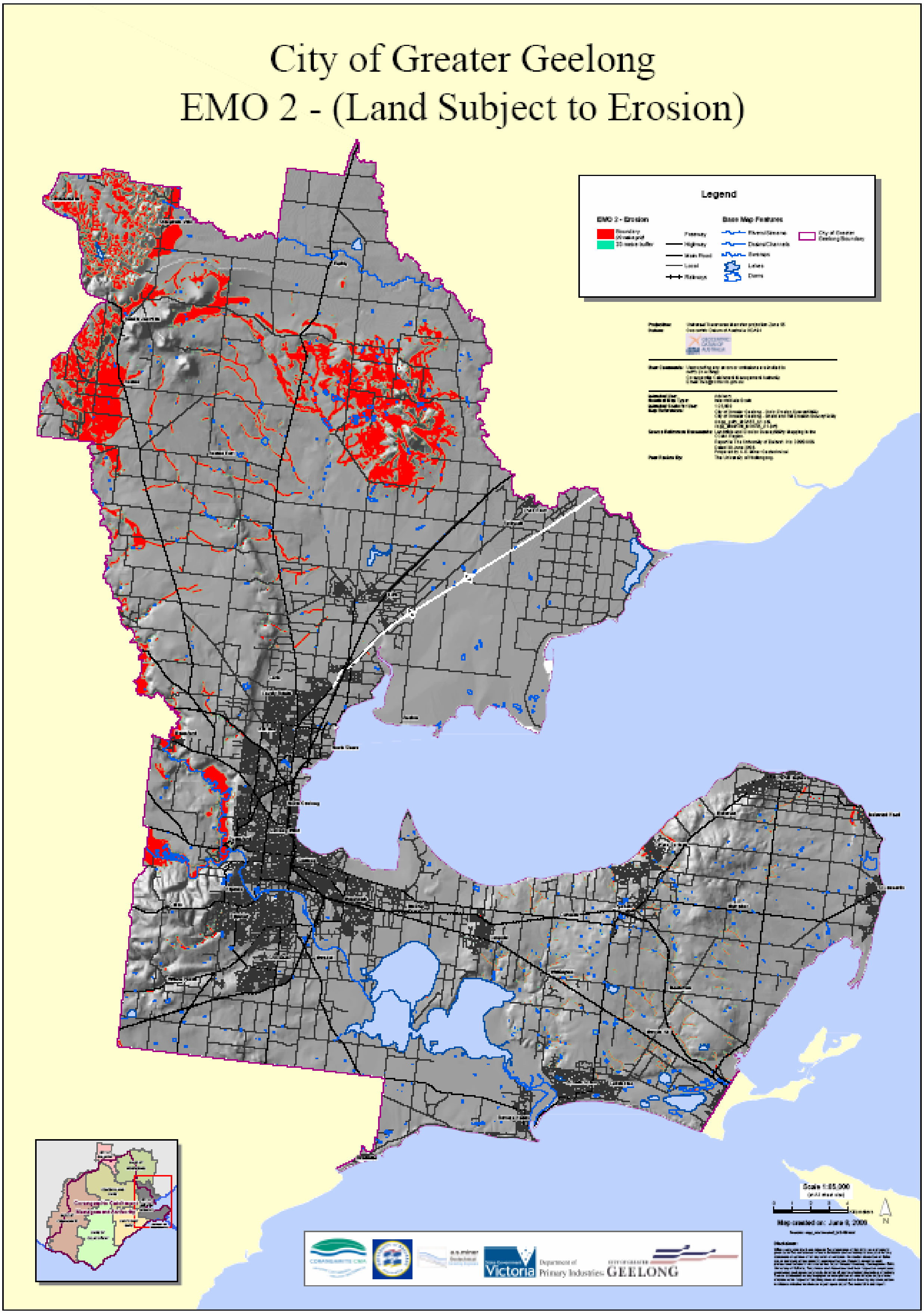
Potential EMO’s for CoGG and COS based on Susceptibility Maps

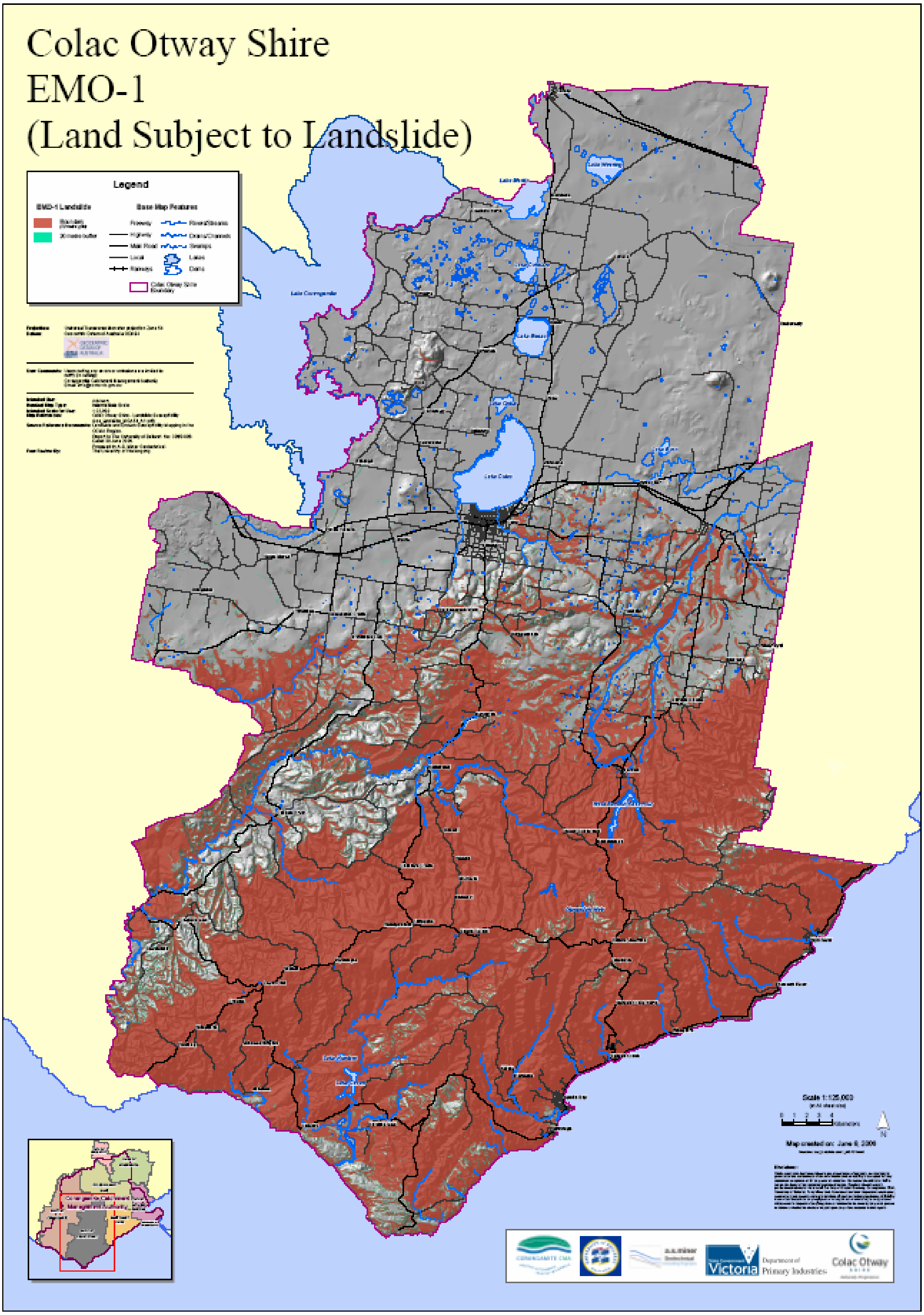
Potential EMO Maps

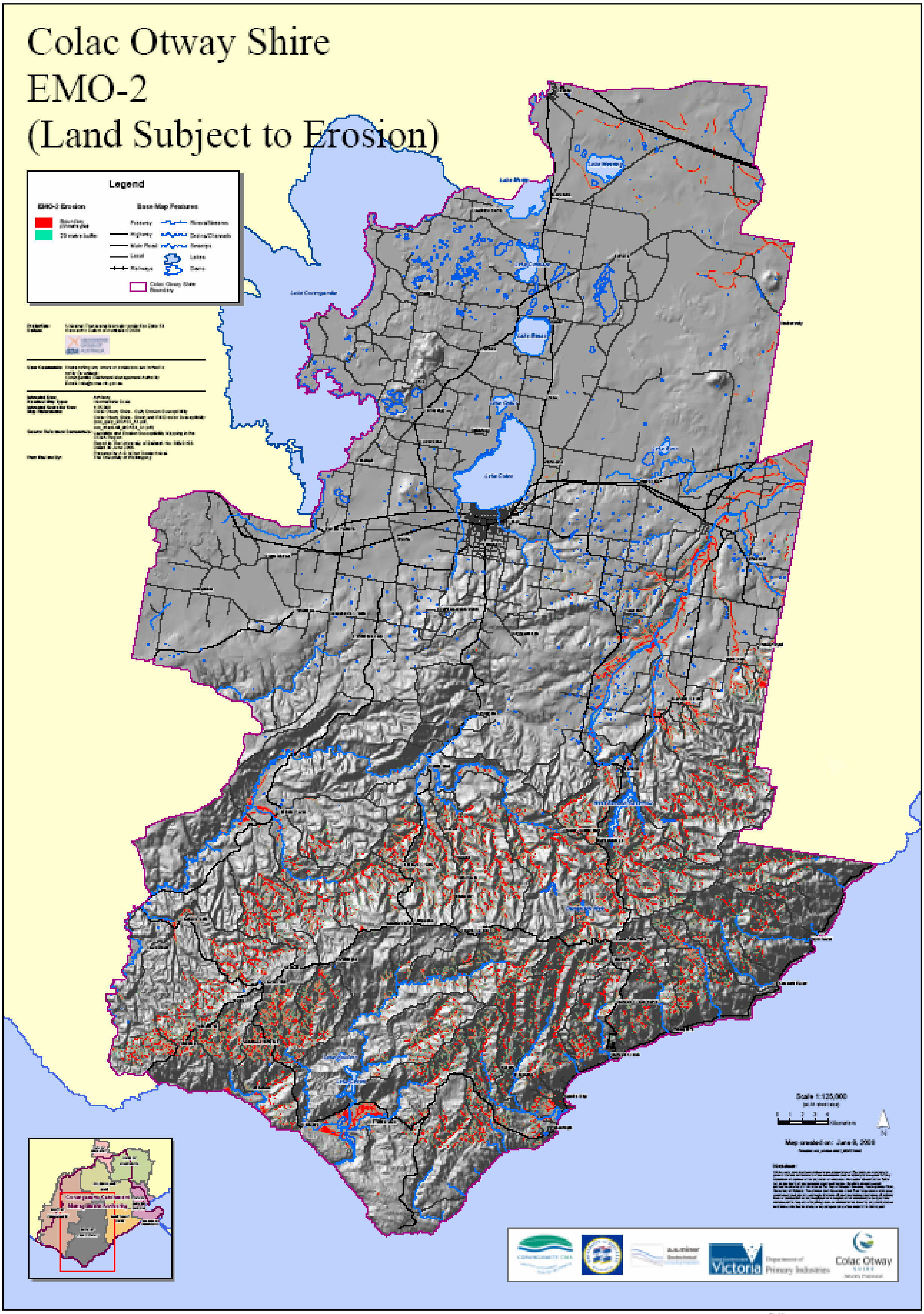
- CoGG EMO1 (lands subject to landslides) 1:85,000 at A1 (printed at A3)
- CoGG EMO2 (lands subject to erosion) 1:85,000 at A1 (printed at A3)
- COS EMO1 (lands subject to landslides) 1:125,000 at A1 (printed at A3)
- COS EMO2 (lands subject to erosion) 1:125,000 at A1 (printed at A3)

City of Greater Geelong
EMO 1 - (Land Subject to Landslide)




City of Greater Geelong
EMO 2 - (Land Subject to Erosion)
Legend
EMO 2 - Erosion
Base Map Features
Highway
Map created on: June 8, 2006
Department of Primary Industries
GEELONG


Colac Otway Shire
EMO-1
(Land Subject to Landslide)
Legend


Colac Otway Shire
EMO-2
(Land Subject to Erosion)
Legend

Appendix J

CD with Maps in PDF Format.